COERCION AND MINIMALITY[1]

1. Introduction

"The slaying of a beautiful hypothesis by an ugly fact" is a tragedy of science, the old adage goes.[2] But it is even more disappointing when a theory is discarded not so much because evidence contradicts it, but because the facts that bear on it are too confusing. This unfortunate event, I submit, befell the hypothesis that connects the minimal size of words with the minimal size of stress feet. This hypothesis has come under suspicion because both its predictions and the relevant typology is complex and does not easily yield to clean results. In this paper I attempt to clarify what the hypothesis means, and how it measures up against the data.

1.1. *Background*

Phonologists have known for a long time that languages can impose minimal size restrictions on words (Hale 1973, Prince 1980). Since at least Prince 1980, word minimality has been understood in terms of the prosodic hierarchy, and since McCarthy and Prince 1985 it has been used as a source of evidence for typological claims about stress systems.

The elegant argument was first spelled out by Prince (1980): if a prosodic word must contain at least a foot, and if there is a minimal restriction on the size of feet, then it follows that words cannot be smaller than the smallest foot. I will refer to the idea that the smallest word is identical to the smallest foot as *The Prosodic Minimality Hypothesis* (henceforth PMH).

(1) **The Prosodic Minimality Hypothesis** (PMH)
The minimal word is identical to the minimal foot.

Over the subsequent years, The PMH has been explored from various angles (Itô 1990, Itô and Mester 2003 [1992], Golston 1991, Piggot 1992, and Crowhurst 1992). It is now well-known that the connection between word size and prosody is not as straightforward as the classic exposition in McCarthy and Prince 1985 would make one believe. As stated, the PMH is not correct, because there are many languages with a mismatch between minimal words and feet.

In this paper I will show that such mismatches are in fact not random, but predicted by independently motivated factors in the context of Optimality Theory (OT; Prince and Smolensky 2004 [1993]). It is too early to set aside the PMH.

OT's version of the PMH involves a minimal foot size constraint, such as the classic Foot Binarity, and some antagonistic constraint, such as GW=PW.

(2) a. FTBIN (FTBIN; Prince and Smolensky 2004 [1993])
'Feet are binary at the moraic or syllabic level of analysis'
b. GW=PW (Prince and Smolensky 2004 [1993]: 51; Kager 1999: 152).
'A grammatical word must be a prosodic word'

Other things being equal, FTBIN should enforce minimal foot size in the same way in monosyllables and longer words. But constraints that conflict with FTBIN often apply differently to monosyllables and longer words; this is what leads to the complex relationship between feet and words.

An alternative to analyzing minimality with FTBIN is to invoke constraints specific to word length, such as Garrett's (1999) BELONG family, which require prosodic words to be above a certain length. While the expectation that the minimal word should in every case be identical to the minimal foot is too strong and empirically falsified, a weaker version of the PMH in the OT context is that no constraints specific to word size, such as BELONG, are necessary to account for word size effects. Rather, the standard constraints, which are motivated on grounds independent of minimality, should be sufficient for the observed range of phenomena. This is the version of the PMH I will defend in the remainder of this paper.

(3) **PMH-OT**
The typology of word minimality is predicted by constraints independently motivated by the typology of stress.

In this section I will outline both the classic approach and the data and arguments that show a more complicated picture, including suggestions that the PMH is wrong. In Section 1.2 I use Latin to illustrate a clean case of minimality that conforms with the PMH, and in Section 1.3 I discuss the counterexamples to it.

1.2. *A classic case of prosodic minimality: Latin*

A classic example of prosodic minimality comes from Latin (Prince and Smolensky 2004 [1993], Prince 1990, Mester 1994). It is an especially clean case of the phenomenon: the prosodic minimum is exactly the same size as the minimal foot, established uncontroversially on independent grounds; the minimum is inviolable, and applies to all content and function words; and the minimum is enforced at the level of surface structure.

Latin words must contain at least two moras. Based on the evidence from stress and meter, CVV and CVC are heavy in the language; CV is light. The words in (4)a below illustrate common examples of monosyllables satisfying the minimum, all of which have either a coda or a long vowel, or both; monomoraic CV words are impossible (4)b.

(4) a.

nunk	'now'	so:l	'sun'	mel	'honey'	de:	'of'
reks	'king'	re:s	'affair'	rem	'affair.ACC'	re:	'affair.ABL'
sunt	'be.3PL'	wi:s	'force'	vir	'man'	vi:	'force.ABL'

b. *na, *te, *pi

The minimum applies to function words as well as lexical words. Prepositions, conjunctions, particles, the copula, etc., all obey the bimoraic minimum.

That the minimality restriction is phonologically active is shown by (5). Subminimal inputs undergo repair in two different ways: lexical words lengthen their vowel; function words cliticize.

(5) a. Lengthening in lexical words

STEM	INFIN	IMPER
da-	da-re	da:

b. Cliticization in function words
-k^{w}e 'and'
-ne 'not'
-we 'or'

Normally, the imperative is identical to the stem of the verb, and it is the only category where the stem surfaces without affixes. The exception is the imperative of /da/ ‘give’, a monomoraic stem, which lengthens to [da:] (see Mester 1994).

The stress foot of Latin is the moraic trochee, a bimoraic foot. This fact is established on the basis of stress, allomorphy, and meter (Prince 1990, Prince and Smolensky 2004 [1993], Mester 1994, *pace* Jacobs 2000, 2003). This means that the minimal word in Latin is identical in size and structure to the minimal foot: Latin offers a canonical example of prosodic word minimality.

The Latin requirement applies to surface words but not to roots. There is one verb root /da/ ‘give’ which consists of a light syllable, and the roots of the verbs [na:re] ‘swim’ and [fle:re] ‘weep’ can plausibly be analyzed as consisting of only consonants, /n/ and /fl/, augmented by the thematic vowels [a:] and [e:]; and there is at least one word, [eksta] ‘entrails’, which appears synchronically not to have any root at all, being composed of a common prefix [eks-] and a common past participle suffix [-t].[3]

(6) a. /da/ ‘give’
b. /n-a:-/ ‘swim’
/fl-e:-/ ‘weep’
c. /eks-∅-t-/ ‘entrails’

In sum, the Latin word minimum is identical to the bimoraic stress foot, applies to surface words, both content and function, and does not apply to roots. This kind of minimality is perfect from the point of view of the PMH.

1.3. *Problems with the PMH*

The typological investigation of the PMH before OT focused on mismatches between smallest words and smallest feet. Hayes (1995) argued that some languages categorically exclude degenerate feet, while others allow them when under main stress, resulting in subminimal words coexisting with foot minimality in longer words (1995: 87). Conversely, many languages with word minimality allow degenerate feet on final syllables. Hayes suggested that final secondary stress are not necessarily evidence of foot structure, but may be due to phonetic lengthening. Kager (1995), developing ideas proposed by Kiparsky (1991), made a connection between final secondary stress, minimality, and catalexis. The upshot of this work was that not all apparent counterexamples to the PMH are fatal to it, but that some mismatches between smallest words and smallest feet result from other factors.

A number of recent researchers argue for abandoning the PMH, because the relationship between minimal words and minimal feet appears too unpredictable to maintain it. Spring 1990 showed that minimal feet differ from minimal words in Axininca Campa. Garrett (1999, originally a 1997 MA thesis) identified several types of word-foot minimality mismatches in both directions (feet smaller than words, words smaller than feet), and proposed constraints directly regulating word size to account for them. Gordon (2006 [1999]), focusing on syllable weight, found a large number of languages where weight criteria differ for the purposes of the minimum and stress.

The most complete treatment of the problem is found in Garrett (1999), who identified several types of foot-minimum mismatches, and concluded that, in the general case, there is no direct relationship between the two. A similar conclusion was reached by Downing (2006: 94–100).

The following is a list of the types of mismatches identified by Garrett, somewhat reorganized from his presentation. The numbers in parentheses refer to sections in his paper; for each type, I mention one or more languages that exemplify it. To avoid repetitive descriptions, I will refer to languages whose minimal words are larger than their minimal feet as exhibiting *conservative* minima, and languages whose minimal words are smaller than minimal feet as exhibiting *liberal* minima.[4]

(7) Minimal words are larger than minimal feet (conservative minima)
- a. Degenerate feet are allowed, but CV words are not allowed (2.1)
  Cahuilla
- b. Disyllabic minimal words that are larger than even maximal feet (2.2)
  Carib, Hixkaryana
- c. CVVC minima (2.3)
  Menominee

Minimal words are smaller than minimal feet (liberal minima)
- d. CVX minimum, but CVC counts as light for stress (2.3)
  Hupa, Yupik, Wintu, Paamese, Buriat
- e. CVX minima in unbounded stress languages (2.4)
  Huasteco Mayan, Aguacatec, Murik
- f. CVX minima in syllabic trochee languages (2.5)[5]
  Nyangumarta, Garawa, Dalabon
- g. CVX minima in quality-driven stress languages (2.6)
  Chuvash, Lushootseed, Au

Gordon's (2006 [1999]) study of syllable weight mismatches in an impressive array of languages identified a subset of the minimality mismatches found by Garrett, viz. those like (7)d, where a difference in what counts as a heavy syllable in monosyllables vs. longer words leads to a liberal minimum.

In order to assess the damage of the facts to the PMH, it is necessary to know what the PMH in fact means in OT. This paper in an attempt to do just that. I begin with the most common type of mismatch, and show that it is in fact predicted to exist by the theory. In Section 3 I discuss the broader range of mismatches predicted by OT, and show that it corresponds closely to the observed typology.

2. Coercion

2.1. *Introduction*

In the majority of word-foot mismatches, the culprit is the coda: it is often moraic in monosyllables, but non-moraic in longer words. Such coda weight effects cannot be taken as counterevidence to the PMH, but are predicted by independently motivated components of the theory. Because syllable weight in OT is subject to negotiation by conflicting constraints, just as any other choice made in the grammar, there is no general expectation of weight uniformity, even if there *is* an expectation that things will not be random.

Morén (1999: 32) proposed a set of constraints shown in (8) prohibiting segments at each step in the sonority hierarchy from carrying a mora. The constraints form a markedness scale; the more sonorous a segment, the more likely it is to be moraic.

(8) *MORA[STOP] 〉〉 *MORA[CONT] 〉〉 *MORA[SON] 〉〉 *MORA[V]

For the purposes of what follows, I will collapse the constraints against consonantal moras into *C_μ. Antagonistic to this constraint is WEIGHT-BY-POSITION (WBP; Morén 1999: 34, based on Hayes 1989), which militates against weighless codas.

*C_μ is undominated in languages where CVV is heavy but CVC and CV are light. In languages where FTBIN outranks *C_μ, codas may count as heavy in situations when there is no other way to satisfy foot binarity. One such situation occurs in CVC monosyllables. To use Morén's terminology, the coda of CVC words is *coerced* to be moraic by FTBIN. The symptom of coercion is liberal minimality: CVC satisfies the word minimum, but is not enough to form a foot on its own in a longer word. If this reasoning is correct, coercion would account for the bulk of mismatches in (7)d, as well as for the mismatches listed by Gordon.

The following tableaux illustrate: the first input, /CVCCV/, surfaces with a non-moraic coda because of the constraint *C_μ. But the monosyllabic input CVC cannot come out the same way without violating FTBIN. High-ranking DEP-μ(V) prevents lengthening, and the only strategy left is treating the coda as moraic, at the cost of violating *C_μ. Finally, the behavior of /CV/ shows that vowel lengthening can be used to satisfy the minimum, but only as a last resort.

(9)

		FTBIN	DEP-μ(V)	*C_μ	WBP
/CVCCV/	☞ ($CV_\mu CCV_\mu$)				*
	($CV_\mu C_\mu CV_\mu$)			*!	
/CVC/	($CV_\mu C$)	*!			*
	☞ ($CV_\mu C_\mu$)			*	
	($CV_{\mu\mu} C$)		*!		*
CV	(CV_μ)	*!			
	☞ ($CV_{\mu\mu}$)		*		

Negotiable weight of this kind is perfectly ordinary in OT thinking. What is unusual (though not unprecedented) is that the repair for subminimality is covert: foot binarity is satisfied by invisibly adding a mora to a coda. The reverse pattern — codas are moraic in longer words but CVC does not satisfy minimality — cannot be derived using the same constraints, without brute-force tools such as constraints directly penalizing words under a certain size.

The analysis implied by (9) is, of course, fanciful speculation until some independent evidence of the mora on the final consonant of monosyllables turns up. In the following sections I provide such evidence from Djaru and Walmatjari, two Pama-Nyungan languages, and illustrate the same idea with a somewhat different pattern from Ancient Greek. Then, in Sections 2.5–7, I discuss the broader typology of coercion.

2.2. *Coercion in Djaru*

Djaru, a Pama-Nyungan language of Kimberley, Western Australia, shows the coda weight mismatch of the type discussed in the preceding section. Under the present analysis, the moraicity of the final consonant in CVC words is coerced by minimality. Djaru offers direct evidence for this moraic coercion effect: the pattern of ergative allomorphy shows the different

weight of CVC in monosyllables and longer words. The discussion of Djaru in this section is based on Tsunoda's (1981) description of the language.

Stress in Djaru is typical of Australian languages: the initial syllable bears primary stress; [a:], the only long vowel of the language, attracts stress, but closed syllables do not. This fact, together with the ergative allomorphy pattern explained below, shows that codas are not moraic in polysyllabic words.

Outside of the nouns and verbs, which are typically at least disyllabic, there are a substantial number of monosyllables in the large class of items commonly called 'preverbs' in the Australian literature (see Schultze-Berndt 2003 and refs.). Unlike other words, preverbs in Djaru are frequently monosyllabic, can have the shape CVC, and often end in consonants which are otherwise prohibited from the word-final position. There are a number of morphophonological processes that apply exclusively to preverbs. While in many related languages the counterparts of the Djaru preverbs are often bound affix-like items (e.g. in Warlpiri, cf. Nash 1982, 1986), in Djaru they clearly form their own phonological words. Evidence for this comes from the fact that they can occur before pause, and can themselves take nominal morphology (Tsunoda 1981: 72, 179).

In addition to the preverbs, Djaru has a few other monosyllables, such as the three CV roots from the class of bound pronouns known as catalysts, and several adverbs. These CV catalysts can surface without affixation as CV words, in which case the vowel is lengthened, e.g. /ŋa/ surfaces as [ŋa:] (Tsunoda 1981: 46). The vowel remains short in longer forms with this root. This lengthening does not apply to underlying CVC preverbs, which surface with short vowels; equally important is that there are no preverbs *without* a coda, of the shape CV. Therefore, Djaru has a bimoraic minimum, and CVC preverbs satisfy it. The only possible source of the second mora is the coda, coerced to bear it by minimality.

So far the argument runs the danger of circularity: the moraic coercion effect is simply compatible with the distributional facts but not necessary to account for them. It turns out that there is an independent argument in favor of coercion, which comes from ergative allomorphy. As in many other Pama-Nyungan languages, the Djaru ergative case marker is sensitive to the mora count of its base (for a survey, see Paster 2006a,b). The relevant allomorphs are -(*ŋ*)*gu*, which attaches to bimoraic stems, and -*lu*, which attaches to stems containing more than two moras (Tsunoda 1981: 54–55; the choice between -*ŋgu* and -*gu* is due to an unrelated OCP effect). The following examples illustrate: (10)a and (10)b show the contrast between a disyllabic and a trisyllabic stem with short vowels; (10)c shows that the allomorph -*lu*, which goes on trisyllabic nouns, is also attached to nouns containing a long vowel. The choice is thus sensitive to mora count rather than syllable count. Finally, the word in (10)d has the structure CVC.CV, and takes the allomorph that attaches to stems of two moras; this shows that codas do not contribute weight in longer words.

(10) a. ŋaba-ŋgu 'water'
b. maŋari-lu 'vegetable food'
c. ga:ja-lu 'bush tomato'
da:di-lu 'daddy'
d. jambi-gu 'big'

As I mentioned, preverbs can take nominal morphology, and the ergative allomorphy treats the final consonants of CVC as moraic, as shown in (11).[6]

(11) a. jud-gu-lu ‘sitting’
jud-ŋu-lu
b. dyad-ŋu-lu ‘standing’

The forms are irregular in two ways: first, the morpheme *-gu* or *-ŋu* is attached to the CVC stem, which does not occur in any other ergative forms[7]. Tsunoda suggests that this augment serves to build the stem up to the canonical disyllabic length; the choice between *-gu* and *-ŋu* is unclear. However, the resulting disyllabic, bimoraic CVC.CV stem should receive the *-ŋgu* allomorph according to the normal generalizations of the language, in the same way as the CVC.CV stem in (10)d is treated as bimoraic. Instead, the allomorph *-lu*, normally reserved for trimoraic stems, is attached.

Coercion under pressure of minimality provides a ready explanation for this peculiarity: the coda of the CVC preverb is moraic, and the morphologically derived ergative form retains it.[8]

2.3. *Coercion in Walmatjari*

Walmatjari, another Pama-Nyungan language from the Kimberley, has coercion effects similar to those in Djaru, but provides a somewhat different kind of evidence for them. The discussion below is based on Hudson and Richard 1969 and Hudson 1978. Walmatjari has three vowels. Stress is typically Pama-Nyungan: initial, with alternating secondary stress on non-final syllables, and some sensitivity to morphological boundaries. While codas are not moraic for the purposes of stress, as CVC syllables do not attract it, they do contribute a mora in monosyllabic words. All monosyllables in Walmatjari have the shape CVC(C). There are no CV words.[9]

(12) *ṭiřp* ‘mark on message stick’ (Hudson and Richard 1969: 182; Hudson 1978: 6)
mil ‘eye’ (Hudson and Richard 1969: 186)
ral ‘hair of head’ (Hudson and Richard 1969: 186)
wil ‘star’ (Hudson and Richard 1969: 187)

The ergative/locative allomorphy also shows that codas are not moraic (Hudson 1978: 11). The allomorph with the retroflex lateral, spelled *-rla*, occurs with stems of three or more syllables, while the velar nasal allomorph *-nga* is attached to shorter stems. As the second item in (13)b shows, the allomorph *-nga* is attached to stems one of whose syllables is closed.

(13) a. nga.pu.rlu-rla ‘with the sister’
ma.nga-ku.ra-rla ‘at the girl’s [place]’
b. ma.nga-nga ‘with the girl’
ngar.pu-nga ‘with the father’

These data show that closed CVC syllables count as light. Thus, Walmatjari has the same type of weight mismatch as Djaru: CVC is light except in monosyllables, where it is heavy. Once again, the interpretation is that Walmatjari has an ordinary two-mora word minimum, and that codas are coerced to be moraic under the pressure of minimality.

The independent confirmation for this analysis comes from the behavior of CVC verb stems with respect to stress; the argument runs along somewhat different lines from the argument in the preceding section on Djaru. Hudson (1978: 13–14) documents an intriguing interaction of the application of consonant deletion with stress assignment. When the simple verb stems *wanti* 'fall', *many-* 'speak', and *ma-* 'do' are compounded with monosyllabic preverbs, the initial consonant of the verb stem is lost under certain phonotactic conditions. Peculiarly, secondary stress on the initial syllable of the verb stem, in clash with the primary stress of the first member of the compound, occurs if and only if that consonant has not undergone deletion.

Whether or not the initial consonant of the second member drops depends on the segmental environment. The *w* of *wanti* always drops (14)a; the *m* of *many-* and *ma-* drops only when the consonant to its left is either a non-coronal or *rr* (14)b; otherwise, it denasalizes into *p* (14)c.

(14)	a.	/yut-wanti/	→	yútanti	'sit down!'
		/jup-wanti/	→	yúpanti	'jump down!'
		/taly-wanti/	→	tályanti	'break and fall [as a tree]'
	b.	/kirr-manyja/	→	kírranyja	'sit!'
		/yuk-manyja/	→	yúkanyja	'lie down!'
		/yung-manta/	→	yúnganta	'cut it!'
		/lap-manyja/	→	lápanyja	'run!'
	c.	/kit-manta/	→	kítpànta	'stick to it!'
		/turt-manta/	→	túrtpànta	'pluck it out!'
		/paj-manyja/	→	pájpànyja	'stink!'

There is consonant deletion and no secondary stress in (14)a, while in (14)c the consonant remains and the secondary stress appears. There is an interpretation of these facts, consistent with general principles of syllabification and stress assignment, that supports my claim that there is moraic coercion in Walmatjari.

When the initial C of the second stem is deleted, the final C of the first stem is resyllabified as an onset, but this resyllabification does not take place when there is no deletion. This syllabification difference between (14)a and (14)c in turn leads to a difference in foot structure: a CVC syllable can form a foot of its own, while a CV syllable cannot. To illustrate this idea, in (15) below I repeat the representative items from above and supply them with syllable and foot boundaries.

(15)	a.	/yut-wanti/	→	(yú.t-an).ti	'sit down!'	*(yú.)(t-ànti)	*(yút).-(ànti)
	b.	/yuk-manyja/	→	(yú.k-any).ja	'lie down!'	*(yú.)(k-ànyja)	*(yúk).-(ànyja)
	c.	/kit-manta/	→	(kít).-(pàn.ta)	'stick to it!'	*(kít.-pan)ta	

There are several conflicting preferences at play. On the one hand, the constraints ONSET and NOCODA make intervocalic consonants syllabify as onsets rather than codas. Next, the high-ranked constraint FTBIN enforces foot minimality. The preference to align foot boundaries with morpheme boundaries, expressed by constraints from the ALIGN family (McCarthy and Prince 1993) such as ALIGN-L(M,Ft), is the force behind assigning secondary stress to the initial syllable of the second member of the compound. Finally, the constraint *C_{μ} ensures that codas are not moraic unless other factors intervene.

Syllabification is in conflict with alignment in (15)a and (15)b, where the morphological boundary occurs after the consonant in a VCV sequence, but the two preferences work in concert in (15)c, where the morpheme boundary occurs in the same place as the unmarked syllable boundary. Walmatjari chooses to syllabify the words in the unmarked way: the consonant in VCV is always an onset.

(I assume that the phonotactic constraints that are responsible for consonant deletion and *m*-denasalization are undominated, and do not show candidates violating them.)

(16)

	ONSET	FTBIN	ALIGN	*C_μ
/yut-wanti/ ☞ (yú.t-an).ti			*	
(yú.)(t-ànti)		*!	*	
(yút$_\mu$).-(ànti)	*!			*
(yút).-(ànti)	*!	*		
/kit-manta/ ☞ (kít$_\mu$).-(pànta)				*
(kít).-(pànta)		*!		
(kít.-pan)ta			*!	

For the input /yut-wanti/, where the *w* of the second member of the compound is deleted, high-ranking ONSET and FTBIN ensure that the conflict between syllabification and alignment can be resolved neither by syllabifying intervocalic consonants as codas, e.g. *[(yút$_\mu$).-(ànti)], nor by assigning a degenerate foot to first half of the compound to the left of the morpheme boundary, e.g. *[(yú.)(t-ànti)]. This leaves the misaligned candidate [(yú.t-an).ti] as the winner. In /kit-manta/, where the consonant is not deleted, ONSET is no longer relevant. FTBIN rules out the candidate [(kít).-(pànta)], where the initial foot is degenerate because the coda is not moraic, and of the remaining candidates, ALIGN rules out [(kít.-pan)ta], where the coda of the initial syllable is not moraic, in violation of *C_μ, but the morpheme boundary is not aligned with a foot. This leaves the candidate with coerced weight, [(kít$_\mu$).-(pànta)], as the only viable option. In this candidate, the first syllable's coda is moraic, against the basic pattern in the language, under pressure of foot minimality.

These data and the analysis in (16) provide the ranking argument FTBIN ⟩⟩ *C_μ, which is precisely the ranking implicated in moraic coercion in (9). This fact lends further support to my claim that what is behind Walmatjari CVC words like *mil* 'eye' in the face of the general coda non-moraicity is moraic coercion.

A final relevant piece of evidence from Walmatjari comes from cases where the stem of the verb has the shape CV (in the available examples these stems are followed by agreement markers; I was not able to identify in Hudson (1978) any true compounds whose first member is CV, which is perhaps significant). Two such items are shown below; in both cases, there is no secondary stress immediately following the initial CV morpheme. This is entailed by my analysis: the only way to have such a stress clash is either with a degenerate foot (má), or by syllabifying an intervocalic consonant as a coda. Both of these options are ruled out by undominated constraints.

(17) / ma- ∅- nyanangu/ → [mányanàngu] 'he for them' (Hudson 1978: 8)
aux 3sgS 3pl.dat

/ pa- lu- rla- nyanu/ → [pálurlanyànu] ‘they each other’ (Hudson 1978: 8)
aux 3plS 3sg.dat refl

(18)

	ONSET	FTBIN	ALIGN	*C_μ
/ma-nyanangu/ ☞ (má.-nya)(nàngu)			*	
(má).-(nyàna)ngu		*!		
(má-ny$_\mu$).(àna)ngu	*!		*	

2.4. *Coercion in Ancient Greek*

A somewhat different case of moraic coercion by foot minimality is supplied by Classical Greek. Unlike Walmatjari and Djaru, where FTBIN competes directly with *C_μ, in Greek the competition is against a non-finality.

Greek has a bimoraic word minimum and a stress system based on the moraic trochee (Golston 1990, 1991). In certain morphological categories where accent is predictable, a foot is constructed at the right edge, and the accent falls on the syllable preceding the head of that foot. Thus, the penult is accented if the final syllable is heavy, and the antepenult otherwise. Codas are moraic, but word-final codas do not count for stress (in pre-OT terms, final consonants are extrametrical). In OT, this is due to the action of the high-ranked constraint against prosodifying final consonants, call it NONFIN(C).[10]

There are no CV content words. The CV items that do exist are all clitics, e.g. *dé* ‘but’, *ge* ‘indeed’, *ti* ‘INDEF.NEUT’. Given final consonant extrametricality, the expectation is that monosyllables that contain a long vowel or two coda consonants (CVV, CVV⟨C⟩, and CVC⟨C⟩) should satisfy bimoraic minimality, while CV and CV⟨C⟩ should not. There are indeed plenty of monosyllables with long vowels and diphthongs, and some CVCC monosyllables with short vowels as well.

(19) a. CVV: *gée* ‘land’, *dóo* ‘give (subj)’
b. CVVC: *p^{h}óos* ‘light’
c. CVCC: *háls* ‘salt’

Although in Gordon’s typology Greek is listed as a language with a match between stress and minimality weight criteria, the match is in fact not perfect. There is one situation where word-final codas are moraic: in CVC monosyllables. The bimoraic word minimum trumps non-finality and coerces the final consonant to carry a mora.

There are some (C)CV verb stems in Greek, *do-* ‘give’, *t^{h}e-* ‘place’, and *he-* ‘hurl’. Because these stems are bound, there is no way to test how their underlying CV structure would surface, but they can come very close to surfacing in a subminimal shape: the smallest affix this class of verbs can take is the aorist imperative *-s*. All other forms in the paradigm are either formed with longer affixes or from longer stem allomorphs.

The aorist imperatives of these stems are *dós*, *t^{h}és*, and *hés*; these are the only CVC content words in Greek. The only way in which a CVC word can be made consistent with the bimoraic minimum is if the final consonant does contribute weight, under pressure of the word minimum. In OT terms, this means that FTBIN outranks NONFIN(C). The final C is coerced by minimality to be moraic.

(20)

		DEP(μ)-V	FTBIN	NONFIN(C)
do-s	$do_{\mu}\langle s\rangle$		*!	
☞	$do_{\mu}s_{\mu}$			*
	$do_{\mu}o_{\mu}\langle s\rangle$	*!		

Without further evidence this argument is circular, for nothing indicates that [$do_{\mu}s_{\mu}$] is the correct output, rather than the homophonous [$do_{\mu}\langle s\rangle$]. The needed evidence comes from the accent of compound (prefixed) verbs. Just as ordinary verbs, prefixed verbs in their finite forms show a recessive accent. When the final syllable has a short V and ends in a single consonant, the accent falls on the antepenult. But the aorist imperatives of the four CV verbs, when prefixed with morphemes like *peri-*, *apo-*, etc. show an unexpected *penultimate* accent: *perí-t^{h}es* instead of the expected recessive **péri-t^{h}es* (21)a (Vendryes 1945: 128).

(21) a. perí-t^{h}es ‘put round’
par-én-t^{h}es ‘insert’
apó-dos ‘give away’
sym-pró-es ‘join in paying’ (from /hes/ with *h*-deletion)
b. pe.ri.(t^{h}es) *pé.(ri.t^{h}e)⟨s⟩

Under the moraic coercion analysis, the reason for the irregular accentuation of the verbs is apparent: the final *-s* of the stems *t^{h}es* and *dos* is moraic, and this moraicity is inherited by the prefixed form. The foot structure necessary for this is shown in (21)b.[11]

2.5. *Factorial typology of coercion*

As is now clear, moraic coercion and the attendant foot-word mismatches are inherent in the interaction of FTBIN and GW=PW. Far from undermining the PMH, the ubiquity of the languages with coercion-type effects such as the pattern in (7)d support the OT analysis. Moreover, in addition to analyzing three coercion systems in detail in the preceding section, I have provided empirical support for the effect from independent evidence. The argument is thus not circular: coercion is not simply invoked to save the PMH, but is grounded in facts independent of it.

In this section I will briefly explore the factorial typology of four relevant constraints: two for foot size (FTBIN and GW=PW), and two for the behavior of codas (WBP and *C_{μ}). Along the two parameters of interest — presence and type of minimality; behavior of CVC syllables with respect to stress — there are six possible grammars, as outlined below, with example languages for each type as described in Hayes 1995, Gordon 2004 [1999], or the discussion above.

(22) a. CVC heavy; CVC minimality
{FTBIN, WBP} ⟩⟩ {GW=PW, *C_{μ}}
Latin

b. CVC light; CVV minimality
{FTBIN, *C_μ} ⟩⟩ {GW=PW, WBP}
Comanche; Winnebago

c. CVC heavy; no minimality
{GW=PW, WBP} ⟩⟩ {FTBIN, *C_μ}
Klamath; Sentani; Tol; Munsee

d. CVC light; no minimality; CVC words are monomoraic
{GW=PW, *C_μ} ⟩⟩ {FTBIN, WBP}
Lenakel; Ossetic

e. CVC light; CVC minimality (coercion)
FTBIN ⟩⟩ GW=PW ⟩⟩ *C_μ ⟩⟩ WBP
Djaru; Walmatjarri

f. CVC light; no minimality; CVC words are bimoraic (overtly equivalent to [d])
GW=PW ⟩⟩ FTBIN ⟩⟩ *C_μ ⟩⟩ WBP

In the straightforward cases are (22)a, there is a match between stress and minimality. Languages in (22)c have no minimal word, discussed below in Section 3.1. The type (22)e is the coercion case — CVC is light for stress but heavy for minimality. Finally, the case (22)f combines absence of minimality with coercion. It differs from (22)d only covertly: both languages treat CVC as light for stress, and both allow CV and CVC words. In (22)d CVC words are monomoraic; in (22)f they are bimoraic under coercion. In Lenakel and Ossetic, where subminimal words occur, and CVC counts as light for stress, are compatible with both systems. I am not aware of evidence in either language of the special behavior of CVC words that would suggest they are in fact coerced to be bimoraic; discovery of such evidence remains for the future.

2.6. *Coercion in other types of prosodic systems*

The idea of coercion extends to other apparent mismatches, viz. those in (7)e: systems with unbounded stress; systems with syllabic trochees; systems with quality-sensitive stress. The common theme is that moraicity is negotiable, and can be forced by minimality.

Aguacatec is an example of a so-called unbounded system with a weight mismatch (McArthur and McArthur 1956) (Garrett's type [7e]). The default-to-same stress rule of the language places stress on the rightmost long vowel, else on the rightmost vowel, but the word minimum is CVC. Assuming, as Bakovic 2004 [1998] and McCarthy 2003 do, that such languages in fact have binary feet, not unbounded feet, this pattern submits to the same type of analysis as the preceding cases. The same ranking as in (22)e, FTBIN ⟩⟩ GW=PW ⟩⟩ *C_μ ⟩⟩ WBP, is responsible for the characteristic behavior of CVC in monosyllables. What distinguishes the stress system of Aguacatec from that of more familiar moraic trochee languages described above is the relative ranking of EXH(Wd), requiring syllables to be parsed by feet (23), and WSP, requiring each heavy syllable to be stressed. In this language, WSP is ranked high enough that feet over light syllables are not constructed. This issue is independent of the ranking implicated in coercion.

(23) EXH(AUSTIVITY)(wd) (cf. McCarthy 2008: 506)
'Every syllable is dominated by a foot node'

Syllabic trochee languages may also exhibit a weight mismatch (7)f, for example, Nyangumarta (Sharp 2004) and Garawa (Furby 1974, Hayes 1995). These languages display another variation on the theme of coercion. In both cases CVC syllables do not attract stress, but count for minimality. In Nyangumarta, the minimum is illustrated by words like [luɳ] 'kingfisher', [jaɻ] 'noise of footsteps', [taɻ] 'species of frog' (Sharp 2004: 51). Minimality is actively enforced, in that it blocks the deletion of high vowels between non-sonorants and liquids (2004: 59). In the following examples, the deletion applies only if it does not create a monomoraic prosodic word (the reduplicants behave as individual prosodic words here).

(24)

kuwarri → kwarri	'now'
pirirri → prirri	'man'
kura-kura ↛ *kra-kra	'place name'
piru-piru ↛ *pru-pru	'uninhabited'

Such languages only differ from those described above in the absence of vowel length, and thus require nothing new in the analysis: the same coercion ranking will produce the needed result.

Languages with vowel-quality stress also present nothing new from the standpoint of coercion. In Javanese, for example, the stress system distinguishes schwa from full vowels, avoiding stressed schwas; the minimal word is CVC (Hayes 1995: 262; Gordon 2006: 213), including CəC, e.g. [blək] 'cut down to size', [brəm] 'sugar foam cookie', [tər] 'go along with' (Suharno 1982: 16). In other words, stressed schwas are avoided except under pressure of minimality; the following tableau illustrates this coercion effect.

(25)

	GW=PW	*ə́	PENULTSTRESS
(Cə́CV)		*!	
☞ Cə(CV́)			*
☞ (Cə́C)			*
CəC	*!		

2.6. *Converse mismatches: CVC light for minimality, heavy for stress*

The coercion analysis of coda weight mismatches is further buttressed by the fact that mismatches in the opposite direction (CVC light for minimality, heavy for stress) do not exist. Indeed, they are not part of the factorial typology of standard constraints. Only a small number of potential cases have been mentioned in the literature; as I show in this section, the appearance of a CVV minimum in such languages is an illusion. (To be sure, CVV minimum is possible — e.g. in Ossetic and Lenakel — but only when CVC counts as light for stress as well as for minimality. I will go through the evidence from languages Gordon lists as having a CVV minimum mismatching with other weight criteria the following languages: Maithili, Cebuano, Chickasaw, and Finnish.[12]

Maithili is the simplest case: while it is true that the language has a CVV minimum, the absence of CVC words is not due to minimality but to a general prohibition against word-final codas, as a result of their deletion in Middle Indo-Aryan (Jhā 1985 [1958]: 132; Hayes 1995:

156; Garrett 1999: 99). While a more advanced dialect of Maithili described by Yadav (1996) subsequently lost many final vowels and thus regained final codas, that dialect also has lost vowel length, and thus has no minimality; cf. the many CV(C) words listed by Yadav: *gæ* 'cow', *bhɔ* 'pretense', *bhæ* 'brother', *das* 'servant', *pran* 'life' (1996: 15, 20, 31, 66). Thus, neither dialect of Maithili is thus an example of a CVV minimum.

Cebuano is also not a genuine example of a CVV minimum. Outside of loan words, the word minimum is actually disyllabic. There are some surface monosyllables, but all are derived by an optional rule of intervocalic *l*-deletion (Shryock 1993: 22).

The situation in Chickasaw is somewhat more complex. CVC counts as heavy for stress, as evidenced by the fact that rhythmic iambic lengthening applies to stressed CV but not CVC syllables; the minimal word is CVV. However, Chickasaw makes a further weight distinction: for primary stress, CVV is treated as heavier than CVC (Gordon 2004, Gordon and Munro 2007). Primary stress falls on a CVV syllable if there is one in the word, otherwise on the final syllable. When primary stress falls on a final CV, that syllable lengthens, though it remains shorter than, and distinct from, a lexical CVV syllable. Assuming that the lengthening does not add a mora, the constraint on primary-stressed feet in Chickasaw is that they must contain not just two moras, but two *vocalic* moras. This places *(CVC) words on one side of the cut, and (CVV) and (CVCV) words on the other. Thus, as far as the primary stress is concerned, there is no mismatch between the smallest foot and the smallest word.[13]

Finnish has CVV minimality where CVC is heavy for stress, and CVC words are actively avoided. For example, colloquial final *-i* deletion is blocked when a CVC would result: *olisi* → *olisi* 'he/she/it rose'; *nousi* → *nous* 'he/she/it rose'; *veisi* → *veis* 'he/she/it would bring'; but *pesi* 'he/she/it washed' ↛ **pes*, *kosi* 'he/she/it proposed (marriage)' ↛ **kos* (Kiparsky 2006). On the other hand, there is ample evidence from stress as well as meter that CVC is heavy (Anttila 2006, 2009; Hanson and Kiparsky 1996). Yet, the minimality mismatch is an illusion, because word-final consonants are in general not moraic. The crucial example is *lapsi* → *laps* 'child.NOM.SG'. Finnish thus furnishes a parallel to Greek, where final consonants are extrametrical *except* in monosyllables, under coercion by FTBIN. In Finnish, unlike Greek, NONFIN(C) outranks FTBIN.

In sum, in the cases where CVV minimality was claimed to coexist with heavy CVC, the CVV minimum is an illusion, as it results from factors other than the weight of CVC.

2.7. *Synthesis*

In the languages discussed in this section, the moraicity of consonants is negotiated by constraint interaction. Such an interaction can produce liberal minimality, viz. CVC words occurring in languages where CVC feet are otherwise not allowed. Of course, not all of the phonologies of languages with such a mismatch conveniently furnish the needed independent evidence of the type discussed above, but given the well-motivated nature of the phenomenon, it is safe to attribute such word-foot mismatches to it.

3. General consequences of OT for minimality

The discussion in the preceding section leads to two consequences. First, weight mismatches of a particular type — the most common type observed typologically — are not only unproblematic but expected given the standard analysis of foot size in OT. Second, and more generally, the lesson is that in OT, the relationship between minimal words and minimal feet is determined not by an all-or-none parameter, but by interaction of several constraints. That interaction projects a non-trivial empirical pattern, where not only perfect agreement between the sizes of words and

feet, but also certain mismatches are the norm. Thus, the PMH means not that minimal words are always minimal feet, but that the minimality facts should fall out from the same constraints that account for the rest of the prosodic system. It thus becomes necessary to scrutinize more thoroughly the previously unexplored range of mismatches predicted by the standard constraint system. The remainder of this section is an attempt to explore that typology.

I will begin with liberal minima in Section 3.1, where I show that languages with minimal foot size but no minimal word size are predicted to exist. In Section 3.2, I move to the more complex case of conservative minima, showing how subminimal feet can arise under pressure of WSP and alignment (3.2.1), and exploring the consequences of non-finality for minimality (3.2.2). I will conclude in Section 3.3 that the observed typology of minimality tracks closely the predictions of OT. In Section 4 I explore some outstanding issues.

3.1. *Liberal minima: Special protection for monosyllables*

There is a large number of languages whose stress systems require binary feet but where CV words are allowed (Hayes 1995: 88–89). Hayes proposes that languages that avoid degenerate feet may relax that prohibition under main stress, a parameter setting he calls "weak prohibition." As the sole foot of a monosyllable bears its main stress, there is no minimality in such languages.

Hayes' proposal can be translated into the constraint FTBIN(HEAD), a version of FTBIN specific to the word head (i.e. the main stress). If a faithfulness constraint such as DEP-μ, or any other antagonistic constraint, intervenes between FTBIN(HEAD) and the general FTBIN, the weak prohibition against degenerate feet results.

However, liberal word minimality of a similar type can also be derived with an otherwise well-motivated constraint, GW=PW. In a language with foot binarity, this constraint confers special protection to subminimal words. Consider the CV input /ta/. To satisfy FTBIN, it can be augmented to [(taa)], or it can remain monomoraic but unparsed by a foot [ta], vacuously satisfying FTBIN (such stressless outputs will be pronounced as clitics).[14] Other constraints decide what happens: DEP-μ militates against lengthening, GW=PW against morphological words that surrender their prosodic wordhood; EXH(wd) is violated by [ta], and NONFIN by any monosyllable, whatever its size, bearing a stress. The following tableau shows a ranking where [(ta)] wins.

(26)

	GW=PW	DEP-μ	FTBIN	EXH(wd)	NONFIN
/ta/ ☞ (ta)			*		*
(taa)		*			*
ta	*			*	

In longer words with enough material for a binary foot, GW=PW would not be violated by unfooted CV syllables. The following tableau for the hypothetical /pataka/ illustrates. The system exemplified in (26) and (27) has degenerate feet only in monosyllables.

(27)

		GW=PW	DEP-μ	FTBIN	EXH(wd)	NONFIN
/pataka/	(pata)(ka)			*		*
	(pata)(kaa)		*			*
☞	(pata)ka				*	

The GW=PW analysis of liberal minima is not empirically equivalent to Hayes' proposal, or its OT translation in terms of FTBIN(HEAD), because GW=PW says nothing about subminimal feet under main stress in longer words. A Hayesian analysis would entail that subminimal monosyllables should correlate with main-stress in subminimal feet elsewhere; the GW=PW makes no such connection.

Languages of both types are in fact found. For example, Dakota, an iambic language, in addition to having subminimal monosyllables, has exceptional initial stress in some words, which requires main-stress degenerate feet (Hayes 1995: 268, citing Miner 1979).[15] But other languages, e.g. Spanish, prohibit (CV) feet from occurring anywhere except in monosyllabic words. Both analytical possibilities are thus necessary.

An equivalent situation can arise in languages with 2σ minima as well; the analyses are identical: what is needed is for GW=PW to outrank the constraint that enforces disyllabic feet.

GW=PW is not the only constraint that may produce the liberal minimality effect. Positional faithfulness constraints that protect initial syllables can do so, too (Lombardi 1999, Smith 2003). Many languages possess a greater variety of segmental, tonal, quantitative, and accentual contrasts in initial syllables. Many Australian languages, for example, have a vowel quantity contrast only in initial syllables. DEP-μ plausibly exists in a version limited to the privileged initial position. If this special DEP-μ(Init) outranks FTBIN, which in turn outranks the general DEP-μ, foot minimality will only be enforced on non-initial syllables. In a left-to-right trochaic system, the result will be equivalent to word minimality being less strict than the general foot minimality.

3.2. *Conservative minima*

Languages with conservative minima present a more complicated picture from the point of view of OT. In the preceding section, liberal minima arose because of constraints that protect degenerate feet in monosyllabic words but not in longer words. Conversely, the common theme in the two following sections will be: what constraint(s) can protect degenerate feet in longer words, but not in monosyllables? The symptom of such a constraint's effect would be word minimality without foot minimality — a conservative minimum. As it turns out, it takes a combination of special circumstances to produce that effect, as I show in Section 3.2.1. In Section 3.2.2 I explore the ability of non-finality to produce conservative minima, following an idea put forth by Garrett, and conclude that the potential effect of non-finality on the predicted typology is quite limited.

The problem of conservative minima is complicated by the general rarity of non-final degenerate feet, under either primary or secondary stress (Hayes 1995: 87). Cahuilla, described in the next section, is one of the few languages where such feet have been seriously proposed. Other cases, e.g. Maithili and Eastern Ojibwe, invite reanalyses without degenerate feet (Hayes 1995: 161, 216). This typological gap, whatever its basis, makes it difficult to test predictions on conservative minima empirically.

However, for there to be a mismatch, the feet in polysyllables need not be degenerate. For example, if the smallest foot in longer words is monosyllabic and the smallest word is disyllabic, the minimum is conservative.

3.2.1. *WSP and alignment.* Cahuilla (Seiler 1977, Hayes 1995: 132, Garrett 1999) has a left-to-right moraic stress system where words beginning with LH are optionally assigned a degenerate foot with stress clash, e.g. [(sú)(kàʔ)ti] 'the deer.OBJ'. Other words appear to have the structure (LH), e.g. [(kávi:)(čìwen)] 'I was surprised'.[16] Despite the existence of main-stress degenerate (L) feet, Cahuilla has no lexical CV words; the smallest word is thus larger than the smallest foot. There are some CVC words, e.g. *net* 'ceremonial chief', *pal* 'water'. All CV items appear to be clitics or bound forms, such as *-na* 'father'; Cahuilla thus has coercion.

The degenerate foot in LH-initial words, Garrett notes, results from the desire to "stress the initial syllable and to stress all heavy syllables" (1999: 72). In other words, ALIGN-L(Ft) and WSP, outrank foot binarity and force suboptimal (L) trochees when no better option is available. Garrett suggests that this has no direct effect on the minimal word.

In a word-initial LH sequence, none of the parses is perfect: [L(H)] is non-exhaustive and non-left-aligned; [(LH)] violates WSP; [(L)(H)] has a monomoraic foot; [(H)(H)] is better in its foot structure but unfaithful to the quantity in the input.

Spelling out the analysis left implicit by Garrett requires three constraints to outrank FTBIN in order to allow (L) feet to surface: ALIGN-L(Ft) to prevent [su(kaʔ)ti], WSP to prevent [(sukaʔ)ti], and DEP-μ, violated by candidates with lengthening, to prevent [(suu)(kaʔ)ti] from surfacing. The optional choice between (LH) and (L)(H) is determined by the ranking of WSP and FTBIN. This is shown by the first subtableau in (28).

(28)

		ALIGN-L	DEP-μ	WSP	FTBIN	NONFIN
/sukaʔti/	su(kaʔ)ti	*				
☞	(sukaʔ)ti			*		
☞	(su)(kaʔ)ti				*	
	(suu)(kaʔ)ti		*			
/ta/	(ta)				*	*
	(taa)		*			*
☞	ta					

The second subtableau shows what happens to a monosyllabic input with these constraints. Neither ALIGN-L(Ft) nor WSP are applicable; together, DEP-μ and FTBIN prevent the input /ta/ from surfacing as either the subminimal [(ta)] or lengthened [(taa)]. This leaves [ta], the footless clitic monosyllable as the winner. Exactly this happens in Cahuilla: CV words are function word clitics. In the language as analyzed in (28), FTBIN is generally satisfied except in inconvenient initial LH sequences, where the last resort is a degenerate foot. Where violating FTBIN does not serve to satisfy higher-ranked ALIGN and WSP, degenerate feet are not tolerated — in the minimal word, or in the last syllables of words like [(sú)(kàʔ)ti], which remain unfooted (see Hayes 1995: 137 for a discussion of the final syllable in Cahuilla).

Garrett's broader claim is that the presence of (L) feet in words like [súkàʔti] has no effect on the minimal word, i.e. the choice of the output for /ta/ should be at least in part independent of the output for LH-initial words. Indeed, assuming [súkàʔti] is the winner, [(ta)] can win if EXH(wd) ranks high. This constraint will favor [(ta)] over [ta], but will have no effect on the choice between [(sukaʔ)ti] and [(su)(kaʔ)ti].

Thus, the presence of minimality is independent of the behavior of LH sequences.[17] (The inclusion of *CLASH, violated by [súkàʔti], does not affect the factorial typology in relevant respects.)

It is thus possible for the minimal word to be larger than the minimal foot, under special circumstances such as those that arise in Cahuilla. A similar pattern is found in some other languages, e.g. Bandjalang (Crowley 1978: 21).

3.2.2. *Non-finality*. The issue of conservative minima is tangled up with the role of non-finality in the typology. In a new variation on the PMH, Garrett proposes to derive a subset of minimality cases from the effects of NONFIN, with the following reasoning. All monosyllables necessarily have final stress. If final stress is categorically avoided — NONFIN is undominated — stressed monosyllables should be absent. A similar point has been made by Hyde (2001, 2003) in a different theoretical context.

Indeed, the presence of NONFIN predicts NONFIN-driven minimality when NONFIN outranks GW=PW, distinct from FTBIN-driven minimality. The symptom — absence of minimal words — can result from two underlying causes, and minima should come in two types, empirically distinguishable by the behavior of non-final degenerate feet. Tableau (29) illustrates two hypothetical inputs in a language with NONFIN-driven minimality. Subminimal words [(pá)] are absent (they surface as clitics in this case), but non-final subminimal feet are possible. An output like [(pá)(táka)] could not surface in a language with FTBIN-driven minimality, because that constraint is insensitive to the location of the degenerate foot in the word.

(29)

		NONFIN	EXH(Wd)	GW=PW	FTBIN
pa ☞	pa		*	*	
	(pá)	*			*
pataka ☞	(pá)(táka)				*
	pa(táka)		*		
	(páta)(ká)	*			*

Non-final degenerate feet are not common. For this reason, languages with what could be diagnosed as NONFIN-driven minimality are also rare. One example is Wajarri (Douglas 1981). Here, the minimum is disyllabic (with the sole excpetion of [t̪a] 'mouth' and some borrowings), and is enforced by the phonology, because final vowel deletion is blocked in disyllables (Blevins 2001: 30). However, degenerate feet are possible in non-final syllables. Primary stress is initial, and secondary stress penultimate, including in trisyllables, resulting in a clashing pattern: *σ́ σ̀ σ*; this is just the situation illustrated abstractly in (29) and requiring analysis with a high-ranked NONFIN.

The ranking NONFIN ⟩⟩ GW=PW can be apparent in ways other than Wajarri-type clash. For example, nothing prevents *both* FTBIN and NONFIN from outranking GW=PW. In such a

language, degenerate feet, final or not, would be impossible. However, NONFIN ⟩⟩ GW=PW could still have an effect if the language is iambic: it would push stress from the final syllable even if the foot size constraints are satisfied. Just such a scenario plays out in Hixkaryana: Garrett (1999: 73) attributes the CVCCV word minimum of this language, which is larger even than its maximal foot, to the action of NONFIN. Hixkaryana and other such cases join the list of languages that exemplify deviations from perfect foot-word agreement *predicted* by standard constraints, and thus requiring no special constraints on word length.

Having established that NONFIN can produce minimality, the next question is about the more general predictions of the theory on the implication relationship, if any, between non-finality and minimality — a question that has been of interest to other theorists (e.g. Kager 1995), and of direct relevance to the PMH-OT. Garrett (1999: 89) is cautious not to claim any such relationship.

A more refined hierarchy of non-finality constraints proposed by Garrett (see [35a]) and Hyde can produce a range of minima, including CVX minima in languages whose minimal feet are not CVX. I will use the slightly simplified version of NONFIN (30) rather than the more elaborate hierarchies proposed by Garrett and Hyde.[18]

(30) a. NONFIN
'The final syllable of a word is not the head of a foot'
b. NONFIN(CV)
'The final CV (light) syllable of a word is not the head of a foot'[19]

First, the implication from non-finality to minimality plainly does not hold. Even in a language without final stress, subminimal monosyllables can be protected by coercion, or by one of the mechanisms outlined in Section 3.1 above. Hayes (1995: 89) lists a good number of such languages. The ranking that is needed for this is GW=PW ⟩⟩ NONFIN ⟩⟩ EXH(Wd), with FTBIN ranking at least below GW=PW.

(31)

		GW=PW	NONFIN	EXH(Wd)
pa ☞ (pá)			*	
pa		*		*
pataka ☞ (páta)ka				*
(páta)(ká)			*	

The converse implication, from minimality to non-finality, is more tricky. Let us deal first with the simpler case, languages with syllabic trochees and no quantity contrasts, where the two versions of NONFIN in (30) coincide. The following table crosses the two parameters, presence vs. absence of minimality and non-finality. The question is only meaningful as applied to primary stress, given the difficulties with evaluating secondary stress evidence on final syllables (Hayes 1995, Garrett 1999).

(32) No vowel length contrast

	*ó#	ó#
no minimal word	(liberal minimum)	*match*
2σ minimum	*match*	*impossible*

The shaded cells labeled *match* have agreement between non-finality and minimality, achieved by either high- or low-ranked NONFIN.

Languages with a 2σ minimum but final stress, are impossible to derive using standard constraints. Such a language would allow a subminimal foot over a final syllable of a longer word, but not over a monosyllable. But any plausible constraint that would trump FTBIN to the former case would also apply to the latter. ALIGN-R, for example, which would force stress to be as far to the right as possible, would not distinguish between polysyllables and monosyllables. So would any constraint militating against syllables unparsed by feet (EXH[Wd]), and any constraint directly calling for final stress.

Thus, the non-finality version of the PMH makes a unidirectional prediction: if a language has minimality, it obeys non-finality, at least for primary stress. (I have verified this claim with the use of OTSoft (Hayes, Tesar and Zuraw 2003), using NONFIN, FTBIN, DEP, FAITH(Stress), GW=PW, ALIGN-R and EXH(Wd). To save space, I leave this exercise to the reader.)

Moving on to languages with a vowel length contrast, we must consider two types of minimum (2μ and 2σ), and two degrees of stringency of non-finality: prohibition against all final stress and prohibition against final stress only on light syllables (cf. constraints in (30) and [35a]). Once again, languages with liberal minima are possible. The shaded cells once again contain languages where NONFIN fully accounts for minimality. As for languages without non-finality but with minimality, there are three types to consider, listed in (34).

(33) Vowel length contrast

	*CV́# *CV́V#	*CV́# CV́V#	CV́# CV́V#
no minimal word	(liberal minimum)	(liberal minimum)	*match*
2μ	(liberal minimum)	*match*	(34)a
2σ	*match*	(34)b	(34)c

(34) a. Absolute non-finality, 2μ minimum
b. *CV́# non-finality, 2σ minimum
c. Absolute non-finality, 2σ minimum

Once again, none of these three language types are derivable in standard OT, for the same reasons outlined above: there are no constraints that favor final stress in longer words without also favoring it in shorter words. That we are considering a more complex situation with final CVV syllables changes nothing: the question is, still, whether any constraint can protect a degenerate foot over a final syllable of a polysyllabic word without also protecting the same degenerate foot on a monosyllable. And the answer is the same: there is no such constraint.

The picture matches typological observations quite well. I am not aware of good examples of languages with minimality but where final primary stress is possible, a point already made by Garrett. One potential example is Alyawarra (Turtle 1977, Yallop 1977, Gordon 2005). Final

stress occurs in all and only words where the initial syllable is onsetless; otherwise stress is initial. The minimum, however, is disyllabic. However, the disyllabic minimum does not hold of surface forms: word-initial *a-* is frequently deleted, resulting in monosyllabic surface forms (Yallop 1977: 27).

3.3. *Synthesis: the OT typology of minimality*

In the preceding sections we have seen several types of mismatches between minimal words and minimal feet that are predicted by uncontroversial OT constraints. Cahuilla illustrates avoidance of trapped syllables resulting in degenerate feet with no effect on the minimal word. Dakota and many other languages afford special protection to monosyllabic forms, through the action of GW=PW or similar constraints. Non-finality can also produce minimality effects, though its effect on the overall typology is limited.

While the situation in OT is more complex than in a parameter-based theory, the scope of disagreement between smallest words and smallest feet is not unlimited. While liberal minima are easy to produce with GW=PW and coercion, conservative minima require a combination of special circumstances, as in Cahuilla. This predicted tendency for word-foot mismatches to lean in the liberal direction tracks the empirical reality well.

We are now in a position to reassess Garrett's observation that "minimal words are not minimal feet." First, the majority of observed mismatches are taken care by coercion; this is the case for (7)d. Conservative minima as (7)a and disyllabic minima (7)b are predicted by standard constraints as well. Remaining are CVVC minima (7)c. Garrett cites Menominee; this language has a typologically aberrant process of lengthening in closed syllables, which accounts for the CVVC minimum (Milligan 2005). There are other languages with CVVC minima, for example Gumbaynggir (Eades 1979) or Guugu Yimidhirr (Haviland 1979). In these languages, CVV counts as heavy for stress, and words may not end in vowels, but CVV monosyllables are generally absent, while CVVC words occur. This type of minimum remains problematic, because it cannot be derived with standard constraints. I speculate on the nature of these minima in the final section of the paper.

Garrett's own analysis of the typological facts rests on assumptions quite different from those that inform this paper. He offers two sources of minimality effects: a set of non-finality constraints, militating against word-final stress on CV, CVX, and CVXX (35)a, and a set of constraints directly penalizing short words (35)b.

(35) a. NONFIN(CV) ⟩⟩ NONFIN(CVX) ⟩⟩ NONFIN(CVXX)
b. BE(CV)LONG ⟩⟩ BE(CVX)LONG ⟩⟩ BE(CVCV)LONG

Garrett attributes the ubiquity of CVC minima to duration-based minimality, implemented directly with constraints against short words. Since CVC and CVV have roughly the same duration, and if minimality is a matter of preference for phonetically longer words, Garrett argues, then there is little reason for a language to distinguish CVC from CVV with respect to the word minimum, regardless of the weight distinctions made elsewhere in the grammar. The constraint BE(CVX)LONG covers both CVC and CVV, and accounts for coercion-type mismatches.

The use of BELONG constraints amounts to abandoning the PMH. Such constraints predict the word-foot size relationship to be random. Because all the patterns they are designed to explain can be analyzed with existing mechanisms, the constraints in (35)b are plainly superfluous.

The only attractive quality of the BELONG theory is that all, or almost all, word-foot minimum mismatches are explained by the same constraints, in contrast to the assortment of devices that Standard OT must resort to for the same data. But the absence of a single explanation for the counterexamples to the PMH should not come a surprise, especially in the context of OT. Indeed, the sheer number of relevant constraints and the complexity of their interaction might lead one to expect something close to chaos in this domain. It is all the more remarkable that the observed situation is not so unruly.

4. Outstanding issues: concurrence and subversion

The PMH-OT appears in good shape: most apparent counterexamples to the classic PMH are in fact predicted by the standard constraint system. In this concluding section I will briefly discuss two related factors outside of that constraint system that may potentially affect the typology of minimality, but which will remain for future investigation: root minimality and non-surface-true minimality.

A language where bare roots can surface as words can satisfy a word minimum in one of two ways: either by augmenting underlyingly subminimal roots through lengthening or coercion, or by requiring that the roots themselves observe the minimum. The root minimality strategy, dubbed *concurrence* by Ketner (2006), is used, among other languages, by German, where words are minimally bimoraic, and roots also must observe the same minimum. The same is true in many languages with disyllabic word minima, where roots are also obligatorily disyllabic. Root minimality concurs with word minimality and helps to enforce it.

Root constraints have an odd place in OT. While the theory tolerates no constraints on inputs, restrictions on underlying forms can be brought in through the back door, via occultation, a phenomenon familiar from Stampe 1979 [1973] and Prince and Smolensky 2004 [1993]. Lexicon optimization forces inputs not to deviate too far from optimal outputs. If outputs are constrained in a certain way, it may appear that so are inputs, by virtue of their closeness to outputs. For minimality, this means that subminimal roots never occur because a larger root is always a closer underlying form to the observed surface forms. Such constraints on inputs are not real, in the sense that they arise as side effects of constraints on surface words. They are not synchronically active, enforceable generalizations, but mere descriptive facts about the lexicon.

Root constraints due to concurrence are kept on a short leash. As Ketner argues (2006: 173), root size constraints only occur in languages with word size constraints, and if they do, root constraints are identical to the word constraints. Under this view, there are only two types of languages with word minima: Latin-like, where roots can be small but are repaired when they surface bare, and German-like, where roots are large enough to begin with.

While concurrence is well-motivated in many languages, the tight correlation between root and word minima alleged by Ketner is difficult to reconcile with the view that the former is a long-term side-effect of the latter. Surface-oriented components of grammar change faster than the lexicon, thus making it possible for word constraints to decouple from root constraints. In Diyari, for example, all roots are disyllabic, but words are not, because VGV sequences surface as long vowels as a result of a recent sound change (Austin 1981). Another example from Pintupi is described in fn.5. The relationship between the two sets of constraints is less straightforward than Ketner lets on.

It remains an open question whether root size constraints can exist independently of, and in addition to, constraints on words (cf. Golston 1991, Downing 2006), and whether they are true

synchronic generalizations rather than long-term consequences of lexicon optimization and occultation.

Another open question is the extent that non-prosodic factors may play a role in root size constraints. One plausible issue is neighborhood density, the measure of closeness a form has to other forms in the language (Goldinger et al. 1989). The shorter a sequence of phonemes, the more similar it is, on average, to a random sequence of the same length (Frauenfelder et al. 1993, Wedel 2002). Thus, short roots reside in neighborhoods of greater density than longer roots. Sparser neighborhood density reduces the difficulty of the task faced by the parser, and thus contributes to better recoverability. Because longer roots are more different from each other, and thus their identity is more easily recoverable in the noisy signal, languages may avoid shorter roots. Many languages prohibit roots consisting of a single segment; if such roots are not excluded for prosodic reasons (as they are allowed in e.g. Latin), neighborhood density is a plausible source. Likewise, CVVC minima, which remain problematic from the point of view of prosodic theory, may turn out to result from root minimality.

From the point of view of this study, the question is whether a root minimum, whatever its nature, can ever have an effect that appears to be incompatible with the PMH. In particular, are root minima necessarily related to the prosodic system of the language in which they are embedded? For word minima, that tie is the constraint system itself; it is less clear what the tie would be for a phenomenon not derived from constraint ranking. A typological investigation of root minima would answer this question; such an investigation remains for the future.

Related to the issue of root minima is the phenomenon I will call *subversion*: situations when an enforced minimum is not true at surface structure. The problem of opacity — enforcement of generalizations at a level other than the surface — is a general problem, present in minimality as well elsewhere in phonology. The question of interest here is to what extent it undermines the PMH.

Mono provides a clear example of subversion. There, minimality-driven epenthesis, which inserts word-initial copies of the root vowel, precedes epenthesis into clusters (36)a (Olson 2001:83). The minimum is enforced, but not at surface structure. Likewise, in Anguthimri, minimality-driven lengthening in monosyllabic inputs precedes the optional ə-epenthesis before word-initial voiced fricatives and [r] (36)b (Crowley 1981: 152).

(36) a. Mono /gbrà/ → àgbrà → àgbàrà ‘bridge’
b. Anguthimri /ra/ → ra: → əra: ‘stomach’

A strong hypothesis would be that root constraints are fossilized word constraints that have been subverted by subsequent sound changes. If true, this hypothesis would imply that root minima are not problematic for the PMH.

Testing this hypothesis remains for the future.

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[1] I am grateful to audiences at Stanford, Berkeley, the University of Ottawa, and the CUNY Graduate Center conference on the Word for useful comments, as well as to two anonymous reviewers for helpful criticism.
[2] Thomas Huxley, “Biogenesis and abiogenesis” (1870).
[3] This word comes from **ex-sec-t-a*; the root disappeared through vowel weakening and degemination.
[4] Languages with conservative minima are less permissive about word size than about foot size, while the liberal minimum languages allow their words to do more than their feet.
[5] Garrett lists Pintupi in this category. Pintupi generally has a disyllabic minimum; the only exception is the word *tja:* ‘mouth’, which presumably leads Garrett to classify it as CVX. But *tʲa:* is plausibly an underlying disyllable,

because Pintupi has a transparent glide-deletion process applying between two [a]s when the first is preceded by a palatal, whose output is a long [a:] (/C^{j}aja/ → [C^{j}a:]) (Hansen and Hansen 1969: 167). The lone monosyllable could be treated as underlyingly /t^{j}aja/, and the disyllabic minimum is then exceptionless.

[6] It is somewhat worrisome that the words in (11) are the only relevant data points that Tsunoda supplies, but we can be comforted by the knowledge that Djaru is not the only language with a pattern that supports my argument.

[7] There is another allomorph of the ergative, *-gulu*, but it attaches to stems ending in *b*, *g*, or *ŋ* (Tsunoda 1981: 55).

[8] The mechanism by which the derived form retains the mora of the base is not spelled out here; the reader's favorite theory of phonology-morphology interface can supply one (e.g. output-output constraints (Benua 1997) or Stratal OT (Kiparsky 2009), to name just two). There is no need to enter this thicket here.

[9] Hammond 1994 is wrong to claim that Walmatjarri has no lexical monosyllables.

[10] Translated into the framework of Hyde 2003, this constraint would become μNonFinal(C,ω) 'No mora-level gridmarks over the final consonant of a word'.

[11] Once again, reader's choice theory of phonology-morphology interface will supply a mechanism by which the moraicity of the consonant in the base is inherited by the prefixed form. See Kiparsky 2003 for an analysis of the Greek phonology-morphology interface.

[12] Hayes (1995: 202) also suggests that Djingili has syllabic trochees and a CVV minimum. However, as Chadwick (1975: 1) proposes, the long vowels of Djingili can be treated as two short vowels, and the minimum is thus disyllabic.

[13] I am grateful to Matt Gordon for clarifying this issue.

[14] As discussed at length by Prince and Smolensky 2004[1993], there is also the possibility of a null parse [∅] — not pronouncing such an input at all. I will not consider such outputs in the discussion here, so that the factorial typology does not become overly cluttered. Little would change in the substance of my points if [∅] is included.

[15] It is striking that many, perhaps most, of the languages in this category do not have contrastive vowel length. Such are: Dakota, Inga, Sentani, Spanish, and Tol. Perhaps the correlation between the weak prohibition against degenerate feet and the lack vowel length is a diachronic one: at least some of these languages (e.g. Dakota and Spanish) have lost length recently, resulting in both subminimal words (CVV > CV) and the exceptional CV feet inside longer words in Dakota.

[16] Hayes (1995: 136) notes, citing a personal communication from Seiler, that the difference between feet like (*kávi:*) and (*ká*)(*vì:*) is difficult to transcribe. Let us assume for the sake of argument that this difference, however subtle on the surface, is phonological.

[17] As far as I can tell, in a Cahuilla-type system it is impossible to derive lengthening in monosyllables if (L) feet are allowed in longer words.

[18] Other versions of NONFIN can prohibit the final syllable from being parsed by a foot rather than from being its head, and that version also may affect the minimal word. In particular, if undominated, it may produce a three-syllable minimum in a language with trochaic feet — a prediction that is clearly pathological. In an effort to keep things simple, I stick to (30) in this discussion, and set such obvious pathologies aside.

[19] The two constraints in (30) are equivalent to Hyde's FNonFinal(σ,ω) 'No foot-level gridmark over the final syllable of a prosodic word' and FNonFinal(μ,ω) 'No foot-level gridmark over the final mora of a prosodic word'.

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