The Iambic/Trochaic Law revisited[*]
Lengthening and shortening in trochaic systems

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Hayes (1995) claims that there is a durational asymmetry between iambic and trochaic feet grounded in an extra-linguistic principle of rhythmic grouping known as the *Iambic/Trochaic Law*. A theory that endorses the Iambic/Trochaic Law predicts lengthening of stressed syllables and shortening of unstressed syllables to take place in iambic feet only. This paper presents evidence that both segmental processes are attested in trochaic systems as well. An alternative to the Iambic/Trochaic Law is proposed that makes use of positional augmentation and prominence reduction constraints. The cross-linguistic bias towards uneven iambs is attributed to foot final lengthening.

1. Introduction: The Iambic/Trochaic Law

Hayes (1985, 1995) has demonstrated that there is a durational asymmetry between iambic and trochaic feet. Trochaic feet, (* .), exhibit no durational contrasts; the head and the tail both have even duration. Iambic feet, (. *), on the other hand, are inherently asymmetrical because the head appears to be durationally enhanced compared to the tail. Hayes claims that the asymmetry in the foot inventory is grounded in an *extra-linguistic* principle of rhythmic grouping known as the *Iambic/Trochaic Law* (Hayes 1995:80):

(1) *The Iambic/Trochaic Law*
a. Elements contrasting in intensity naturally form groupings with initial prominence.
b. Elements contrasting in duration naturally form groupings with final prominence.

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In this paper, following Revithiadou & van de Vijver (1997) and van de Vijver (1998), it is claimed that the Iambic/Trochaic Law (henceforth ITL) does not make the right empirical predictions with respect to stress-related segmental processes (i.e. lengthening and shortening) in trochaic systems and, therefore, should be dispensed with. The evidence presented here comes to complement Kager's (1993) claim that quantitative asymmetries between iambic and trochaic systems can be accounted for without reference to the ITL. Before presenting the argumentation, it is necessary to have a closer look at the ITL and its typological effects on metrical structure in general and foot inventories in particular.

Perception experiments (Woodrow 1951; Fraisse 1974, and more recently Rice 1992) suggested that in the case of intensity contrasts, subjects preferred groupings with the most prominent element first (i.e. trochaic). In the case of durational contrasts, however, the preferred grouping was with the most prominent element last (i.e. iambic).[1] Hayes gives a principled formulation of the findings of these experiments in terms of the ITL in (1). More precisely, he maintains that the ITL is a rhythmic principle that exerts influence on the typology of metrical templates and, by extension, on the internal formal principles of the linguistic system (Hayes 1995:81).[2] According to the ITL, trochaic systems are expected to have durationally *even* feet whereas iambic systems are expected to have durationally *uneven* feet. This results in the asymmetric foot inventory in (2), taken from Hayes (1987).

(2) *asymmetric foot inventory*

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a. syllabic trochee   (* .)
                      σ σ
b. moraic trochee     (* .)   or   (*)
                      |  |         |\
                      μ μ          μμ
c. iamb               (. *)        (. *)
                      |  |\        |  |
                      μ μμ         μ μ
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To achieve the *canonical* uneven iambic shape, the second syllable in an even iamb may be augmented either by vowel *lengthening* or by gemination of the following consonant. Durational contrasts in iambic feet can also be achieved when the first (weak) syllable of the foot undergoes vowel *reduction*. Consequently, a number of segmental changes are expected to take place every

[1] Rice (1992:198) showed, however, that variations in pitch also lead to a significant shift towards iambic groupings, a result that does not lend support to the ITL.

[2] McCarthy and Prince (1986) and Prince (1990) reformulate the ITL as a linguistic principle that governs the quantitative balance inside feet of different headedness. This principle gives rise to a wellformedness hierarchy of iambic and trochaic feet. For instance, an uneven trochaic foot is allowed but is considered to be non-optimal compared to an even trochee.

time the ITL is violated. In general, Hayes holds the ITL to be responsible for the widespread occurrence of *iambic lengthening* in iambic languages.

Moreover, the ITL is claimed to be implicitly associated with segmental effects in trochaic languages as well. First, Hayes (1995) claims vowel reduction to be functionally motivated only in moraic trochee languages and only when an uneven trochee, (μ́μ μ), would arise. In this case, *trochaic shortening* takes place to repair the ill-formed foot structure. More importantly, vowel shortening, expressed either as reduction or deletion is claimed to be a general phonological or even phonetic characteristic of quantity sensitive (iambic and trochaic) systems and hence absent in syllabic trochee systems.

Second, Hayes maintains that lengthening in trochaic systems is typically phonetic in character[3] and limited to the main stressed syllable only (e.g. Icelandic, Wargamay). Therefore, it can be seen as a direct manifestation of stress and not as an optimization of foot structure. Furthermore, there is a threshold, around 1.5-2.0,[4] for the duration ratio needed to induce iambic grouping whereas lower degrees of lengthening are typical for trochaic languages. It is worth pointing out, however, that trochaic languages with comparable or even longer durational contrasts have also been reported.[5]

In this paper, I show that the ITL makes the wrong predictions with respect to trochaic systems. More specifically, I argue that, first, durational contrasts between the head and the tail of a foot are common in trochaic systems, even those that lack quantitative distinctions. Second, I claim that durational contrasts in trochaic systems are not phonetic nor limited to the stressed syllable only. These facts, coupled with the findings of Revithiadou & van de Vijver (1997) and van de Vijver (1998), lead us to reject the ITL as an organizing principle of metrical structure. This outcome is further enhanced by Kager's (1993) non ITL-based explanation of the quantitative asymmetries between iambic and trochaic feet. Kager shows that the motivation for the inherent asymmetry in foot typology relies on theory internal principles related first, to rhythm, i.e. avoidance of clash and lapse within the foot domain and, second, to the syllable-internal sonority-dependent moraic prominence.

In the spirit of Revithiadou & van de Vijver (1997), I propose that the segmental effects of the ITL arise in languages as the result of two independently established phonological principles: the *Stress and Length Principle* (van de Vijver 1998) and the *Domain Final Lengthening Principle* (based on Klatt 1975; Nakatani & Aston 1981; Guasti & Nespor 1999, among others). To explain, the former principle requires long (i.e. heavy, sonorous) peaks to be stressed. The latter principle requires elements standing at the right

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[3] Polgárdi (1995), however, shows that iambic lengthening in Hixkaryana is also phonetic.

[4] Revithiadou & Van de Vijver (1997) correctly raise the question how this ratio is to be calculated and, more importantly, be interpreted phonologically in cases of vowel reduction in iambic feet (e.g. Eastern Ojibwa).

[5] See Revithiadou & Van de Vijver (1997) for Greek in which stressed vowels are reported to be on average 1.4 times longer than their unstressed counterparts, and Goedemans (1997) for Mathimathi in which primary and secondary stressed vowels are reported to be on average 2.7 times and 1.5 times, respectively, longer than unstressed ones.

edge of prosodic domains such as intonational phrases (i-phrase), phonological phrases (p-phrase) and, of course, feet, to be long. The fact that durational contrasts are more pervasive in iambic systems is directly related to the combined effects of stress-based and domain final-based lengthening which together assign extra length to the stressed element in rightheaded feet. On the contrary, in leftheaded (trochaic) systems the effects of these principles are counterbalanced since each operates on different parts of the foot.

The paper proceeds as follows: Section 2 presents cases of lengthening in trochaic quantity sensitive (§2.1) and quantity insensitive (§2.2) systems. Section 3 discusses shortening in trochaic quantity sensitive (§3.1) and quantity insensitive (§3.2) systems. Section 4 presents an alternative proposal to the ITL, which accounts for lengthening and shortening in terms of positional augmentation constraints and prominence reduction constraints (§4.1). Section 5 concludes this paper.

2. Lengthening in trochaic languages
2.1. Trochaic languages with quantitative distinctions

Ancient Greek is a pitch accent system which phonemically distinguishes between long and short vowels. Footing for accent assignment is quantity insensitive and trochaic: a leftheaded foot is built at the right edge of the word, e.g. *lipa(rọ́isin)* 'fat-DAT.PL' Homer, β4. The head of the foot is assigned a high accent unless it is word final, in which case a low accent occurs, e.g. *kalòs* 'good'. Final syllables are often extrametrical. The quantity sensitivity of the system, however, is evidenced in poetic meter. Homeric epic songs are written in dactylic exameter, a metrical unit composed of two trochaic feet / –́ ◡́◡/.[6] Often when an accented light syllable appears in a place where a long one is expected, its short vowel is lengthened by gemination of the following consonant. For instance, in the examples in (3), the dactylic exameter is disturbed by the final short vowels of the words *hyp<u>ó</u>* 'under' and *kat<u>á</u>* 'under'. The illegitimate occurrence of a light syllable in a metrical position where a heavy one is expected is repaired by geminating the consonant of the following syllable even if it belongs to another word. Thus, /hy.pó/ and /ka.tá/ become /hy.pól/ and /ka.tár/, respectively.

(3) *dactylic exameter: lengthening of a short vowel by gemination*

        – ◡ ◡ – ◡◡ –
a. possí d hyp<u>**òl**</u> liparóisin … 'under his fat feet' Homer, β4

          – ◡ ◡ – ◡ ◡
b. ... ei te kat<u>**àr**</u> rhóon... '(as) if (sailing) downstream' Homer, ξ254

[6] The symbol '–' stands for a heavy (CVC and CVV) syllable and the symbol '◡' stands for a light syllable.

Ancient Greek evidences that trochaic lengthening by consonant gemination is attested in trochaic systems as well. This is further supported by lengthening in Swedish (Riad 1992) discussed in the ensuing paragraph.

Swedish provides an example of phonologically conditioned lengthening in a trochaic system (Riad 1992:270). At some stage at the history of the Scandinavian languages main stress shifted to the first syllable. At a later stage the first syllable lengthened. Both CVC syllables and the first syllables of CV.CV words lengthened under stress. Final consonant extrametricality in CVC words could account for lengthening in this type of words in terms of word minimality considerations. For CV.CV words, however, the only viable explanation would be to say that the first syllable lengthened under stress and that this was later grammaticalized in the language. The examples in (4) illustrate this point.

(4) *lengthening in Swedish*

	Old Swedish	Modern Swedish	
a.	nidh	need	‘down’
	kul	kool	‘coal’
	skip	skeep ~ skepp	‘ship’
	brut	broot ~ brott	‘break, crime’
b.	ta.la	taa.la	‘to speak’
	vi.ka	vee.ka ~ vek.ka	‘week’
	mu.si	moo.se ~ mos.se	‘moss’
	sku.ta	skoo.ta ~ skot.ta	‘to shovel’

The above case studies demonstrate that phonological lengthening is not a segmental process specific to iambic rhythm. This is quite unexpected given the ITL, which predicts lengthening only in iambic systems. Lengthening as a phonetic effect of stress is found in many trochaic systems (e.g. Dutch, German, Greek, and so on). In Swedish, however, lengthening has influenced the grammar of the language and resulted in a wellformedness condition which requires words to begin with a heavy syllable. In Ancient Greek, lengthening by gemination was a basic condition in poetic rhythm enforced as a repair strategy for impermissible occurrences of accented light syllables.

Additional evidence for length-related contrasts in trochaic feet is also provided by moraic trochee systems in which long consonants are licensed only under stress. This is the case of Western Neo-Aramaic (WNA), which consists of the dialects Ma‘luula, Bax‘a and Ğubb‘adiin (Jastrow 1997). Word stress in this language is on the penultimate syllable, unless the final syllable has a long vowel or ends in two or more consonants; in this case, stress is on the ultimate syllable.

(5) *stress in WNA* (Jastrow 1997:336)

a.	zappé:n	‘sell-IMP.2SG.MASC’[7]
b.	yifθúħ^{ə}l[8]	‘he opens for me’
c.	tarbó:	‘way, path-PL’
d.	fḳí:rtsa	‘the old one-FEM.SG’
e.	tárbun	‘way, path-3POSS.MASC.PL’

As is evident from the above examples, a moraic trochee is built at the right edge of the word: *zap(pé:)<n>*. Because final consonants are extrametrical, word final CVC syllables fail to be parsed into a foot. In this case, the preceding closed syllable is parsed into a moraic trochee: *(tár)bu<n>*.

As mentioned earlier, long vowels surface only under stress and, consequently, there can be only one long vowel per word. This is not the result of lengthening under stress because long and short vowels can contrast both in open and closed syllables, e.g. Ma‘luula *ḥɔ́:tsma* ‘judge’ vs. *ḥɔ́tsma* ‘judgment’, Bax‘a *í:ða* ‘hand’ vs. *íða* ‘when’. Long vowel shortening applies only in non foot-head positions. This is further verified by the examples in (6):

(6) *long vowel reduction in unstressed position*

	stressed		unstressed	
a.	(ḥú:)ya	‘snake’	ḥu(yó:)	‘snake-PL’
b.	sa(fi:)riʃ	‘travel-2SG.FEM.PAST’	safi(rín)naḥ	‘travel-1PL.PAST’
c.	sa(fi:)ra	‘travel-PERF.FEM’		

It is worth pointing out that this process is clearly distinguished from trochaic shortening which applies to foot-heads in order to establish quantitative equality between the syllables of an uneven moraic trochee: [µ́µ µ] → [µ µ]. This is a different type of trochaic shortening that also aims at establishing foot wellformedness by balancing the weight between the head and the tail of an unstressed foot. The long vowel of the syllable /fi:/ in *(safi:)(rín)na<ḥ>*, for instance, shortens because, due to exhaustive footing, it is forced to be parsed as a foot-tail; as a consequence, the form surfaces as [safirínnaḥ]. To conclude, length contrasts in a moraic trochee system such as WNA arise only under stress. Given the ITL, this is unexpected.

In the next section, I present some interesting cases of lengthening in quantitative insensitive languages. Lengthening in syllabic trochee systems is also excluded by the ITL as a theoretical possibility as well as an empirical fact. As Hayes states (1995:84) ‘… it would serve no rhythmic function at all, since syllables are treated as equal.’

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[7] The following abbreviations are used in this paper: ACC (accusative), AUGM (augmentative), DAT (dative), DIM (diminutive), FEM (feminine), FUT (future), GEN (genitive), MASC (masculine), NOM (nominative), PERF (perfective), POSS (possessive), PL (plural), PRES (present), SG (singular).

[8] Groups of two or more consonants may be interrupted by a non-phonemic epenthetic ultra-short vowel /^{ə}/.

2.2. Lengthening in quantity insensitive trochaic systems

Chimalapa Zoque (Knudson 1975; Hayes 1995; McGarrity 2003) is a Mixe-Zoque language spoken in Mexico. McGarrity (2003) claims that the language is bi-directional: primary stress is assigned at the right edge, while secondary stress is assigned at the left edge. The examples in (8) illustrate that feet are trochaic. Hayes (1995:104) analyzes Chimalapa Zoque as a syllabic trochee system. The example in (8a), however, suggests that CVC syllables count as heavy and attract stress. Interestingly, a general process lengthens all stressed vowels in open syllables no matter whether they bear primary or secondary stress. Vowel length is not contrastive in the language, therefore all long vowels are derived by this rule.

(7) *Chimalapa Zoque* (McCarrity 2003:107)

a.	mɨ̀nkéʔtpa	'he is coming again'
b.	mɨ̀nsukkéʔtpa	'they are coming again'
c.	mɨ̀nsukkeʔtpaʔítti	'they were going to come again'
d.	hóːho	'palm tree'
e.	hùːkúːti	'fire'

To account for the pattern of stressed vowel lengthening in Chimalapa Zoque, it is necessary to appeal to a general principle that demands stressed syllables be heavy, (CVV, CVC), regardless of foot structure. Trochaic lengthening cannot be ascribed to a principle that governs foot wellformedness such as the ITL because uneven trochees score worse than even ones.

An analogous process of lengthening under stress is reported to apply in Earlier and Later Egyptian and in Sahidic Coptic.[9] In Earlier Egyptian (Loprieno 1995), long vowels appear only in open stressed syllables, as shown in (8a). Short vowels, on the other hand, appear in closed syllables and in open unstressed ones, as illustrated by the examples in (9a). The same holds for Coptic as well (Reintges 2004). Interestingly, in Coptic the vowels /ɛ, ɔ, o, u/ are licensed only under stress whereas the vowels /e, a/ occur both in stressed and unstressed positions. That is, the range of unstressed vowels is confined to the set /i, e, a, ə/. The Earlier Egyptian examples are taken from Loprieno (1995) (abbreviated to L) whereas the Coptic examples are drawn from Reintges (2004) (abbreviated to R).

(8) *stressed syllables in Earlier Egyptian and Coptic*

a. Earlier Egyptian

ráː.mac	'man' L36
sVt.páː.ku	'I chose' L36
wap.wúː.tij	'messenger' L37

[9] Earlier Egyptian is the language of the 'Old Kingdom' (2800-2150 BC) whereas Later Egyptian is the language of the 'New Kingdom' (1550-1000 BC). Sahidic Coptic reflects the upper Egyptian variety of the language and is documented from the fourth century CE.

b. Sahidic Coptic

úː.tah	'fruit' R29
sɔ́ː.təm	'to hear' R29
ɟáː.baʔ	'to seal' L44

(9) *unstressed syllables in Earlier Egyptian and Coptic*

a. Earlier Egyptian

jaf.dáw	'four' L37
wa.báχ	'to become white' L37
χu.pír.waw	'transformations' L37

b. Sahidic Coptic

ʃáf.te	'enemy' R34
a.máh.te	'to prevail' R34
ɟár.jaw	'he is strong' L49

In these systems, stress is usually on the penultimate syllable. This is exemplified by the following words from Sahidic Coptic: *ke.lén.keh* 'elbow', *úː.tah* 'nine', *af.ráː.ʃe* 'he rejoiced'. The stress pattern suggests a trochaic analysis: a syllabic trochee is built at the right edge of the word.[10] (Cf. McCall 1999 for an analysis of Earlier Egyptian in terms of uneven trochees.) Given that vowel length has been argued to be non phonological (Edgerton 1947; Loprieno 1995; Reintges 2004), vowel lengthening is taken to be a phonetic effect of stress which was probably phonologized in the language.

To sum up, the syllable types allowed in unstressed positions, /CV, CVC/, constitute only a subset of the syllable patterns allowed in stressed positions, /CV́ː, CV́C, CV́CC#/.

In addition to vowel lengthening, there are other processes employed by languages in order to enhance the duration of the stressed syllable. Greek dialects constitute an interesting area of research in this respect. Greek is a trochaic quantitity insensitive system with a three-syllable window limitation (Malikouti–Drachman & Drachman 1989; Drachman & Malikouti–Drachman 1999). It also has lexical accents which cause stress to occur on any of the last three syllables of the word (Revithiadou 1999). Although the three-syllable-window restriction is not enforced in all Greek dialects, lexical accentuation is an essential property of Greek stress. Thus, the exact position of the head of the syllabic trochee is dictated by the lexical accent, e.g. /sí́mera/ *(sí́me)ra* 'today', /pavl-ák-os/ *pa(vlá́kos)* 'Pavlos-DIM'.

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[10] Reintges (2004) maintains that Coptic is a quantity sensitive system. This is not totally accurate, however, since a closed syllable can claim stress from an open one only when the latter contains a vowel that is allowed in an unstressed position, e.g. *a.náʃ* 'oath'. A closed syllable, however, can lose stress to an open one provided the latter contains a vowel that can be licensed by stress, e.g. *úː.tah* 'fruit'. In this example, the vowel /u/ of the open syllable can only be realized under stress, therefore it wins over the closed syllable.

Despite quantity insensitivity in footing, several Greek dialects opt to durationally enhance the head of the foot. This is achieved by means of various strategies such as consonant gemination (Cypriot), high vowel metathesis with subsequent diphthongization of the stressed syllable (Misti and Mani), and stressed vowel lowering (Samos and Livisi).

Cypriot Greek (Newton 1968, 1972) supports a phonemic contrast between geminate and single consonants, e.g. *énna* 'FUT particle' vs. *éna* 'one'. The distinction between long and short consonants is mainly preserved from the ancient period. However, Newton (1968) shows that contrastive consonant length occurs in this dialect even in items which had simple consonants at the corresponding ancient word, e.g. Ancient Greek *séemeron* 'today', *ákoue* 'listen-IMP.2SG' vs. Cypriot *símmeron*, *ákku*. Newton calls this process 'spontaneous gemination' (SG). Some representative examples are given in (10) below. The productivity of SG is also evidenced by the fact that it applies to loanwords introduced to Cypriot Greek from other languages, (10c-d).

(10) *consonant gemination in Cypriot*

a.	pavlákkos	'Pavlos-DIM'
b.	víxxas	'cough'
c.	sákkos	'sack'
d.	kólla	'glue'

As obvious from the above examples, an open stressed syllable is closed by geminating the consonant of the following (unstressed) syllable within the trochaic foot domain: *(kól.la)* vs. standard Greek *(kó.la)*. We conclude, therefore, that SG applies only to post-stressed consonants. This explains the ungrammaticality of **jemmátos* 'full', *kallós* 'good', and so on.

Gemination of heads in syllabic trochee systems is totally unexpected under the ITL. Problems for the ITL raise also phenomena such as high vowel metathesis which results in the diphthongization of the stressed syllable. Lengthening by metathesis takes place in the dialects of Misti and Mani and is discussed in the ensuing paragraphs.

Misti belongs to the group of Cappadocian dialects which is a branch of Asia Minor Greek. Dawkins (1916:63) describes a process of high vowel metathesis triggered by the need to yield a diphthong in stressed position. The examples in (11) are telling in this respect. For instance, in (11a), the high vowel moves to the nucleus of the stressed syllable. In this way, the segmental complexity of the stressed syllable is enhanced. Although footing does not pay attention to syllable weight, metathesis seems to be driven by the need to assign extra duration to the stressed syllable. The example in (11a) is clearly contrasted with words such as *daɲís* 'sea', *psofíʃ* 'die (for animals)-PERF.2SG.PRES', *xorí.is* 'separate-PERF.2SG.PRES' (Dawkins 1916:386). In these words, stress blocks high vowel metathesis and, consequently, the diphthongization of the preceding unstressed syllable. The same process takes place in the dialect of Mani (Newton 1972:30), as shown in (12).

(11) *metathesis and diphthongization in Misti*

a. /klóxis/ klójs 'weave-2SG.PRES'
b. /klóxi/ klóix 'weave-3SG.PRES'
c. /fáɣi/ fájx[11] 'eat-3SG.PRES'

(12) *metathesis and diphthongization in Mani*

a. /póðja/ pójða 'foot-PL'
b. /mátja/ májta 'eye-PL'
c. /xérja/ ʃéjra 'hand-PL'

Curiously, lengthening yields a rather 'marked' type of trochaic foot, namely an uneven trochee: [μ́μ μ]. Thus, unlike lengthening in iambic systems, which aims at optimizing foot structure, lengthening in syllabic trochee systems has the opposite effect. We conclude that an ITL-based interpretation of these facts leads to a paradox. The emergence of uneven trochees, however, receives a straightforward explanation if it is viewed as the result of the combined effects of positional augmentation constraints on prosodic (and morphological) heads (Dresher & van der Hulst 1998; Smith 2002) and domain-final lengthening. This issue is further addressed in section 4.

The dialect of Livisi, which also belongs to the Asia Minor Greek branch (Andriotis 1961), and the dialect of Samos, which is part of the Central Aegean dialectal zone (Zafeiriou 1995), share a very interesting property known as 'antikofosi', or else, high vowel lowering (HVL). Mid and high vowels are in complementary distribution: mid vowels occur only under stress and high vowels elsewhere. In other words, high vowels lower to their corresponding mid ones only under stress. Furthermore, in these dialects, the unstressed high vowels, /i, u/ delete and the unstressed mid vowels /e, o/ raise to [i, u], respectively. This issue is further discussed in section 3.2, which addresses reduction phenomena in trochaic systems.

Let us now have a look at the examples in (13) and (14) from Livisi and Samos, respectively. Surface forms are given at the leftmost column and underlying forms with the respective footings are listed in the middle column.

(13) *stressed high vowel lowering in Livisi* (Andriotis 1961:28-31)

a. é < í

iðépsasa	e(ðípsa)sa	'be thirsty-1SG.PAST'
éðrona	(íðro)na	'sweat-1SG.PAST'
félaksa	(fíla)ksa	'watch over-1SG.PAST'

b. ó < ú

vótus	(vútos)	'dive'
pólakas (AUGM)	pu(l'í)	'bird'

[11] Asia Minor Greek has been influenced by Turkish at all grammatical levels. As evidenced by this example, final consonant devoicing is a productive rule in all Cappadocian dialects including Misti.

c.	suffix /-i/ > [-e] when stressed		
	γjatr-é	γja(tr-í)	‘doctor-NOM.PL’
	γambr-é	γam(br-í)	‘groom-NOM.PL’
	aft-é	a(ft-í)	‘this-NOM.PL’
cf.	aθróp-i		‘man-NOM.PL’

d.	suffix /-us/ > [-os] when stressed		
	γabr-ós	γam(br-ús)	‘groom-ACC.PL’
	ftux-ós	fto(x-ús)	‘poor-ACC.PL’
	rumj-ós	ro(mj-ús)	‘Greek-ACC.PL’
cf.	aθróp-us		‘man-ACC.PL’

(14) *stressed high vowel lowering in Samos* (Zafeiriou 1995:31)

a.	é > í		
	pléruma	(plíro)ma	‘payment’
	agélusi	a(gílo)se	‘prick-1SG.PAST’
	θa filésu	(θa fi)(líso)	‘kiss-1SG.FUT’

b.	ó > ú		
	paljufóstano	(paljo)(fústa)no	‘lousy dress’
	fóndus	(fúndos)	‘bottom’

HVL is the converse of unstressed vowel reduction/ deletion since it results in more sonorous vowels in stressed positions. Both processes aim at maximizing the durational contrast between stressed and unstressed syllables within the foot. As a result of this process, the head of the foot in *(pléru)ma*, for instance, becomes more sonorous than its dependent, in contrast with the standard Greek form *(plíro)ma*.

Ewen & van der Hulst (2001) view vowels as being composed of basic particles or elements, in accordance with versions of dependency phonology (Anderson & Ewen 1987) and government phonology (Kaye *et al.* 1985). According to these theories, the basic units are unary features [I, A, U] which can occur separately or in combination. Non-peripheral (i.e. mid) vowels are more complex than peripheral ones because they are branching. For instance, an /e/ is a combination of an A and an I feature whereas an /o/ is a combination of an A and a U feature. In the examples discussed here, the generalization is that vowels with branching structures are permitted only in foot-head position, i.e. the stressed syllable (Dresher & van der Hulst 1998).

In Optimality-Theoretic terms (Prince & Smolensky 1993), HVL in stressed positions can be accounted for by means of the peak prominence scale in (15), originally proposed by Prince & Smolensky (1993) for syllabification and later modified for sonority-driven stress by Kenstowicz (1994). The scale evaluates candidate peaks from 'worst to best' and, in simple words, it states that non-sonorous vowels should not appear in a stressed position.[12]

(15) *peak prominence scale for metrical feet* (Kenstowicz 1994:4)
*Peak/ə >> *Peak/i,u >> *Peak/e,o >> *Peak/a

With respect to the dialects we look at here, it has been shown that optimal peaks can be constructed if the sonority of the vowels is improved. Thus, according to (15), mid vowels qualify as better peaks compared to high vowels. This means that in the dialects of Livisi and Samos faithfulness to the featural specification of the stressed vowel occupies a ranking between *Peak/i,u and *Peak/e,o. An account along these lines is proposed in section 4.1.

Regardless of the analysis one chooses to adopt, HVL adds to the bulk of evidence that stressed syllables in trochaic languages are subject to phonological lengthening. Similar phenomena have been reported for Old Church Slavonic and Zabiče Slovene (McGarrity 2003).

Another interesting case study is the Shaipanese dialect of Chamorro (Chung 1983; Halle & Vergnaud 1987; Crosswhite 1998; McGarrity 2003). In this language, primary stress is limited to the last three syllables of the word, although the default pattern is on the penultimate, a fact that suggests trochaic footing. Secondary stress is assigned from left to right (McGarrity 2003:160). Stressed syllables are either long (CVV) or closed (CVC); in the latter case, however, only mid vowels are allowed. That is, short high vowels /i, u/ may not occur in a syllable bearing stress.

Based on the above, we conclude that lengthening and lowering are both processes initiated by stress. The examples in (16) exemplify this point.

(16) *lengthening and lowering in Shaipanese Chamorro* (Chung 1983)

a.	lá:pis	'pencil'	vs.	lapéssu	'my pencil'
b.	malǽ:guʔ	'wanting'	vs.	màlægóʔmu	'your wanting'

2.3. Summary

In this section, I discussed a number of case studies that challenge the predictive power of the ITL. More specifically, I argued that lengthening is found in trochaic systems irrespective of whether they support quantitative contrasts or not. Ancient Greek poetic meter resorts to consonant gemination in order to change an illegitimate light (accented) syllable into a heavy one. In the same spirit, Old Swedish assigned extra length to a stressed syllable in word initial position, a rule that was later grammaticalized and became a wellformedness condition in the modern language. In WNA, on the other hand, long nuclei are licensed under stress regardless of foot type.

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[12] The same results can also be reached with the reverse scale: *Unstressed/a >> *Unstressed/e,o >> *Unstressed/i,u >> *Unstressed/ə.

Consonant gemination was also shown to be an important property of trochaic systems which lack phonemic length distinctions. Cypriot Greek is a typical example of a syllabic trochee system which, nevertheless, exhibits consonant gemination under stress. Several Greek dialects, however, show a range of lengthening effects. In Misti and Mani, high vowels metathesize only when this would give rise to a diphthongized stressed syllable. In Livisi and Samos, high vowels lower in order to form more sonorous (or structurally more complex) stress peaks. In general, lengthening and lowering seem to be strategies that many trochaic languages employ in order to improve the prosodic salience of the stressed syllable.

The above facts entail that the ITL seems to score poorly at the empirical level since it predicts systems like the ones discussed here to be impossible. The ITL encounters some problems at the theoretical level as well. By excluding the possibility of having augmented heads in leftheaded systems, it clearly conflicts with recent theoretical developments that propose special markedness constraints such as positional augmentation constraints (Smith 2002), that operate on prosodic and morphological strong positions, i.e. heads (Dresher & van der Hulst 1998). In other words, a theory that endorses the ITL must also address how the ITL relates to other phonological processes, especially, those responsible for positional augmentation effects. More importantly, it should also provide a convincing explanation for the fact that there cannot exist augmentation constraints specific to leftheaded (trochaic) environments.

3. Shortening in trochaic languages

Besides lengthening, a further possible segmental effect of the ITL is vowel reduction. An iambic language maximizes the durational contrast between the head and the tail of the foot by shortening its unstressed part. Hayes clearly states that syllabic trochee systems "generally eschew vowel reduction" (Hayes 1995:85). Vowel reduction, however, could be a general trait of languages with distinctive vowel quantity regardless of whether they are trochaic or iambic. Furthermore, he maintains that vowel reduction need not be represented structurally since it is possible for the ITL to govern both phonetic and phonological length (Hayes 1995:84).

In this section, I present evidence for vowel reduction both from moraic and syllabic trochee systems. Many of the languages discussed here provide robust evidence that vowel reduction cannot be attributed to phonetic factors but rather is part of the phonology of the language.

3.1. Vowel reduction in moraic trochee systems

Vowel reduction phenomena are found in quantity sensitive trochaic systems such as Biyyaːðiy and Axrasiy Arabic. Both dialects are spoken by Bedouin tribes in the northwest of Sinai (De Jong 2000:345). As shown by the examples in (17), moraic trochees are built from left to right. Primary stress is assigned to the rightmost foot. Final consonant extrametricality holds in these dialects, as expected.[13] The data in (17) are taken from De Jong (2000:346-347).

(17) *left-to-right moraic trochees in Biyyaːðiy and Axrasiy Arabic*

a. HHL
(bíd)dha 'she wants'
(ʃuf)(túː)<h> 'you-MASC.PL saw him'

b. HLL
(meː)(dána) 'minaret'
(mad)(rása) 'school'
(il)(táfa)<t> 'he looked back'

c. LLLL
(xáda)tu 'she took it-MASC.SG'
(masa)(kátu) 'she took it'
(ðara)(bátu) 'she hit him'

In these dialects, however, high vowels /i, u/[14] are elided in unstressed open syllables:

(18) *unstressed high vowel deletion*

a.	(ʃíri)bi<t>	[ʃírbit]	'she drank'
b.	(níki)di<h>	[níkdih]	'troublesome-FEM.SG'
c.	(min)(táʃi)ri<h>	[mintáʃrih]	'wide-spread'

One may claim that reduction here aims at optimizing the foot structure since it changes a sequence of two light syllables [µ́ µ] into one heavy syllable [µ́µ]. Such a change involves no loss of moraic material and, at the same time, satisfies the condition that heavy syllables constitute better peaks for stress. Even under this interpretation, however, unstressed vowel elision poses a serious threat to the ITL. If weak/unstressed vowels lose part or all of their quantity in iambic languages in order to improve the durational contrast within the foot, then the triggering force for reduction in trochaic systems could be the same: optimization of durational contrasts. Such an explanation, however, challenges one of the basic premises of the ITL, namely that trochaic groupings are not contrast-driven. A proponent of the ITL, therefore, has to seek the motivation for vowel reduction in moraic trochee systems in some other principle. Regardless of what the explanation could be, it will be difficult to be accommodated within a theory that acknowledges the ITL as an organizing principle of footing. Trochaic lengthening discriminates between light and

[13] Extrametricality in Axrasiy affects the last light syllable as well. Thus, *(íʃ)ṛa<bu>* 'drink-IMP.MASC.PL'.

[14] De Jong (2000) explicitly states that deletion affects both high vowels but, unfortunately, he does not provide any examples of u-deletion.

heavy syllables in favor of the latter suggesting that duration does matter for foot headedness in moraic trochee systems.

The situation is further complicated if we take into consideration that, contra expectations, vowel reduction appears rather systematically in many quantity insensitive trochaic systems. This is the topic of the following section.

3.2. Vowel reduction in syllabic trochee systems

Vowel reduction is attested in several Greek dialects where it takes the form of either mid vowel raising (MVR) or high vowel deletion (HVD). There are dialects which exhibit both forms of vowel reduction (Northern Greek, Cappadocian) and dialects which exhibit either MVR (Samos, Livisi) or HVD (Pontic, Farasa, Kouvoukliotika). Let us start from the dialects of Samos and Livisi which, as we have seen in section 2.2, are also characterized by HVL under stress.

In both dialects, unstressed mid vowels raise, as shown by the examples in (19). Moreover, in Samos, mid vowels delete only in foot-tail position – provided word disyllabicity and several phonotactic restrictions are respected. This is illustrated in (20). In contrast, high vowels in stressed positions are lowered. For convenience's sake, some representative examples are repeated in (21). As has been shown in section 2.2, lowering has been attributed to lengthening under stress. In the same spirit, it is argued here that HVD is closely related to stress as well: metrically weak vowels are elided in order to improve the perceptual salience of the stressed syllable. Surface forms are given at the leftmost column and underlying forms with the respective footings are provided in the middle column.

(19) *unstressed mid vowel raising*

a. <u>Livisi</u> (Andriotis 1961:28)

kósmus	(kósmos)	'world'
ágilus	(áge)los	'angel'

b. <u>Samos</u> (Zafeiriou 1995:32-35)

sténu	(stíno)	'place-1SG.PRES'
péti	(píte)	'say-IMP.2SG'

(20) *unstressed high vowel deletion in Samos* (Zafeiriou 1995:34-35)

aklúθ	(ako)(lúθi)	'attendant-PL'
férti	(fére)te	'bring-IMP.2PL'

(21) *stressed high vowel lowering*

a. <u>Samos</u>

éðrona	(íðro)na	'sweat-1SG.PAST'
pólakas	pu(l'í)	'bird'

b. Livisi
pléruma (plíro)ma ‘payment’
fóndus (fúndos) ‘bottom’

There is independent evidence that MVR is a phonological rule and not just a phonetic effect of stress. In both Livisi and Samos, a vowel assimilates to the roundedness and backness value of a more sonorous neighboring vowel (Revithiadou *et al.* in prep.). For instance, the word /skulíki/ ‘worm’ is pronounced as [skulúki] because the stressed /i/ assimilates to the roundedness and backness of the more sonorous /u/ (Andriotis 1961:32-33). Our interest in this process relies on the fact that raised /u/s also appear to be triggers of vowel assimilation: in Livisi, the word /(kalo)(rízi)kos/ ‘of good luck’ surfaces as [kalurúzikus]. This is why: the weak /o/ of the first foot raises to [u] and, naturally, becomes more sonorous than the stressed /í/. As a consequence, the latter vowel is forced to assimilate to the backness and roundedness values of the more sonorous [u]. Vowel assimilation bleeds HVR, as inferred by the ungrammaticality of **kalurézikus*. Similarly in Samos, /ka(kósi)ros/ ‘of lower social status’ surfaces as [kakósurus] (Zafeiriou 1995:42).

We observe that these dialects exploit stress-related segmental effects to the full. In a way, they are the mirror image of iambic systems with vowel shortening such as Eastern Ojibwa (Bloomfield 1956; Piggott 1980, 1983; Hayes 1995):

(22) *unstressed vowel deletion in Eastern Ojibwa*
a. ninamadabimi [nnámdàbmì] ‘we (excl.) sit’ (Piggott 1980:69)
b. odaːweːwigamigw [dàːwéːgàmìk] ‘a store’ (Piggott 1980:84)

HVD is also found in dialectal branches of Asia Minor Greek and, more specifically, in Pontic (Papadopoulos 1955), Farasa (Dawkins 1916, Andriotis 1948) and Kouvoukliotika (Deligiannis 2002):

(23) *unstressed high vowel deletion*
a. Pontic (Papadopoulos 1955:18)
férsmon (férsi)mon ‘behavior’
aθróps a(θrópus) ‘man-ACC.PL’

b. Farasa (Andriotis 1948:23)
pátse (páti)se ‘step-2SG.PAST’
rótsan (róti)san ‘ask-3PL.PAST’

c. Kouvoukliotika (Deligiannis 2002:52)
axúr a(xúri) ‘hole’
kolvózmos (koli)(vózu)mos ‘boiled wheat juice’

As evidenced by the examples in (24), syllabic trochees are built from right to left – according to the dictates of lexical accents – and HVD applies to vowels in foot-tail position.

Cappadocian (Dawkins 1916) and the Northern Greek dialects (Papadopoulos 1926) have both HVD and MVR (see also Revithiadou & van de Vijver 1997). For instance, in the Northern Greek dialect of Siatista (Margariti–Roga 1985), a word like *vróxino* 'of rain' is pronounced as [vróx'nu].[15] Remarkably, in these dialects HVD is blocked in environments where vowel deletion would create a syllable with more complex structure than the stressed one. That is, in a word like *tsimuðjá* 'silence' the unstressed /i/ is preserved because deletion would give rise to the output [tsim.ðjá]. This output is, however, ungrammatical because the unstressed closed syllable /tsim./ is closed and, therefore, structurally more complex than the open stressed syllable /ðja./. Strikingly, when the genitive singular suffix /-s/ is added, HVD applies as expected, giving the output [tsimðjás]. This can be easily explained if we take into consideration that the stressed syllable /ðjás./ is at least as complex as the unstressed /tsim./.

To summarize, in this section we examined several Greek dialects that display various forms of vowel reduction. This is unexpected given that they are syllabic trochaic systems. Table 1 portrays the distribution of HVD and MVR in the dialects under investigation.

DIALECTS	MVR	HVD
Livisi Samos	yes	no yes (in foot-tail)
Pontic, Farasa, Kouvoukliotika	no	yes
Northern Greek, Cappadocian	yes	yes

Table 1. Distribution of HVD and MVR in Greek dialects

Revithiadou and van de Vijver (1997) discuss several other syllabic trochee systems which also exhibit segmental processes relevant to unstressed vowels. In Pashto, Byelorussian and Russian, for instance, the effects of vowel shortening are even more dramatic because all unstressed vowels are affected.

3.3. Summary

The case studies discussed in this section make clear that vowel reduction aims at the enhancement of durational contrasts within the trochaic foot. This conclusion was drawn on the basis of vowel reduction phenomena in moraic as well as syllabic trochee systems. More specifically, it was shown that vowel reduction results in foot structures with structurally complex peaks: (LL) → (H). This type of shortening, although distinct from trochaic shortening, it leads to the emergence of well-formed moraic trochees, i.e. (H).

[15] The apostrophe /'/denotes palatalization of the preceding consonant.

Contra to the ITL predictions that vowel reduction cannot affect unstressed/weak vowels in syllabic trochee languages, there is convincing evidence that both vowel shortening and vowel reduction are found in such stress systems as well. This suggests that footing in some syllabic trochee systems is not quantity sensitive but foot-headedness is. To explain, reduction seems to be blocked in situations where its application will lead to foot-heads of lesser duration compared to foot-tails. The *tsimuðjá* ~ *tsimðjás* pair from the Northern Greek dialect of Siatista is telling in this respect; reduction takes place only when the resulting foot-head is of equal or greater duration than the foot-tail.

Finally, it was shown that vowel reduction/shortening is not a phonetic side-effect of stress but part of the phonological system of the examined languages. The evidence in support of the phonological character of shortening is twofold: first, reduced vowels act as triggers of other segmental processes such as vowel assimilation. Second, reduction is found to be sensitive to syllable structure as well as to the phonotactic restrictions of the languages in question. If reduction were phonetically-driven, it would have applied blindly to all environments.

In sum, trochaic systems exploit vowel reduction/shortening to the full. Therefore, a theory that endorses the ITL as part of its theoretical apparatus cannot provide a viable explanation for unstressed vowel reduction/shortening in moraic *and* syllabic trochee languages. Lengthening and shortening must therefore be attributed to some other principle of natural languages. This issue is addressed in the final section of this paper.

4. An alternative to the Iambic/Trochaic Law

Revithiadou and van de Vijver (1997) attribute lengthening and shortening phenomena in trochaic languages to two different principles: the *Stress and Length Principle* and the *Domain Final Lengthening Principle*. More specifically, they propose that the former principle assigns extra length to prosodic heads whereas the latter principle assigns extra length to domain final elements such as constituents standing at the right edge of feet, prosodic words, and so on. According to this proposal, lengthening of foot-heads in iambic systems results from these two principles whereas the related lengthening in trochaic systems is basically due to the *Stress and Length Principle*. This explains why there is cross-linguistically a drift towards uneven length in iambs. Revithiadou and van de Vijver, however, do not spell out the specifics of their proposal and, moreover, do not provide an explanation of reduction phenomena in trochaic systems.

This section presents an alternative to the ITL along the lines of the account proposed by Revithiadou & van de Vijver (1997). More specifically, the analysis builds on Smith's (2002) prominence-enhancing markedness constraints which are considered to be responsible for augmentation effects observed in stressed syllables. Moreover, it accounts for shortening of the least sonorous vowels on the basis of prominence reduction constraints, which affect vowels in unstressed positions (Crosswhite to appear). It should be clarified that the purpose of the paper is not to give an exhaustive analysis of all phenomena presented in the previous sections but rather to sketch out a general framework within which lengthening and shortening phenomena can be accounted for without resorting to extra-linguistic principles such as the ITL.

The significance of the proposed analysis relies on the fact that, first, it dissociates lengthening and shortening from the directionality of headedness within the foot and second, it derives both effects from independently needed constraints of Universal Grammar. More specifically, lengthening and shortening arise from ranking schemata in which prominence-enhancing and prominence reduction constraints interact with faithfulness constraints on syllable weight (such as a constraint against vowel lengthening or a constraint against consonant gemination) or faithfulness constraints that preserve the featural specification of vowels.

To conclude, the present analysis draws heavily on principles that refer to perceptually strong positions and not on psycholinguistic principles of rhythmic organization.

4.1. Positional augmentation and prominence reduction constraints: a typology of lengthening and shortening effects

Smith (2002) recognizes a special relationship between stress and perceptual prominence. A stressed syllable identifies a phonetically strong position since it contains salient cues (i.e. pitch, duration and amplitude) to the perception of certain phonological contrasts. That stressed syllables are 'strong positions', that is, *heads* (à la Dresher & van der Hulst 1998) is evidenced by the resistance of stressed syllables to positional neutralization effects, for instance. Smith, therefore, proposes the existence of *positional augmentation constraints* relativized to stressed positions. These prominence-enhancing markedness constraints, M/σ́, are responsible for a wide range of augmentation effects observed in stressed syllables. To illustrate with a few examples from the languages discussed in the preceding sections, lengthening in Swedish and gemination in Cypriot, for instance, are due to a M/σ́ constraint that requires stressed syllables to become heavy. This is derived by a ranking in which the constraint HEAVYσ/σ́ (Smith 2002:81)[16] is engaged in a dominance relation with a weight-related FAITH constraint: HEAVYσ/σ́ >> FAITH. In Swedish, FAITH militates against vowel lengthening whereas in Cypriot it militates against converting an underlying singleton consonant into a geminate.

Similarly, high vowels are banned from stressed positions in Livisi and Samos because a constraint of the M/σ́ family which rules out high vowels as

[16] HEAVYσ/σ́: For all syllables *x*, if *x* is a σ́, then *x* dominates >1 mora.

stressed peaks (see [*PEAK/X]/σ́, Smith 2002; *STRESSED/X, Crosswhite 1999a) dominates a FAITH constraint that preserves certain vocalic features.[17]

On the other hand, shortening results from the application of *prominence reduction constraints* to vowels in unstressed positions. The hierarchy in (25) is particularly crucial to the discussion here. Depending on the position of a FAITH constraint that preserves certain vocalic features, a language can exhibit a wide spectrum of reduction patterns ranging from raising of mid vowels to deletion of high vowels. The ranking in (24), in particular, is responsible for raising of unstressed mid vowels.

(24) *ranking for reduction of unstressed syllables*
*Unstressed/a >> *Unstressed/e,o >> FAITH >> *Unstressed/i,u >> *Unstressed/ə

In conclusion, we arrive at the factorial typology of stress-related segmental effects outlined in (25). The ranking schema in (25a) derives lengthening under stress. For trochaic systems, Swedish qualifies as an example, whereas for iambic systems Chaplinski Yupik (Hayes 1995) falls into this category. The ranking in (25b) is responsible for unstressed vowel reduction. Eastern Ojibwa is an iambic language which displays unstressed vowel shortening and Biyyaːðiy Arabic and Farasa are moraic and syllabic trochee systems of this type, respectively. The ranking in (25c) yields outputs with maximal durational contrasts between unstressed and stressed vowels because both stressed syllable lengthening and unstressed syllable reduction take place. Cayuga has been reported (Hayes 1995) to be an iambic system which displays lengthening of stressed syllables and reduction of unstressed ones. From trochaic languages, Livisi and Samos are representative examples because they display high vowel lowering in stressed positions and high vowel deletion in unstressed ones. Finally, the ranking in (25d) derives systems which lack durational contrasts between stressed and unstressed syllables. Paumari has been analyzed by Everett (2002) as a right-to-left iambic system with exhaustive footing and no durational contrasts. Hayes (1995:266-267) mentions several systems such as Southern Paiute (Hayes 1981; Jacobs 1990 and references cited therein) and Araucanian (Echeverría & Contreras 1965) which are also analyzed by means of even (syllabic) iambs. Trochaic systems have been traditionally considered to be lacking durational contrasts. Hayes (1995:198-200) mentions Badimaya (Dunn 1988) and Mayi (Breen 1981), among many others.

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[17] The emergence of phonemic contrasts in prosodically strong positions such as, for instance, the long vs. short vowel contrast in WNA, can be accounted for by means of a stressed syllable sensitive licensing constraint that disallows long vowels in unstressed syllables (Crosswhite 1999b). This constraint guarantees that long vowels will have the chance to be surface without losing part of their duration.

(25) *typology of lengthening and shortening*

a. M/σ́ >> FAITH >> [*PEAK/X]/σ̆
b. [*PEAK/X]/σ̆ >> FAITH >> M/σ́
c. M/σ́, [*PEAK/X]/σ̆ >> FAITH
d. FAITH >> M/σ́, [*PEAK/X]/σ̆

The question that naturally arises at this point is why there is a drift towards uneven length in iambs rather than in trochees. In other words, why are durational contrasts more common in iambic systems than trochaic ones? To answer this question we must take into consideration the role of *domain final lengthening* in grammar. It is well-known that constituents that occupy a final position in a prosodic domain (i.e. foot, phonological phrase) are either long or lengthen (Klatt 1975, Nakatani & Aston 1981). For instance, in Pontic phrase final constituents usually receive the epenthetic element /i(n)/, e.g. *orfanó**ni*** 'orphan-ACC.SG', *klés**in*** 'cry-2SG.PRES' (Papadopoulos 1955). Moreover, Guasti & Nespor (1999) present evidence that right edges of prosodic constituents are usually heavy. To mention an example, in fixed expressions such as *tic tac, ping pong*, the more sonorous rhyme occurs at the end of the prosodic word.

Based on the above, the cross-linguistic bias for uneven iambs now receives a straightforward explanation: durational contrasts in iambs stem from stressed syllable lengthening and/or foot-final lengthening. In contrast, the related foot-head elongation in trochaic systems results from lengthening specific to the stressed syllable only. Foot-final lengthening can never have an effect on the head of a trochaic foot; it operates, however, on its weak part canceling out the effects of shortening.[18]

Let us assume that a constraint such as FINALLENGTHENING$_{\text{Foot}}$ (FL), which requires constituents at foot-final position to be lengthened, occupies a position in the ranking from which it can exercise influence on the shaping of outputs. Such a ranking guarantees that the effects of prominence reduction constraints will be counterbalanced by the extra lengthening demands of FL on outputs. Indeed, as shown in Table 2, the impact of FL domination on each of the rankings listed in (25) has important consequences for foot structure in languages of different rhythm. The crucial cases are derived from rankings 2 and 3. Let us start from ranking 2. In trochaic systems, FL cancels out the effects of prominence reduction constraints to weak syllables within the foot and the result is an even trochee. In iambic systems, however, it adds extra length to the foot-final element, i.e. the foot-head. With respect to ranking 3, in trochaic systems, FL adds extra duration to the head yielding an uneven trochee, which is an attested albeit marked foot type (but see van der Hulst & Klamer 1996). In iambic feet, on the other hand, it enhances the augmentation effects of positional augmentation constraints by adding extra weight to the already lengthened stressed vowel yielding a superheavy (H) foot-head.

[18] I wish to thank Harry van der Hulst who proposed this idea in one of the many discussions we had together during my graduate years at HIL/Leiden University.

Overlengthening is reported to take place in St. Lawrence Island Yupik (Krauss 1985; Hayes 1995). It is important to notice that foot-final lengthening yields the same result as the M/σ́ constraints in languages in which M/σ́ is too low to exercise any influence on the shaping of outputs. A remark about ranking 4 is also in order, because in this case the grammar leads to an ungrammatical for trochaic systems output, namely ĹH. This is not a permissible trochee and is ruled out by foot-wellformedness restrictions (Kager 1993). The same applies to the output (H́H) of ranking 1 in trochaic systems.

ranking	*trochee*	*iamb*
1. FL >> M/σ́ >> FAITH >> [*PEAK/X]/σ́	LL → H́L or H́H	LL → LH̄
2. FL >> [*PEAK/X]/σ́ >> FAITH >> M/σ́	LL → **ĹL**	LL → **(L)H́**
3. FL >> M/σ́, [*PEAK/X]/σ́ >> FAITH	LL → **H́L**	LL → **(L)H̄**
4. FL >> FAITH >> M/σ́, [*PEAK/X]/σ́	LL → *ĹH	LL → LH́

Table 2. Effects of foot-final lengthening in trochaic and iambic feet

Summing up, lengthening in iambs originates from two different sources: positional augmentation of stressed syllables and/or foot-final lengthening. In other words, the *uneven* shape of feet in iambic systems originates from different grammars which strive towards the same optimal output, namely LH́.

5. Conclusions

Hayes (1995) proposed that the ITL is reflected in the typology of rhythmic alternation in word stress systems. This entails that systems which lack durational contrasts between syllables are trochaic, while systems that have durational contrasts between syllables tend to be iambic. As Kager (1993) pointed out, the key factor in the ITL is the presence of durational contrasts *within the foot*. A grammar that endorses the ITL makes certain typological predictions with respect to stress-related segmental changes. More specifically, it predicts lengthening of stressed syllables and shortening of unstressed syllables in iambic but not in trochaic feet. This is because both segmental processes alter the balance between the stressed and the unstressed syllable within the foot with respect to duration. Therefore, such a theory excludes the existence of analogous segmental processes from trochaic (syllabic and moraic) systems because trochees are expected to be even.

Following previous work by Revithiadou & van de Vijver (1997) and van de Vijver (1998), this paper presented striking argumentation against the ITL. First, it showed that lengthening of the stressed syllable is found in moraic and syllabic trochee systems. A wide range of segmental processes besides vowel lengthening such as consonant gemination, lowering, metathesis and dipthongization, just to mention a few, are employed in order to enhance the duration or complexity of the stressed syllable. Second, the paper provided convincing evidence that shortening does affect trochaic systems. More importantly, shortening is sensitive to foot-wellformedness as well as the phonotactic restrictions of a language, suggesting that it is a phonological and not a phonetic effect of stress, as has been argued by Hayes. This is further supported by the fact that the output of shortening serves as an input, to use the traditional jargon, to other phonological processes.

The alternative to the ITL is a theory that embraces two independently needed constraint families, namely positional augmentation and prominence reduction. The interaction of these archetypical constraints with each other and various forms of faithfulness accounts for lengthening and shortening both in trochaic and iambic languages. The cross-linguistic bias towards uneven iambs is attributed to the extra lengthening effects of domain final lengthening.

The proposal advanced here has considerable descriptive and explanatory power success with any of the empirical issues presented in this paper. It raises, however, some important questions with respect to foot typology since lengthening in syllabic trochee systems, for instance, leads to the emergence of *uneven syllabic* trochees. This is an issue that definitely merits further investigation. Unfortunately, space limitations refrain us from pursuing this line of research here though it is clearly worth exploring. There is certainly a need to examine the consequences of recent developments in phonological theory for foot typology, in general, and the principles that govern foot-wellformedness, in particular.

References

Anderson, J.M. & C.J. Ewen (1987). *Principles of dependency phonology*. Cambridge University Press, Cambridge.

Andriotis, N.P. (1948). *To glossiko idioma ton Farason*. [The dialect of Farasa.] 8 Collection de l' Institute Français d' Athenes. Mousiko Laografiko Archeio, Archeio Mikrasiatikis Laografias, tomos 4: Kappadokia 2. Ikaros, Athens.

Andriotis, N.P. (1961). *To idioma tu Livisiou Lykias*. [The idiom of Livisi of Lykia.] Kentro Mikrasiatiko Spoudon, Athens.

Bloomfield, L. (1956). *Eastern Ojibwa: grammatical sketch, texts and word list*. University of Michigan Press, Ann Arbor.

Breen, G. (1981). *The Mayi languages of the Queensland Gulf country*. AIAS new series 29, Australian Institute of Aboriginal Studies, Canberra.

Chung, S. (1983).Transderivational relationships in Chamorro phonology. *Language* 59, pp. 35-66.

Crosswhite, K. (1998). Segmental vs. prosodic correspondence in Chamorro. *Phonology* 15, pp. 281-316.

Crosswhite, K. (1999a). Vowel reduction in Optimality Theory. Doctoral, dissertation, University of California, Los Angeles.

Crosswhite, K. (1999b). Length neutralization and vowel lengthening in Orlec Čakavian. Holloway King, T. & I.A. Sekerina (eds.), *Annual workshop on formal approaches to Slavic linguistics: the Philadelphia meeting* (Michigan Slavic Materials 45). University of Michigan Slavic Department, Ann Arbor.

Crosswhite, K. (to appear). Vowel reduction. Hayes, B., R. Kirchner & D. Steriade (eds.), *Phonetically Based Phonology*.

Dawkins, R.M. (1916). *Modern Greek in Asia Minor*. University Press, Cambridge.

De Jong, R.E. (2000). *A grammar of the Bedouin dialects of the Northern Sinai littoral: bridging the linguistic gap between the eastern and western Arab world*. Brill, Leiden, Boston & Köln.

Deligiannis, K. (2002). *Kouvoukliotika: to glossiko idioma ton Kouvouklion Prousas*. [Kouvoukliotika: the dialect of Kouvouklia of Prousa.] Adelaida.

Drachman, G. & A. Malikouti−Drachman (1999). Greek accentuation. Van der Hulst, H. (ed.), *Word prosodic systems in the languages of Europe*. Mouton de Gruyter, Berlin & New York, pp. 897-945.

Dresher, B.E. & H. van der Hulst (1998). Head-dependent asymmetries in phonology: complexity and visibility. *Phonology* 15, pp. 317-352.

Dunn, L. (1988). Badimaya, a Western Australian language. *Papers in Australian Linguistics*, No. 17, Pacific Linguistics A71. Australian National University, Canberra, pp. 19-149.

Echeverría, M.S. & H. Contreras (1965). Araucanian phonemics. *International Journal of American Linguistics* 31, pp. 132-135.

Edgerton, W.F. (1947). Stress, vowel quantity, and syllable division in Egyptian. *Journal of Near Eastern Studies* 6, pp. 1-17.

Everett, D.L. (2002). Iambic feet and syllables in Paumari. Analysis and theoretical consequences. Ms., University of North Dakota.

Ewen, C.J. & H. van der Hulst (2001). *The phonological structure of words: an introduction*. Cambridge University Press, Cambridge.

Fraisse, P. (1974). *Psychologie du rythme*. Presses universitaires de France, Paris.

Goedemans, R.W.N. (1997). Putting the Mathimathi stress rule in its proper perspective. *Australian Journal of Linguistics* 17, pp. 43-69.

Guasti, M.T. & M. Nespor (1999). Is syntax Phonology-free? Kager, R. & W. Zonneveld (eds.) *Phrasal phonology*. Nijmegen University Press, Nijmegen, pp. 125-159.

Halle, M. & J.-R. Vergnaud (1987). *An essay on stress*. MIT Press, Cambridge, Massachusetts.

Hayes, B. (1981). A metrical theory of word stress. Doctoral dissertation (1980), MIT, Cambridge.

Hayes, B. (1985). Iambic and trochaic rhythm in stress rules. Niepokuj, N., M. VanClay, V. Nikiforidou, & D. Jeder (eds.), *Proceedings of BLS 11: parasession on poetics, metrics, and prosody*. BLS, Berkeley, pp.429-446.

Hayes, B. (1987). A revised parametric metrical theory. *Northeastern Linguistic Society* 17, pp. 274-289.

Hayes, B. (1995). *Metrical stress theory: principles and case studies*. The University of Chicago Press, Chicago & London.

Jacobs, H. (1990). On markedness and bounded stress systems. *The Linguistic Review* 7, pp. 81-119.

Jastrow, O. (1997). The Neo-Aramaic languages. Hetzron, R. (ed.), *The semitic languages*. Routledge, Lodon & Neww York, pp. 334-377.

Kager, R. (1993). Alternatives to the Iambic-Trochaic Law. *Natural Language and Linguistic Theory* 11, pp. 381-432.

Kaye, J.D., J. Lowenstamm & J.-R. Vergnaud (1985). The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook* 2, pp. 305-328.

Kenstowicz, M. (1994). Sonority-driven stress. Ms., MIT.

Klatt, D. (1975). Vowel lengthening is syntactically determined in a connected discourse. *Journal of Phonetics* 3, pp. 129-140.

Knudson, L.M. (1975). A natural phonology and morphophonemics of Chimalapa Zoque. *Papers in Linguistics* 8, pp. 283-346.

Krauss, M. ed. (1985). *Yupik Eskimo prosodic systems: descriptive and comparative studies*. Alaska Native Language Center, Fairbanks.

Loprieno, A. (1995). *Ancient Egyptian: a linguistic introduction*. Cambridge University Press, Cambridge.

Malikouti−Drachman, A. & G. Drachman. (1989). Tonismos sta Ellinika [Stress in Greek.] *Studies in Greek linguistics 1989*, University of Thessaloniki, pp.127-143.

Margariti–Roga, M. (1985). Fonologiki analisi tu Siatistinu idiomatos. [Phonological analysis of the Siatista dialect.] Doctoral dissertation, Aristotle University of Thessaloniki.

McCall, B. (1999). Vowel lengthening in a moraic trochee system: stress in Ancient Egyptian. Ms., Indiana University.

McCarthy, J.J. & A. Prince (1986). Prosodic Morphology. Ms., University of Massachusetts, Amherst and Brandeis University, Waltham, MA. [Annotated version 1996, issued as Technical report no. 32, Rutgers Center for Cognitive Science.]

McGarrity, L.W. (2003). Constraints on patterns of primary and secondary stress. Doctoral dissertation, Indiana University.

Nakatani, L. & C. H. Aston (1978). Acoustic and linguistic factors in stress perception. Ms., ATT Bell Laboratories, Murray Hill, N.J.

Newton, B.E. (1968). Spontaneous gemination in Cypriot Greek. *Lingua* 20, pp. 15-57.

Newton, B.E. (1972). *The generative interpretation of dialect: a study of Modern Greek phonology*. Cambridge University Press, Cambridge.

Papadopoulos, A.A. (1926). *Grammatiki ton vorion idiomaton tis Neas Ellinikis glossis*. [Grammar of the Northern Greek dialects.] P.D. Sakellarios, Athens.

Papadopoulos, A.A. (1955). *Istoriki grammatiki tis pontikis dialektou.* [Historical grammar of the Pontic dialect.] Epitropi Pontiakon Meleton, Periodikou “Archeion Pontou”. Parartima 1, Athens.

Piggott, G.L. (1980). *Aspects of Odawa morphophonemics*. Garland Publishing, New York.

Piggott, G.L. (1983). Extrametricality and Ojibwa stress. *McGill Working Papers in Linguistics* 1, pp. 80-117.

Polgárdi, K. (1995). Iambic lengthening : phonetics or phonology? Van der Hulst, H. & J. van de Weijer (eds.), *Leiden in last: proceedings of the first HIL Phonology conference*. Holland Academic Graphics, The Hague, pp. 355-368.

Prince, A. (1990). Quantitative consequences of rhythmic organization. Ziolkowski, M., M. Noske & K. Deaton (eds.), *Parasession on the syllable in phonetics and phonology*. Chicago Linguistics Society, Chicago, Illinois, pp. 355-398.

Prince, A. & P. Smolensky, (1993). Optimality Theory: constraint interaction in Generative Grammar, Report no. RuCCS-TR-2, Rutgers University Center for Cognitive Science, New Brunswick, NJ.

Reintges, C. H. (2004). *Coptic Egyptian (Sahidic dialect): a learner’s grammar*. Rüdige Köppe Verlag, Köln.

Revithiadou, A. (1999). Headmost accent wins: head dominance and ideal prosodic form in lexical accent systems. Doctoral dissertation, LOT Dissertation Series 15 (HIL/Leiden University). Holland Academic Graphics, The Hague.

Revithiadou, A. & R. van de Vijver (1997). Durational contrasts and the Iambic/Trochaic Law. Samiian, V. (ed.), *Proceedings of WECOL*. Department of Linguistics, California State University, Fresno, CA, pp. 229-242.

Revithiadou, A., M. van Oostendorp, K. Nikolou & M. Tiliopoulou (in prep). Vowel harmony in contact-induced systems: the case of Cappadocian and Silli. Paper presented at the Second International Conference on Greek Dialects, 30 September-3 October 2004, Mytilene.

Riad, T. (1992). Structures in Germanic prosody: a diachronic study with special reference to Nordic languages. Doctoral dissertation, Stockholm University.

Rice, C. (1992). Binarity and ternarity in metrical theory: parametric extensions. Doctoral dissertation, University of Texas, Austin, Texas.

Smith, J.L. (2002). Phonological augmentation in prominent positions. Doctoral dissertation, University of Massachusetts, Amherst.

van der Hulst, H. & M. Klamer (1996). The uneven trochee and the structure of Kambera roots. Nespor, M. & N. Smith (eds.), *Dam phonology: HIL Phonology papers II*. Holland Academic Graphics, The Hague, pp. 39-57.

van de Vijver, R. (1998). The iambic issue: iambs as the result of constraint interaction. Doctoral dissertation, HIL dissertation series 37. Holland Academic Graphics, The Hague.

Woodrow, H. (1951). Time perception. Stevens, S.S. (ed.), *Handbook of experimental psychology*, Wiley, New York, pp.1234-1236.

Zafeiriou, M. P. (1995). *To glossiko idioma tis Samou*. [The dialect of Samos.] Ekdosis M.P. Gregoris, Athina.