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Morphological Complexity and Prosodic Minimality*

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Abstract

It is widely attested, cross-linguistically, for both words and prosodic morphemes to be required to be minimally bimoraic or disyllabic. Work since McCarthy and Prince (1986) argues that these minimality effects fall out from the Prosodic Hierarchy. Requiring the relevant morpheme to be a Prosodic Word and dominate a stress Foot automatically also imposes a two mora or two syllable minimality requirement. In this paper I show, based on a reanalysis of reduplication in Axininca Campa, that this Prosodic Hierarchy-based theory of minimality is inadequate. I argue instead that morphological minimality conditions are better explained as a form of Head-Dependent Asymmetry (Dresher and van der Hulst 1998). Head morphemes are enhanced by requiring more complex prosodic structure, mirroring their more complex morphological structure. This alternative approach not only provides a uniform account of minimality effects holding for Axininca Campa reduplication, it also solves the problems raised by McCarthy and Prince's (1993, 1995) analysis of the data.

Key words: compounds, head-dependent asymmetry, minimal word, minimality, onset, Optimality Theory, positional prominence, prosodic hierarchy, prosodic word, reduplication, stem; Axininca Campa, Diyari.

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1. Introduction

As work like McCarthy and Prince (1986) shows, it is widely attested, cross-linguistically, for the lexical words of a language to be required to have a minimum size, typically two moras or two syllables. Prosodic morphemes, like reduplicants, also often have this same minimum size. The standard analysis of these minimality effects is that they fall out from the Prosodic Hierarchy (McCarthy and Prince 1986, 1993, 1999; McCarthy 2000; Hayes 1995; Prince and Smolensky 1993; Selkirk 1995):

(1) Prosodic Hierarchy

Prosodic Word
|
Foot
|
σ
|
μ

In this hierarchy, each Prosodic Word must contain at least one stress Foot; and each stress Foot must contain minimally (and maximally) two moras or two syllables. Therefore, any morpheme parsed as a distinct Prosodic Word must minimally contain one bimoraic or disyllabic stress foot. Minimality (and maximality) conditions on morphemes are then straightforwardly accounted for by parsing the relevant morpheme as a Prosodic Word.

While this theory of minimality is very elegant, it faces recognized empirical problems. For example, work like Downing (1999, 2000, 2005) shows that the reduplicative morpheme in many Bantu languages is minimally disyllabic, yet tonal processes do not treat the reduplicative morpheme as a separate Prosodic Word from the Base. Similarly, Urbanczyk (1996) shows that the distributive reduplicative morpheme in Lushootseed is a CVC syllable, yet this syllable type is not a possible minimal foot in the quantity-insensitive trochaic stress system of the language. A further problem is that work like Itô (1990) and Ussishkin (2000) has shown that derived words are often subject to a disyllabic minimality condition while underived words are not, even though both are clearly Prosodic Words.

The goal of this paper is to argue for an alternative theory of minimality conditions which addresses these problems. I follow Dresher and van der Hulst (1998) in proposing that morphological minimality conditions are better explained through the correlation between morphological and phonological complexity that follows from Head-Dependent Asymmetries pervasive in phonological systems. More concretely, Head morphemes like Stem and Root are subject to minimality to satisfy a requirement that Heads branch, creating an asymmetry with non-branching non-Heads (Affixes). Derived words (Stems) can be subject to a disyllabic minimality requirement while underived words are not, as they have more complex morphological structure.

The argument is organized as follows. Section 2 briefly presents reduplication in Diyari to illustrate the Prosodic Hierarchy-based theory of minimality. Section 3 presents McCarthy and Prince's (1993, 1995) analysis of Axininca Campa reduplication, and shows that it in fact contradicts the central claim and predictions of the Prosodic Hierarchy-based theory of minimality. Section 4 develops an alternative theory of minimality, and illustrates it with a reanalysis of Axininca Campa reduplication.

2. How the Prosodic Hierarchy accounts for minimality

The central claim of the Prosodic Hierarchy-based theory of minimality (McCarthy 2000; McCarthy and Prince 1993, 1994a, b, 1999; Prince and Smolensky 1993) is that any constituent (e.g., word or reduplicative morpheme) subject to a bimoraic/disyllabic minimality condition is parsed as a distinct Prosodic Word. Markedness constraints define each Prosodic Word as minimally (and maximally) coextensive with a stress Foot, the constituent dominated by Prosodic Word in the Prosodic Hierarchy (1). To illustrate, in Diyari (an Australian language) the reduplicative prefix (underlined) is disyllabic:

(2) Diyari reduplication (McCarthy and Prince 1994a: 350, fig. (29))

a.	wíl̪a	wíl̪a-wíl̪a	'woman'
b.	kánku	kánku-kánku	'boy'
c.	kúɭkuŋa	kúɭku-kúɭkuŋa	'to jump'
d.	tʲílparku	tʲílpa-tʲílparku	'bird sp.'
e.	ŋánkan̪t̪i	ŋánka-ŋánkan̪t̪i	'catfish'

As McCarthy and Prince (1994a, b, 1995, 1999) argue, we can account for this disyllabic size constraint without recourse to a reduplicative template. The reduplicant is labeled a Stem, so that the reduplicative construction is a Stem-Stem compound. The constraints in (3) correctly optimize its disyllabic minimal and maximal size:

(3) a. STEM → PRWORD HOMOLOGY: Stem ≈ Prosodic Word (McCarthy 2000)
Align the left and right edges of every Stem with the left and right edges of some Prosodic Word.

b. HEADEDNESS (Orie 1997; Selkirk 1995)
Any prosodic category [of the Prosodic Hierarchy (1)] C^i must dominate a C^{i-1} [e.g., Prosodic Word must dominate a Foot].

c. BINARITY (McCarthy and Prince 1993; Prince and Smolensky 1993; Orie 1997)
A prosodic constituent contains exactly two daughters [i.e., Prosodic Word contains exactly 2 Feet; Foot contains exactly two syllables or moras; syllable contains exactly two moras].

By transitivity, each Stem (reduplicative or other) must minimally contain two syllables or two moras.

This approach is known as Prosodic Hierarchy-based Generalized Template Theory (GTT) because the general principles of constituent parsing and constituent size in (3) define the size constraints on reduplicative morphemes. No reduplication-specific template is required. This theory of minimality makes the following predictions, all borne out by Diyari (McCarthy and Prince 1995, 1999; Poser 1989). All morphemes parsed as Prosodic Words satisfy the same minimality requirement. In Diyari, reduplicative morphemes, like other Prosodic Words are minimally disyllabic (Poser 1989). Each Prosodic Word is a stress domain (i.e., independently aligned with stress Feet). In Diyari, the reduplicative morpheme is assigned main stress, independent of the Base, like other Prosodic Words. All morphemes parsed as Prosodic Words undergo the phonological processes conditioned by the Prosodic Word domain (edge). In Diyari, the reduplicative morpheme ends in a vowel, a requirement holding for all Prosodic Word-final syllables. As McCarthy and Prince (1995, 1999) and Poser (1989) argue, defining the reduplicant as simply a Foot, rather than a Prosodic Word, would incorrectly predict that the reduplicant Foot and Base Foot would segmentally match, to give, for example: **(t^{j}ílpar) = (t^{j}ílpar)ku*.

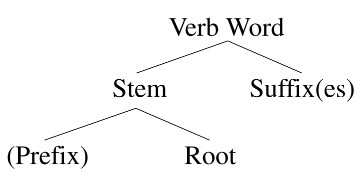
In the next section, we shall see how this theory attempts to account for minimality conditions on Axininca Campa reduplication (McCarthy and Prince 1993, 1995). In fact, it will become clear that the analysis of Axininca Campa raises serious problems for Prosodic Hierarchy-based GTT.

3. Minimality and reduplication in Axininca Campa[1]

3.1. The data to be accounted for

Axininca Campa is an Arawakan language spoken in Peru. Verbs in Axininca Campa have the morphologically complex structure in (4):

(4) Verb structure of Axininca Campa (Payne 1981; Wise 1986)



As Payne (1981) shows, all verbs consist minimally of a Stem + Tense/Aspect suffix. The Stem ((Prefix) + Root) is the Base for reduplication (and inflectional

1. The data in the paper comes from Payne (1981), Spring (1990, 1991) and McCarthy and Prince (1993, 1995). Citations are mainly to McCarthy and Prince (1993, 1995), to facilitate comparison with their analysis.

affixation), and forms a distinct phonological domain from the rest of the word (Payne 1981; McCarthy and Prince 1993). While the Stem is canonically bimorphemic, prefixes do not occur in the infinitive.

The data in (5) show that total Stem reduplication is productive for verbs. Note, though, that the Prefix is not reduplicated if the Root has two or more syllables. (In the following examples, «]» marks the right Stem edge; the reduplicative morpheme (RED) is underlined; prefixes are italicized; epenthesized material is also italicized.)

(5) C-initial Stems of two or more syllables (McCarthy and Prince 1993: 63, fig. (1), 64, fig. (4); Spring 1990: 106)

a. Without prefix		b. With prefix
kawosi]-kawosi-wai-*t*-aki	'bathe'	*noŋ*-kawosi]-kawosi-wai-*t*-aki
tʰaaŋki]-tʰaaŋki-wai-*t*-aki	'hurry'	*non*-tʰaaŋki]-tʰaaŋki-wai-*t*-aki
kintʰa]-kintʰa-wai-*t*-aki	'tell'	*noŋ*-kintʰa]-kintʰa-wai-*t*-aki

The role of minimality in Axininca Campa reduplication is illustrated by the monosyllabic and vowel-initial Roots in (6) and (7). As shown in (6), monosyllabic C-initial Bases are augmented either by epenthesis (6a) or by including the Prefix in the Base (6b). A further point illustrated by the prefixed forms is that the Base and reduplicative morpheme are both disyllabic if the Base is a bimorphemic Prefix-Root complex. Bimoraic Bases (and reduplicative morphemes) are not augmented to disyllabicity, though, showing that this is an alternative minimality target:

(6) C-initial monosyllabic Stems (McCarthy and Prince 1993: 63, 64)[2]

a. Without prefix		b. With prefix	
p*aa*]-paa-wai-*t*-aki	'feed'	*no*-wa]-nowa-wai-*t*-aki	/p-/
naa]-naa-wai-*t*-aki	'chew'	*no*-naa]-nonaa-wai-*t*-aki	/naa-/
		**no*-naa]-naa-wai-*t*-aki	
na*ta*]-nata-wai-*t*-aki	'carry'	*no*-na]-nona-wai-*t*-aki	/na-/
tʰo*ta*]-tʰota-wai-*t*-aki	'kiss, suck'	*non*-tʰo]-nontʰo-wai-*t*-aki	/tʰo-/

The vowel-initial roots in (7) confirm the role of a disyllabic minimality condition on the reduplicative morpheme. The data in (7a, b) show that the initial vowel of longer roots does not appear in the reduplicative morpheme, arguably to avoid hiatus between the Base and the reduplicative morpheme. However, the initial vowel of disyllabic Roots (7c, d) does appear in the reduplicative morpheme, even if the remainder would be bimoraic (compare the first two forms in (6a) with (7c)). The motivation for including the initial vowel must be to satisfy disyllabic minimality:

2. As McCarthy and Prince (1993: fn. 24) note, the Root-initial /p/ in the form for 'feed' in (6b) spirantizes to [w] after a prefixal vowel by a regular —though phonologically idiosyncratic— process of Axininca Campa.

(7) V-initial Roots (McCarthy and Prince 1993: 63, 64)

Roots of 3 or more syllables:

a. Without prefix		b. With Prefix
osaŋkina]-saŋkina-wai-*t*-aki	'write'	*n*-osaŋkina]-saŋkina-wai-*t*-aki
osampi]-sampi-wai-*t*-aki	'ask'	*n*-osampi]-sampi-wai-*t*-aki
aacik*a*]-cika-wai-*t*-aki	'stop'	*n*-aacik*a*]-cika-wai-*t*-aki

Disyllabic Roots («||» indicates Prosodic Word break):

c. Without prefix		d. With prefix
api || apii-wai-*t*-aki	'repeat'	*n*-apii]-napii-wai-*t*-aki
*api || pii-wai-*t*-aki		
asi || asi-wai-*t*-aki	'cover'	*n*-asi]-nasi-wai-*t*-aki
ooka || ooka-wai-*t*-aki	'abandon'	*n*-ooka]-nooka-wai-*t*-aki

As we can see, both the Base Stem and the reduplicative morpheme are subject to minimality requirements in Axininca Campa. A critical review of McCarthy and Prince's (1993, 1995) analysis of these minimality effects is presented in the next section.

3.2. McCarthy and Prince's (1993, 1995) analysis

McCarthy and Prince (1993, 1995) develop a detailed analysis of Axininca Campa reduplication. This section summarizes their treatment of the minimality conditions holding for the reduplicative morpheme and the Base. The data in (6) show that bimoraic Roots must satisfy a minimality condition on the Base, as they are not augmented. This is accounted for by the constraint in (8) defining the Base for suffixation (including reduplication) as a Prosodic Word:

(8) ALIGNSFX: Align(L, Suffix; R, Prosodic Word)
The left edge of every suffix coincides with the right edge of some Prosodic Word (McCarthy and Prince 1995: 300).

As the minimal stress Foot in Axininca Campa is minimally bimoraic, Prosodic Words must also be minimally bimoraic (McCarthy and Prince 1995). The constraint in (8), then, is consistent with Prosodic Hierarchy-based GTT in accounting for the minimality conditions on the Base by parsing it as a Prosodic Word. The constraint in (9) accounts for why CV Bases are augmented to two syllables rather than only two moras: augmenting to two moras by lengthening the input vowel would misalign the input stem with a syllable.

(9) ALIGN-R: Align(Stem, Right; σ, Right)
The right edge of every [lexical] stem coincides with the right edge of some syllable (McCarthy and Prince 1995: 306).

These points are illustrated by the tableau in (10):

(10)

/tʰo-RED-/	ALIGNSFX	ALIGN-R	RT-ANCHOR-BR	DEP-IO	MAX-BR
☞a. tʰo*ta*]-<u>tʰota</u>]-				**	
b. tʰo]-<u>tʰo</u>]-	*!				
c. tʰo*ta*]-<u>tʰo</u>]-			*!	**	**
d. tʰo*o*]-<u>tʰoo</u>]-		*!		*	

Candidate (10a) is optimal, as it only violates constraints against epenthesis into the Base. Not epenthesizing, as in candidate (10b), is non-optimal because this violates ALIGNSFX (8): the Base is not a bimoraic Prosodic Word. RT-ANCHOR-BR requires material at the right edges of the Base and the reduplicative morpheme to match. It is violated when epenthetic material in Base does not appear in RED, as candidate (10c) illustrates. Candidate (10d) is non-optimal, as lengthening the Base vowel misaligns the input stem /to-/ with the output syllable, in violation of ALIGN-R (9).

As we saw in (6) and (7), there is a disyllabic minimality condition on the reduplicative morpheme. As Prosodic Words are only required to be minimally bimoraic, McCarthy and Prince (1993) propose that a distinct minimality constraint is required to account for this, namely, the reduplication-specific constraint, DISYLL:

(11) DISYLL (McCarthy and Prince 1993: 87, fig. (49)):
The left and right edges of the Reduplicant [RED] must coincide, respectively with the left and right edges of *different* syllables.

The constraint ranking, DEP-BR/DEP-IO » DISYLL » RED≤ROOT, optimizes copying the prefix to satisfy disyllabic minimality. (The constraint RED≤ROOT accounts for the fact that prefixes are only copied in order to satisfy disyllabic minimality.) The tableau in (12) exemplifies the analysis with a prefixed form of the verb in (10):

(12)

/*non*-tʰo-RED-/	ALIGNSFX	RT-ANCHOR-BR	DEP-IO	DISYLL	RED≤ ROOT	MAX-BR
☞a. *non*-tʰo]-<u>nontʰo</u>]-					*	
b. *non*-tʰo]-<u>tʰo*ta*</u>]-		*!				***
c. *non*-tʰo]-<u>tʰo</u>]-				*!		***

Notice that the winning candidate, (12a), violates only RED≤ROOT by copying prefixal material. Other candidates violate higher-ranked constraints. The reduplicative morpheme in candidate (12b) satisfies DISYLL by epenthesizing material not found in the Base, in violation of RT-ANCHOR-BR. The reduplicative morpheme in candidate (12c) violates DISYLL.

Tableau (13) shows why it is optimal not to augment bimoraic Bases:

(13)

/naa-RED-/	ALIGNSFX	RT-ANCHOR-BR	DEP-IO	DISYLL	RED≤ ROOT	MAX-BR
☞a. naa]-<u>naa</u>]-				*		
b. naa]-<u>naa*ta*</u>]-		*!				
c. naa*ta*]-<u>naata</u>]-			*!*			
/*no*-naa-RED-/	ALIGNSFX	RT-ANCHOR-BR	DEP-IO	DISYLL	RED≤ ROOT	MAX-BR
☞d. *no*-naa]-<u>nonaa</u>]-					*	
e. *no*-naa]-<u>naa</u>]-				*!		**

Candidate (13a) is optimal, even though it violates DISYLL, as competing candidates violate higher-ranked constraints. Because bimoraic Bases satisfy ALIGNSFX (8), augmentation of a bimoraic Base incurs gratuitous DEP violations. This is why candidate (13c) is non-optimal. Augmenting only the reduplicative morpheme to a disyllable leads to a violation of RT-ANCH-BR, as shown by non-optimal candidate (13b). The prefixed forms in the second candidate set in (13) show the independent roles of ALIGNSFX (8) and DISYLL (11) in choosing the optimal candidate. In non-optimal (13e), the Base satisfies minimality (ALIGNSFX), but the reduplicative morpheme violates the reduplicative minimality constraint (DISYLL).

While the analysis works, it is obvious that DISYLL (11) violates the principles of Prosodic Hierarchy-based GTT. All minimality constraints should fall out from parsing the relevant morpheme as Prosodic Word. Construction-specific size constraints like DISYLL (11) are never to be resorted to. The analysis of the vowel-initial forms in (7) emphasizes why the reduplicative morpheme cannot be parsed as a Prosodic Word to account for disyllabic minimality. Prosodic-Word initial position is the one place where onsetless syllables are tolerated in Axininca Campa (Payne 1981; Spring 1990; McCarthy and Prince 1993). If the reduplicative morpheme were a Prosodic Word, it would be optimal to copy the initial vowel. Yet, the data shows that the initial vowel is only copied to satisfy DISYLL (11). These points are made clear by the tableau in (14), where the «||» notation indicates that the Base and the reduplicative morpheme have been parsed into separate Prosodic Words:[3]

3. Prosodic Word-initial ONSET violations are not counted in (14) and (15) as an abbreviatory convention to keep the tableaux to a more manageable size. In McCarthy and Prince's (1993) full analysis, ONSET violations in Prosodic Word-initial position do not *count* in choosing optimal

(14) Analysis of disyllabic V-initial Root

/apii-RED-/	ONSET	DEP-IO	DISYLL	RED≤ROOT	MAX-BR
☞a. api ‖ apii]-					
b. apii]-pii]-			*!		*
c. apii]-apii]-	*!				
/*n*-apii-RED-/	ONSET	DEP-IO	DISYLL	RED≤ROOT	MAX-BR
☞d. *n*-apii]-napii]-				*	
e. *n*-apii]-pii]-			*!		**
f. *n*-apii]-apii]-	*!				*

In the optimal candidate (14a), the reduplicative morpheme begins a new Prosodic Word. This allows it to satisfy the ONSET constraint, as only ONSET violations which are not in Prosodic Word-initial position are counted. The initial vowel allows this candidate to also satisfy DISYLL.[4] Candidate (14b), which omits the initial vowel in the reduplicative morpheme, violates DISYLL, while candidate (14c), with a suffixal reduplicative morpheme, violates ONSET. (ALIGNSFX (8) is omitted in this tableau and the next. The inputs satisfy the constraint, so it cannot play a role in choosing optimal candidates.)

The analysis of the disyllabic vowel-initial verb stems cannot be extended straightforwardly to longer vowel-initial stems, however. The problem is, if the Base and the reduplicative morpheme can be parsed in separate Prosodic Words, the pattern found with longer verb stems in (7a, b), where the reduplicative morpheme omits the initial vowel, should not be optimal. This is shown by the tableau in (15):

(15) Analysis of longer V-initial Roots

/osaŋkina-RED-/	ONSET	DEP-IO	RED≤ROOT	MAX-BR
☹ a. osaŋkina]-saŋkina]-				*!
💣b. osaŋkina- ‖ osaŋkina]-				
c. osaŋkina]-osaŋkina]-	*!			
/*n*-osaŋkina-RED-/	ONSET	DEP-IO	RED≤ROOT	MAX-BR
☹ d. *n*-osaŋkina]-saŋkina]-				*!*
💣e. *n*-osaŋkina- ‖ osaŋkina]-				*
f. *n*-osaŋkina]-nosaŋkina]-			*!	

candidates for the usual OT reason: a higher-ranked constraint requires left-edge alignment of Prosodic Word and Stem. RIGHT-ANCHOR-BR is also left out of these tableaux, as it is too high-ranked to play a role in choosing the optimal candidates.

4. In candidate (14a), the input Base long vowel is shortened as it occurs word-finally, by a regular process of Axininca Campa phonology (Payne 1981; McCarthy and Prince 1993).

Candidates (15a, d) are the correct forms. However, (15b, e) are optimal if the same set of constraints and rankings as for the disyllabic V-initial Roots is adopted, *and if* it is possible to have an output candidate with the Base and the reduplicative morpheme in separate Prosodic Words, as required for the disyllabic V-initial Roots.

To address this problem, McCarthy and Prince (1993: 91) propose a new constraint, Red=Suffix, which defines the reduplicative morpheme as a Suffix, morphologically and prosodically dependent on the Base. This constraint is violated by outputs like (15b, e) where the reduplicative morpheme begins an independent Prosodic Word, forming a Prosodic Word compound with the Base rather than a suffixation structure. As shown in (16), ranking Red=Suffix below Disyll (11) correctly optimizes the compounding structure when the alternative would violate either Onset (16e) or Disyll (16f). Otherwise, the suffixation structure is optimal (16a):

(16)

/osaŋkina-RED-/	Rt-Anchor-BR	Onset	Disyll	Red=Suffix	Max-BR
☞a. osaŋkina]-saŋkina]-					*
b. osaŋkina- ‖ osaŋkina]-				*!	
c. osaŋkina]-osaŋkina]-		*!			
/apii-RED-/	Rt-Anchor-BR	Onset	Disyll	Red=Suffix	Max-BR
☞d. apii ‖ apii]-				*	
e. apii]-pii]-			*!		*
f. apii]-apii]-		*!			

This result comes at a cost, however, as Red=Suffix only emphasizes that disyllabic reduplicative minimality cannot fall out, in McCarthy and Prince's (1993, 1995) account, from the Prosodic Word status of the reduplicative morpheme.

McCarthy and Prince's (1993, 1995) analysis of Axininca Campa reduplicative minimality, then, poses a number of problems for the Prosodic Hierarchy-based theory of minimality outlined in section 2. First, the central claim of this approach is not fulfilled, as the disyllabic minimality constraint on the reduplicative morpheme is not accounted for by parsing it as a Prosodic Word. In fact, the reduplicative morpheme is explicitly defined as a Suffix rather than a Prosodic Word. A templatic constraint, Disyll (11), is therefore needed to account for reduplicative minimality. The important predictions of this approach are also not borne out, as McCarthy and Prince (1993: 155) acknowledge. Because the Base is a Prosodic Word, it should be stressed following the same principles as other Prosodic Words. However, while Prosodic Word-final syllables that coincide with morphological word-final position are not stressed, Base-final syllables can be, as shown in (17). («[ ]» denotes Prosodic Word edges posited by their analysis.)

(17) [[[kowà]-kowa]-wáitaki] ‘has continued to search more and more’
(cf. [máto] ‘moth’)

Further, all Prosodic Words should undergo or trigger the same phonological processes. However, while Prosodic Word-final syllables in morphological word-final position must be short, internal Prosodic Word final syllables can be long, as shown in (18):

(18) [[[n-apii]-napii]-waitaki] ‘I will continue to repeat more and more’

[api] [[apii]-waitaki] ‘has continued to repeat more and more’

To resolve these problems, McCarthy and Prince (1993) propose that there are two levels of Axininca Campa phonology: one with the internal Prosodic Word constituency motivated by minimality, and one without. However, it is clearly undesirable to have a distinct level of phonology motivated by a single process —the definition of prosodic well-formedness constraints on the Base for suffixation— if an alternative analysis is available. The next section develops an alternative theory of minimality which solves the problems with the Prosodic Hierarchy-based theory highlighted by the Axininca Campa analysis.

4. An alternative approach to minimality: time for a pedicure!

4.1. Basic elements of the theory[5]

The alternative theory of minimality takes up another line of thinking about the correlation between morphological and prosodic constituents found in the recent OT literature (e.g., G. B. Feng 2004, 2005; McCarthy and Prince 1994b; Russell 1997; Urbanczyk 1996). While the Prosodic Hierarchy in (1) proposes that the basic correlation is between Stem (parsed as Prosodic Word) and a stress Foot, this alternative proposes that the basic morphology-prosody correlation is between smaller units, namely, between a single morpheme and a single syllable. This proposal is formalized by the constraint in (19):[6]

(19) MORPHEME-SYLLABLE CORRELATION (MORPH-SYLL):
Every morpheme contains at least one syllable.

As argued in Downing (2000), following McCarthy and Prince (1999), constraints like those in (19) which evaluate the prosodic weight of a string can be considered a variety of correspondence constraint, establishing a relationship between the segments and prosody of a single morpheme. Further, I follow van

5. See Downing (forthcoming) for more detailed discussion of problems with the Prosodic Hierarchy-based theory of minimality and a more detailed working out of this alternative.
6. See G. B. Feng (2004, 2005); McCarthy and Prince (1994b); Russell (1997); Urbanczyk (1996) for alternative formulations of this principle.

Oostendorp (2004) in assuming that constraints like (19) which define correspondence between a string and a syllable are only satisfied if some element of the string which realizes a morpheme is associated with the head of a syllable.

There is considerable evidence for the MORPHEME-SYLLABLE CORRELATION in (19). First, it is consistent with the traditional definition of Word as the minimal independently pronounceable meaningful unit of language (see, e.g., Bloomfield 1933): morphologically, a single free morpheme, or Root; phonologically, a syllable (Harris 1994; Itô 1986). Furthermore, cross-linguistic surveys by Garrett (1999), Gordon (1999), Hayes (1995) and Kager (1992) find no consistent correlation between foot size and word size, though the Prosodic Hierarchy-based theory of minimality outlined in section 2, above, predicts one. Instead, the most common minimal Word size is a single syllable. (Over 300 of the 396 languages in Gordon's 1999 survey have CV or CVC as the minimal Word size.) As a minimal word is, morphologically, minimally a single Root morpheme, these surveys confirm the morpheme-syllable correlation. Studies of particular languages or language families also show that canonical morpheme size (for Roots and (lexical) Affixes) is often a single syllable. Examples are provided by: Chinese (S. Feng 2003; G. B. Feng 2004; Yip 1992), Bantu languages (Downing 2005), Lushootseed (Urbanczyk 1996), Fijian (Dixon 1988), Yoruba (Orie 1997) and ASL (Wilbur 1990). Further, Peters and Menn (1993) and Russell (1995) suggest that children use a syllable-based strategy in acquiring the morphological structure of their language, as grammatical morphemes are easier to learn if they correspond to syllables. This would follow if a child's first morpheme-identification and production strategy is to assume there is a morpheme-syllable correlation.

I propose that any tendency for (prosodic) morphemes to satisfy a binary minimality requirement falls out from Dresher and van der Hulst's (1998) proposal that there is a correlation between morphological complexity and phonological complexity. Lexical heads (Roots and Stems) meet minimality requirements, not because they contain a stress Foot, but rather because heads require branching phonological structure. As Dresher and van der Hulst argue, a branching requirement on heads is one way of enforcing a Head-Dependent complexity asymmetry which is characteristic of phonological systems cross-linguistically.

Theoretical precedent for the proposal that phonological complexity correlates with head status is found in work on positional markedness by, e.g., Barnes (2002); Beckman (1997, 1998); Harris (1990, 1994, 1997, 2004); Steriade (1994). Beckman (1997, 1998), for example, proposes that the ROOTFAITHFULNESS » AFFIXFAITHFULNESS ranking hierarchy is one instantiation of a theory of positional markedness, which shares with Dresher and van der Hulst's (1998) Head-Dependent Asymmetry (HDA) theory the goal of providing a general account of the correlation between prominent positions (or heads) and marked (or complex) structure. Positional markedness theory and HDA theory agree that the repertoire of prominent positions (heads) includes both morphological entities, like Root or Root-initial position, and phonological ones, like stressed syllable. Where the two differ is that positional markedness theory follows other work (e.g., Harris 1990, 1994, 1997, 2004; Steriade 1994; Barnes 2002) in proposing that prominent positions passively license marked structure, by penalizing marked structure in non-prominent (non-head) positions. In contrast, HDA theory proposes that languages can actively require marked structure in prominent (head) positions, by penalizing unmarked structure in those positions. As Dresher and van der Hulst (1998) observe, it is familiar from work on stress systems that languages like Norwegian (Kristoffersen 2000) and Choctaw (Nicklas 1974; Lombardi and McCarthy 1991) can require every stressed syllable to be heavy. HDA theory extends this «obligatory branching principle» (Hayes 1980) —or Stress-to-Weight principle (SWP) in OT (Kager 1999: 172)— from stressed syllables to morphologically prominent entities like Root. It is an advantage of the alternative approach to minimality argued for here that it explicitly formalizes this parallel between the asymmetrical complexity requirements of phonologically and morphologically prominent entities.

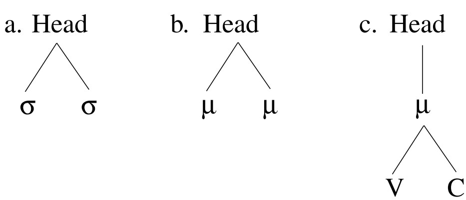
The branching principles motivating binary minimality are formalized by the following markedness constraints:

(20) a. HEADSBRANCH (adapted Dresher and van der Hulst 1998):
Lexical heads (Roots, Stems) must prosodically branch.

b. PROSODICBRANCHING (adapted Ussishkin 2000: 43):
A constituent branches *iff* it or its daughter contains more than one daughter.

The representations in (21) all satisfy PROSODICBRANCHING.[7] The heads in (21a) and (21b) contain two syllables or moras as daughters; the head in (21c) dominates a mora with two daughters:

(21)



Roots, as monomorphemic heads, are predicted to be at least monosyllabic by MORPH-SYLL (19) and so satisfy branching by matching (21b) or (21c). (Lushootseed, discussed in the introduction, provides an example of a Root which minimally matches (21c).) Affixes, as monomorphemic non-heads, are also predicted to be monosyllabic by MORPH-SYLL (19), but are not required to branch.

7. See Dresher and van der Hulst (1998: 320) for discussion of how representations nearly identical to those in (21) satisfy complexity, one of the properties that they show asymmetrically characterize heads. Ussishkin (2000) also redefines minimality in terms of branching, and the theory developed here adopts his definition of PROSODICBRANCHING. Unfortunately, Ussishkin (2000) does not give any clear motivation for why certain prosodic morphemes should branch. An advantage of Dresher and van der Hulst's (1998) approach is that it links the branching requirement on Heads to a larger research program on Head-Dependent Asymmetries.

This morphologically-based approach to minimality straightforwardly accounts for the problem raised in the introduction of why derived words are often required to be minimally disyllabic in languages where underived words can be monosyllabic (Itô 1990; Ussishkin 2000). Axininca Campa (Spring 1990, 1991) provides an example of this correlation. Monomorphemic nouns and adjectives minimally contain a bimoraic monosyllable, while the minimally bimorphemic Verb (see (4), above) is minimally disyllabic. One can easily find more examples of languages where morphologically complex forms must be minimally disyllabic: Athabaskan (Hargus and Tuttle 1997), Bantu (Downing 2005), German (Féry 1991), Hebrew (Ussishkin 2000), Japanese (Itô 1990), Javanese (Uhrbach 1987), Turkish (Inkelas and Orgun 1995), and Yoruba (Orie 1997). This disyllabicity condition clearly falls out from the MORPHEME-SYLLABLE CORRELATION (19). Derived words and other morphologically complex structures —here termed «Stems»— are, by definition, minimally bimorphemic. The representation in (22a) illustrates the morphologically complex structure of Stems (defined as a constituent minimally consisting of a Root plus an Affix). By the MORPHEME-SYLLABLE CORRELATION (19), Stems must therefore minimally contain two syllables, one for each morpheme. The PROSODICSTEM constraint in (22b) formalizes this disyllabic minimality constraint on morphologically complex structures:

(22) Prosodic Stem Minimality

a. Stem → Root Affix

b. PROSODICSTEM → σ σ

Theoretical precedents for the disyllabic Stem requirement in (22b) are found in Itô (1990) and Ussishkin (2000). In their analyses, disyllabic minimality is accounted for by stipulating that WORDBINARITY or PROSODICBRANCHING constraints hold only for derived words. The approach argued for here improves on these earlier accounts by proposing that the disyllabic minimality condition follows from a general principle, namely, the MORPHEME-SYLLABLE CORRELATION (19).

To sum up this section, I propose to divorce minimality from the Prosodic Hierarchy, and relate it, instead, to two other independently motivated principles of the grammar. The MORPHEME-SYLLABLE CORRELATION (19) requires every morpheme to optimally contain at least one syllable. It follows from this that derived words and other Stems should contain at least two syllables. Minimality requirements on lexical monomorphemes fall out from HEADSBRANCH (20a), a corollary of the Head-Dependent Asymmetry. In the next section, I show that this morphology-based approach to minimality provides a straightforward account of Axininca Campa reduplication which avoids the problems raised by McCarthy and Prince's (1993, 1995) analysis.

4.2. Minimality in Axininca Campa: a reanalysis

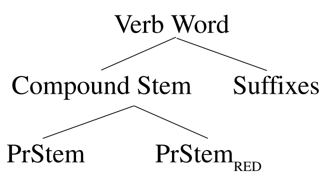
The key proposal underlying the reanalysis of Axininca Campa reduplication is that the Base and reduplicative morpheme are subject to similar minimality requirements because both are Prosodic Stems. The Base is plausibly a Prosodic Stem, as it roughly corresponds to the morphological Stem (the prefix-root complex shown in (4), above), augmented to satisfy minimality. The constraint in (23) formally defines the Prosodic Stem as the Base for reduplication:

(23) ALIGNPRSTEM: Align(L, RED; R, PrStem)

This constraint, like ALIGNSUFFIX (8), above, in McCarthy and Prince's (1993, 1995) analysis, accounts for the minimality constraint on the Base by defining it as a particular morpho-prosodic constituent, subject to the general minimality requirements the theory defines for constituents of this type. In McCarthy and Prince's analysis, the Base, as a Prosodic Word, is minimally a bimoraic stress Foot. In this analysis, the Base, as a Prosodic Stem, is minimally disyllabic, by definition (see (22b)). It is important to note that (23) defines the Base for reduplication as a Prosodic Stem —canonically bimorphemic and so subject to disyllabic minimality— whether the corresponding morphological Base stem actually contains a prefix or not.

The reduplicative morpheme is also a Prosodic Stem, if we assume, following work like McCarthy and Prince (1995), Inkelas and Zoll (2005) and Downing (2003), that reduplication is essentially compounding. In the default case, each half of the reduplicative complex has the same morpho-prosodic category, as shown in (24):

(24) Compound reduplicative structure for Axininca Campa



Even though the Prosodic Stem, which includes prefixes, is the Base for reduplication, as we saw in section 3, above, prefixes do not appear in the reduplicative morpheme except to satisfy minimality. This is accounted for by the constraint in (25) restricting prefixes to word-initial position:

(25) ALIGNPREFIX: AlignL(Prefix, Prosodic Word)

ALIGNPREFIX (roughly the equivalent of McCarthy and Prince's RED≤ROOT, illustrated beginning in tableau (12)) must outrank MAX-BR, as it optimizes a mismatch between the segments in the Base and the reduplicative morpheme. Constraints (23) and (25) account for the total reduplication pattern found with the C-initial verbs illustrated in (5). (AlignPrStem (23) is omitted from the tableaux in this section, however, as it is never violated and so never chooses the optimal candidate.)

Recall that the monosyllabic C-initial stems in (6) and the vowel-initial stems in (7), above, provide evidence for minimality requirements on the Base and reduplicative Stems. As we can see from this data, the Base and the reduplicative Stems are usually identical in size, and the reduplicative Stem matches the augmentation strategy of the Base. Both the Base and the reduplicative Stems are mostly minimally disyllabic, and the disyllabic minimality requirement is never violated when the Base contains a prefix. This is, indeed, what we expect, as the Base and the reduplicative morpheme are defined as minimally disyllabic by ProsodicStem (22b). However, we can see that, in a few cases when the Base is a monomorphemic Root, the Base and reduplicative Stems can be bimoraic. Bimoraic Base stems are not augmented, and consonantal stems, like /p-/ 'feed', are augmented to a bimoraic monosyllable not a disyllable. These conflicting minimality constraints on the Base Stem — bimoraic vs. disyllabic— reflect that the Base for reduplication is only optionally bimorphemic. When it does not contain a prefix, it can be bimoraic, the minimum size required for Roots by HeadsBranch (20a). When the Base Stem does include a prefix, it is always minimally disyllabic, satisfying ProsodicStem (22b).

The role of these conflicting minimality requirements in accounting for Axininca Campa reduplication patterns is defined by the constraint ranking: HeadsBranch (20a) » Dep-IO » ProsodicStem (22b). HeadsBranch (20a) outranks Dep-IO, as moras (and segments to realize the moras) are optimally epenthesized to satisfy the bimoraic minimality requirement on monomorphemic Bases. Dep-IO outranks ProsodicStem (22b), as only material present in the input is recruited to satisfy the disyllabic minimality requirement imposed on Prosodic Stems. (Dep-IO and Dep-BR evaluate moras and associations between segments and moras in this analysis, rather than segments as in McCarthy and Prince's 1993, 1995 analysis. The motivation for this is that material is being epenthesized to satisfy constraints on the prosodic, rather than the segmental, composition of these forms.)

The analysis of the bimoraic C-initial Roots is exemplified in (26). (In the analysis in this section, «[ ]» indicates Prosodic Stem edges.)

(26)

/naa-PrStem$_{\text{RED}}$-/	HeadsBranch	Dep-IO Dep-BR	PrStem	AlignPrefix	Max-BR
☞a. [naa]-[naa]-			**		
b. [naa]-[naa*ta*]-		*!(BR)	*		
c. [naa*ta*]-[naata]-		*!(IO)			
/*no*-naa-PrStem$_{\text{RED}}$-/	HeadsBranch	Dep-IO Dep-BR	PrStem	AlignPrefix	Max-BR
☞d. [*no*-naa]-[nonaa]-				*	
e. [*no*-naa]-[naa]-			*!		**
f. [*no*-naa]-[naa*ta*]-		*!(BR)			**

In the first candidate set, the bimoraic Base (containing only a Root) satisfies high-ranked HEADSBRANCH, so it is optimally not augmented (candidate (26a)). Competing candidates with disyllabic Bases and/or reduplicative morphemes are non-optimal as they gratuitously violate DEP, the constraint banning augmentation. In the second candidate set, we see in candidate (26d) that including the prefix in the Base Prosodic Stem and copying it in the reduplicative Prosodic Stem is optimal, as this allows both to satisfy the disyllabic minimality requirement (PROSODICSTEM (22b)). Candidate (26e) is non-optimal, as it violates PROSODICSTEM (22b). Candidate (26f) incurs gratuitous DEP violations, as it satisfies PROSODICSTEM (22b) by epenthesis rather than copying the Base. (In the tableau, candidates (26b, c, f) earn one violation each of DEP, because in each case only one mora has been inserted.) This tableau shows that in this approach there is no need for a distinct disyllabic size requirement on the reduplicative morpheme comparable to DISYLL (11) in McCarthy and Prince's analysis. Instead, the disyllabicity requirement falls out from the Prosodic Stem status of both the Base and the reduplicative morpheme, motivated by the canonical bimorphemic structure of the Base.

As shown by the data in (6), some monomorphemic Bases are augmented to disyllabicity. In McCarthy and Prince's (1993, 1995) analysis, a special constraint, ALIGN-R (9), was required to account for this. As shown by the tableau in (27), no new constraints are required in this analysis:

(27)

/t^{h}o-PrStem$_{RED}$-/	HEADS BRANCH	DEP-IO DEP-BR	PRSTEM	ALIGN PREFIX	MAX-BR
☞a. [t^{h}o*ta*]-[t^{h}ota]-		*(IO)			
b. [t^{h}o]-[t^{h}o]-	*!*		**		
c. [t^{h}o*o*]-[t^{h}oo]-		**!(IO)	**		
/*non*-t^{h}o-PrStem$_{RED}$-/	HEADS BRANCH	DEP-IO DEP-BR	PRSTEM	ALIGN PREFIX	MAX-BR
☞d. [*non*-t^{h}o]-[nont^{h}o]-				*	
e. [*non*-t^{h}o]-[t^{h}o]-	*!		*		***
f. [*non*-t^{h}o]-[t^{h}o*ta*]-		*!(BR)			***

In the first candidate set, the monomoraic Root is optimally augmented by epenthesizing a mora (candidate (27a)) to satisfy HEADSBRANCH (20). Not augmenting, as in candidate (27b), violates this constraint. Since the Stem consists only of a single morpheme, the Root, we might expect it to be optimal to augment it to a single bimoraic syllable by lengthening the vowel, as in candidate (27c). While lengthening satisfies HEADSBRANCH, it fatally incurs extra DEP violations. Lengthening an input vowel involves not only inserting a mora (as in (27a)) but also changing the moraic linking of an input segment. As we can see, disyllabicity is optimal in (27a) for phonotactic reasons, not because the morphological structure requires it. In the second candidate set, (27d) is optimal for the same reasons discussed for the prefixed candidate in tableau (26). A bimorphemic Base is also disyllabic, satisfying ProsodicStem (22b). Copying the prefix is the optimal way for the reduplicative morpheme to also satisfy ProsodicStem (22b).

Recall from tableaux (14) and (15), above, that the vowel-initial stems were especially problematic for McCarthy and Prince's (1993, 1995) analysis. In this analysis, we need just one additional constraint, to account for the fact that an initial vowel is not copied for longer stems. I follow Downing (1998a, b) in proposing that the initial vowel is not copied because the Prosodic Stem, the Base for reduplication (see (23)), must be left-aligned with an Onset:

(28) AlignOnset: AlignL(PrStem, σ) ∩ Onset.[8]

Ranking this constraint below Dep-IO and ProsodicStem (22b) optimizes making the initial vowel extraprosodic —i.e., parsed outside the Prosodic Stem (the string for evaluation by Max-BR)— except to satisfy minimality.

The analysis of the V-initial Roots is exemplified in tableaux (29) and (30):[9]

(29) Analysis of V-initial Root with more than two syllables

/osaŋkina-PrStem$_{RED}$-/	Dep-IO Dep-BR	PrStem	Align Onset	Align Prefix	Max-BR
☞a. o[saŋkina]-[saŋkina]-					
b. [osaŋkina]-[osaŋkina]-			*!*		
/*n*-osaŋkina-PrStem$_{RED}$-/	Dep-IO Dep-BR	PrStem	Align Onset	Align Prefix	Max-BR
☞c. [*n*-osaŋkina]-[saŋkina]-					**
d. [*n*-osaŋkina]-[nosaŋkina]-				*!	

Candidate (29a) is optimal in the first set. This candidate violates none of the constraints, as the initial vowel is optimally excluded from the Base Prosodic Stem to satisfy AlignOnset (28), and the reduplicative Prosodic Stem matches the resulting Base. In the second candidate set, it remains optimal to exclude the initial vowel from the reduplicative morpheme. Including it would require also reduplicating the prefix, in violation of AlignPrefix (25), to avoid an AlignOnset violation. As a result, candidate (29d) is non-optimal.

8. See Downing (1998b) for detailed arguments in favor of formalizing this constraint as a logical conjunction, and for more examples of the role of Onset alignment in reduplication and other prosodic phenomena.
9. HeadsBranch is omitted from tableaux (29) and (30) as it is not violated by any of the outputs, and so plays no role in choosing the optimal candidate.

As shown in (30), the same constraints and ranking straightforwardly optimize including the initial vowel in the Prosodic Stem of disyllabic vowel-initial verb stems:

(30) Analysis of disyllabic V-initial Root

/apii-<u>PrStem</u>$_{\text{RED}}$-/	DEP-IO DEP-BR	PRSTEM	ALIGNONSET	ALIGNPREFIX
☞a. [api] ‖ [<u>apii</u>]-			**	
b. a[pii]-[<u>pii</u>]-		*!*		
c. a[pii]-[<u>pii*ta*</u>]-	*!(BR)	*		
/*n*-apii-<u>PrStem</u>$_{\text{RED}}$-/	DEP-IO DEP-BR	PRSTEM	ALIGNONSET	ALIGNPREFIX
☞d. [*n*-apii]-[<u>napii</u>]-				*
e. [*n*-apii]-[<u>pii</u>]-		*!		
f. [*n*-apii]-[<u>pii*ta*</u>]-	*!(BR)			

Candidate (30a) is optimal when the Root is unprefixed. Even though it violates ALIGNONSET, all the other constraints are satisfied. This candidate shows that PROSODICSTEM (22b) crucially outranks ALIGNONSET (28). Not copying the initial vowel, as in candidate (30b), violates higher-ranked PROSODICSTEM. (As noted above, independent constraints account for word-final shortening in (30a).) This candidate also shows why the relationship between branching morphological structure and the disyllabic minimality requirement, PROSODICSTEM (22b), can be an indirect one. Since both the Base and the reduplicative morpheme are defined as Prosodic Stems, they are subject to PROSODICSTEM (22b) minimality, even when the Base is monomorphemic. However, as PROSODICSTEM (22b) is ranked below DEP, it plays a role in motivating a disyllabic Base Prosodic Stem only in this particular case: when the Base Stem provides a second syllable without epenthesis.

In the second candidate set, the prefix is optimally copied, as shown by candidate (30d). Competing candidates either violate higher-ranked PROSODICSTEM (candidate (30e)) or incur gratuitous DEP violations (candidate (30f)). (MAX-BR is omitted from this tableau, as it plays no role in choosing the optimal candidate.)

To sum up the analysis of Axininca Campa reduplication, I have shown that minimality constraints on the Base and the reduplicative morpheme follow from proposing that both are optimally disyllabic Prosodic Stems (22b). This analysis improves on McCarthy and Prince's (1993, 1995) analysis of Axininca Campa in the following ways. No reference is made to Prosodic Word to define minimality, so there is no need to parse strings into Prosodic Words at one level to account for prosodic well-formedness, and reparse them at a separate level to account for all other phonological processes. Moreover, McCarthy and Prince's (1993, 1995) minimality constraint on the reduplicative morpheme, DISYLL (11), violates the basic tenet of Generalized Template Theory, which bans construction-specific size constraints. In the morphology-based alternative, the minimality requirements for both the Base and the reduplicative morpheme fall out from the general constraints requiring (Prosodic) Stems to satisfy HEADSBRANCH (20) and PROSODICSTEM (22b). As a result, this analysis better fulfills the goal of Generalized Template Theory: to account for minimality requirements through general morphological and prosodic principles.

4.3. Diyari, a slight return

The Axininca Campa analysis has emphasized that the morphology-based theory of minimality predicts disyllabic minimality to hold primarily for derived Stems (or constructions based on canonically derived Stems). The Diyari reduplication pattern in (2) appears to be problematic for this proposal. We saw that there is a disyllabic minimality condition on the Prosodic Word reduplicant (and other Prosodic Words of the language), even though Prosodic Words can be monomorphemic Roots in Diyari. The theory developed here seems to predict they should be monosyllabic, as this would satisfy the MORPHEME-SYLLABLE CORRELATION in (19). I suggest that phonotactic factors independent of stress favor the disyllabic (21a) satisfaction of HEADSBRANCH in Diyari. There are no long vowels in Diyari, so the branching representation in (21b) cannot define a possible minimal word. And words cannot end in a consonant in Diyari, so the branching representation in (21c) also cannot define a possible minimal word. Therefore, disyllabic (21a) is the only representation which both satisfies the branching requirement on Head morphemes like Roots and also satisfies constraints on possible (word-final) syllables in this language.

5. Conclusion

In conclusion, I have shown that the Prosodic Hierarchy-based account of morpheme minimality does not provide an adequate analysis of Axininca Campa verb reduplication. In the Prosodic Hierarchy-based theory, minimality should fall out from parsing a morpheme as a Prosodic Word, containing a stress Foot, yet neither the Base nor the reduplicative morpheme are independent Prosodic Words in Axininca Campa. I have proposed that an alternative, morphology-based approach to minimality provides a better analysis. In this approach, stems and other morphologically derived constructions have a tendency to be minimally disyllabic because they are minimally bimorphemic. This falls out from the MORPHEME-SYLLABLE CORRELATION (19). Lexical monomorphemes (Roots) are also subject to minimality conditions because of the HEADSBRANCH (20a) requirement. In Axininca Campa, defining the Base for reduplication and the reduplicative morpheme as Prosodic Stems straightforwardly accounts for why they are subject to a disyllabic minimality constraint: the Base is a canonically bimorphemic stem. The Base can, however, consist only of a Root. This explains why a bimoraic monosyllable provides a secondary minimality target for this construction: it satisfies

HEADSBRANCH (20a). Finally, we have seen that while phonotactic factors can play a role in optimizing minimally disyllabic Roots in Axininca Campa and Diyari, stress Footing plays no role. Minimality can be unproblematically divorced from the Prosodic Hierarchy.

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