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*A mismatch between morphological and prosodic domains: evidence from two Igbo rules**

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In order to adequately describe the application of phonological rules across word boundaries, phonologists have appealed to the notion of prosodic domains (Selkirk 1980, 1986; Nespor & Vogel 1982, 1986; Kaisse 1985; Inkelas & Zec 1990). This research has suggested that the domains within and across which rules apply cannot be defined in purely syntactic terms, but rather that a domain structure consisting of prosodic entities such as the phonological word, phonological phrase and intonational phrase must be built up from the syntactic structure. It is to these prosodic categories that phonological rules refer. Prosodic domains are derived from but not necessarily coextensive with syntactic or morphological domains. In fact, some of the best evidence for the necessity of a prosodic structure in addition to a syntactic structure comes from cases where the two do *not* match, and where the correct phonological generalisations can only be captured in terms of the prosodic structure. Igbo presents just such a mismatch. This paper will examine two rules – ATR vowel harmony and vowel assimilation – that make the mismatch clear. These two rules apply in complementary situations: harmony applies only within the word, assimilation only between words. Both rules delineate the same domain, although one operates within the domain boundaries, one across them. This paper will show that, because of complications introduced by compound words, the syntactic or morphological word does not correctly describe this domain, while a prosodic definition allows a straightforward account. This single prosodic domain will be shown to be present in the lexicon and to persist, unchanged by morphological derivation, into the postlexical phonology. §1 will briefly describe some basic aspects of Igbo phonology and morphology and will introduce the system of vowel harmony. The application of the harmony rule in different morphological environments will be discussed. In §2 the need to

invoke a prosodic word that is not coextensive with the syntactic word will be demonstrated. Vowel assimilation will be described in §3, where it will be shown that reference to the prosodic word is again necessary to account for the application of this rule. An alternative approach, not relying on prosodic domains, will be discussed in §4. It will be seen, however, that while a non-prosodic approach can account for the facts of vowel harmony if some crucial assumptions are made, it offers no insight into vowel assimilation. Only the domain-based approach offers a unified account of these two systems.

1 Vowel harmony

1.1 The vowel system

Igbo has an eight-vowel system which is symmetric with regard to the feature [advanced tongue root] (ATR). Four of the vowels are pronounced with the tongue root stiffened or advanced, the other four with the tongue root relaxed. Vowels also contrast for the features [high] and [round]:

(1)

	i	ị	u	ụ	o	ọ	e	a
high	+	+	+	+				
round			+	+	+	+		
ATR	+		+		+		+	

In the Igbo orthography, which will be used here, [−ATR] vowels, with the exception of /a/, a low central vowel, are written with a dot beneath the letter. (The orthographic practice of marking low tones with a grave accent and mid tones with a bar, leaving high tones unmarked, will also be followed here. Tone will not be a focus of this paper.)

Note that /e/ and /a/ are described as featurally alike except for the ATR value. This is to account for the fact that /e/ and /a/ alternate in morphemes subject to harmony (such as the participial prefix, *a-/e-*). As the basic phonological opposition in height is between high and non-high vowels only, lowering and backing of the [−ATR] vowel may be described as a secondary phenomenon, dependent on relaxation of the tongue root (Ladefoged 1968). The exact pronunciation of /a/ varies by dialect and by phonological environment (Emenanjọ 1978).

1.2 Nouns

The basic Igbo noun is disyllabic, as illustrated in (2). Longer words may be formed by reduplication (as in *gbùrùgbùru* 'roundness' or *ìkìghìkwighi* 'owl'), or by compounding (discussed below in §1.4). Nouns carry no inflection for gender or number. (All the examples cited in this paper are from Emenanjọ 1978 unless otherwise noted.)

(2) *Igbo nouns*

[−ATR]	
ụzọ̀	'road'
ákpị̀	'scorpion'
ọjị	'kola nut'
ụkà	'discussio
àjà	'sacrifice'

As these examples show within simple nouns.

The only exceptions occurs with a [+ATR] v dialect to dialect: where an initial /e/ and *vice* disharmonic roots are g

(3)

àdù	'bitter kol
àkpo	'roof of th
afè	'shirt'

The fact that all cases of in initial position sugges value of the root due to (following Clark 1990) th These disharmonic prefi of, the domain in which value by default.[1] No res In the following discuss account for the cases of applies without exceptio

1.3 Verbs

Igbo verb stems are m compound verb, and 'extensional' suffixes wh direction. Verbal prefixe and inflectional suffixe Inflectional affixes do n verbal template and an e (segmental) inflectional indicated by tonal cha infinitive or participial f

(2) *Igbo nouns*

[−ATR]		[+ATR]	
ụzọ̀	'road'	ozu	'corpse'
akpị̀	'scorpion'	ùbe	'pear'
ọjị	'kola nut'	obì	'heart'
ụkà	'discussion'	ero	'mushroom'
àjà	'sacrifice'	ele	'deer'

As these examples show, [+ATR] and [−ATR] vowels do not cooccur within simple nouns.

The only exceptions are a small class of nouns in which an initial /a/ occurs with a [+ATR] vowel. The roots that belong to this class vary from dialect to dialect: where some dialects have an initial /a/ others will have an initial /e/ and *vice versa* (Emenanjọ 1978). Some examples of these disharmonic roots are given in (3):

(3)

àdù	'bitter kola'	àku	'traditional door'
àkpo	'roof of the mouth'	akpe	'soap box'
afẹ̀	'shirt'	alò	'thought'

The fact that all cases of disharmony within simple nouns involve an /a/ in initial position suggests that these vowels are invisible to the [+ATR] value of the root due to extraprosodicity. It will be argued in §2 below (following Clark 1990) that all initial vowels in nouns are in fact prefixes. These disharmonic prefixes, then, are marked as invisible to, or not a part of, the domain in which harmony applies, and are assigned a [−ATR] value by default.[1] No restrictions on the harmony rule itself are necessary. In the following discussion it will be assumed that extraprosodicity can account for the cases of disharmony, and that ATR harmony otherwise applies without exception within non-compound nouns.

1.3 Verbs

Igbo verb stems are monosyllabic. Two or more stems may form a compound verb, and the verb may be modified by one or more 'extensional' suffixes which add semantic information such as manner or direction. Verbal prefixes indicate infinitive, participial or inflected form, and inflectional suffixes indicate time reference or temporal aspect. Inflectional affixes do not alter the semantic structure of the verb. The verbal template and an example are given in (4). In some verb forms the (segmental) inflectional suffix is optional, as tense and aspect are often indicated by tonal changes, and there is no inflectional suffix in the infinitive or participial forms:

(4) *The Igbo verb*

prefix	–	stem	–	stem	–	extensional suffix	–	inflectional suffix
ọ	–	tụ	–	pụ̀	–	wa	–	ra
infl	–	throw	–	go out	–	begin	–	indic

'he/she/it began to throw out'

The morphological and phonological properties of each verbal component will be dealt with in the sections below. A more detailed discussion of the morphological domains and processes assumed will be provided in §2.1.

1.3.1 *Inflectional suffixes.* Inflectional suffixes harmonise with verb stems. No affix of this type is invariant: the ATR category of the stem determines the ATR category of the affix. Examples of harmony to inflectional suffixes are given in (5). Tonal changes in the verbs, which depend on the inflection, the underlying tone of the verb and the tonal environment, will not be discussed here.

(5) *Harmony to inflectional suffixes*

-a/-e 'imperative'
-ghī/-ghī 'negative'
-Vla/-Vle 'perfective'

sị-a	'tell!'	si-e	'cook!'
sị-ghị	'did not tell'	si-ghi	'did not cook'
sị-ala	'has told'	si-ele	'has cooked'

1.3.2 *Inflectional prefixes.* The ATR category of the stem also determines the ATR category of an inflectional prefix, as shown in (6):

(6) ị-/i- 'infinitive'
ọ-/ò- 'agentive'
a-/e- 'participial'[2]

ị-sī	'to tell'	i-sī	'to cook'
ọ-sị	'the teller'	ò-si	'the cook'
à-sị	'telling'	è-si	'cooking'

Harmony also applies from the stem to what traditional grammars have called 'dependent pronouns', vowels immediately preceding the verb that indicate the person and number of the subject when a full NP is not used. Some examples are given in (7):

(7) *Harmony to dependent pronouns*

ọ sị-ala	's/he has told'	o si-ele	's/he has cooked'
ị sị̀-rị̀	'you (SG) said'	i sì-rì	'you (SG) cooked'
a sị̀-rị̀	'someone said'	e sì-rì	'someone cooked'

Although these elements are written separately from the verb, and have been described as pronouns, their phonological behaviour and morphological distribution indicate that they ought to be considered as affixes.

There are three class pronouns described abo and object pronouns. Th shown in (8). Gender is 'he', 'she' or 'it'. The dependent or object for

(8) *Pronouns*

	dependen
1sg	a/e...m
2sg	ị/i
3sg	ọ
1pl	—
2pl	—
3pl	a/e...ha
indef.	a/e

The 1st person singul dependent form, consis pronominal element foll

(9) e- jè- rè
prefix-go-indic
'I went'

e- jè- rè
prefix-go-indic
'they went'

These three types of pr harmony. The independ the verb but invariantly pendent pronouns do har are not considered affixe complicated in order to i (but not independent) p

There is morphologica are affixes. Dependent p a semantically empty ve verbs when a subject NP

(10) *Verbal prefixes*

àda *e-* b
A. *vb.prefix-* c
'Ada is not carry

àda *a-* c
A. *vb.prefix-* w
'Ada does not w

There are three classes of 'pronouns' in Igbo: the dependent subject pronouns described above, independent (or emphatic) subject pronouns and object pronouns. The different forms for each person and number are shown in (8). Gender is not specified: the 3rd singular pronoun may mean 'he', 'she' or 'it'. The indefinite subject pronoun, which has no independent or object form, means 'someone'.

(8) *Pronouns*

	dependent subject	independent subject	object
1sg	a/e...m	ṁ (m̀mụ)	m (mụ)
2sg	ị/i	ngị	gị
3sg	ọ	ya	ya
1pl	—	ànyị	ànyị
2pl	—	ụnụ	ụnụ
3pl	a/e...ha	ha	ha
indef.	a/e	—	—

The 1st person singular and 3rd person plural pronouns, in their dependent form, consist of the *a-/e-* prefix preceding the verb and a pronominal element following:

(9) e- jè- rè m
prefix-go-indic 1SG
'I went'

a- zà- rà m
prefix-sweep-indic 1SG
'I swept'

e- jè- rè ha
prefix-go-indic 3PL
'they went'

a- zà- rà ha
prefix-sweep-indic 3PL
'they swept'

These three types of pronouns behave differently with respect to vowel harmony. The independent and object pronouns do not harmonise with the verb but invariantly retain their [−ATR] specification.[3] The dependent pronouns do harmonise. If these dependent pronominal elements are not considered affixes, the harmony rule will have to be made more complicated in order to include the disjoint classes of affix and dependent (but not independent) pronouns.

There is morphological evidence as well indicating that these elements are affixes. Dependent pronouns are in complementary distribution with a semantically empty verbal prefix (*a-/e-*), which appears on inflected verbs when a subject NP is expressed.[4] Some examples are given in (10):

(10) *Verbal prefixes*

àda *e-* bu- ghi ìtè
A. *vb.prefix*- carry-not pot
'Ada is not carrying a pot'

àda *a-* chǭ- ghị egō
A. *vb.prefix*- want-not money
'Ada does not want money'

chikē *a-* zụ- ọla ụlọ ahụ
C. *vb.prefix*- buy-perf house that
'Chike has bought that house'

ụzọ *ê-* ri- ele jī
U. *vb.prefix*- eat-perf yam
'Uzo has eaten yams'

compare:

ọ chọ̄-ghị egō 's/he does not want money'
ị chọ̄-ghị egō 'you (SG) do not want money'
o rī-ele jī 's/he has eaten yams'
i rī-ele jī 'you (SG) have eaten yams'

a sị-rị 'someone said'
e sị-rị 'someone cooked'

The verbal prefix never appears with a dependent pronoun. It does appear, however, with independent pronouns, as shown in (11a) for disyllabic pronouns and (11b) for emphatic monosyllabic pronouns:

(11) a. ànyị *e-* jī- ghi egō
1PL *vb.prefix*- hold-not money
'we are not holding money'

ụnụ *â-* zà- ala ebe ahụ
2PL *vb.prefix*- sweep-perf place that
'you (PL) have swept that place'

b. ha *ē-* ri- ele ya
3PL *vb.prefix*- eat-perf it
'*they* have eaten it'

The different phonological and morphological behaviour of the different kinds of pronouns would be difficult to account for if they were given the same status. The disyllabic (11a) and emphatic (11b) pronouns, which do not harmonise, occur outside a verbal prefix, while the pronouns that do harmonise occur in the prefix slot. This fact is most easily captured without stipulative morphological marking if it is assumed that dependent pronouns are prefixes and thus part of the verb, while disyllabic and emphatic pronouns are independent words. It is especially telling that the verbal prefix on inflected verbs is homophonous with the indefinite dependent pronoun 'someone'. These two are in fact the same morpheme, a prefix indicating that the verb is inflected for a subject, whose person and number are indicated elsewhere or inferred from the context.

We have seen, then, that vowel harmony applies from a verb stem to the inflectional affixes adjacent to it.

1.3.3 *Extensional suffi*
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independent words be
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inflectional affix per
inside any inflectional
extensional affixes are

(12) *Extensional suf*
gba-kiri
run-up and do

nwụ-chu
die- prematur

bi- kọ
live-assoc

bi- kọ- rị-
live-assoc-app
'live together t

Most extensional suffi
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class of extensional suf
extensional suffixes liste
few of these are listed ir
given in (13b):

(13) a. *Harmonic ex*
-ba/-be (or -
-ba/-be
-bụ/bu
-gbà/-gbè
-rị/-ri (or rV
-sịsi/-sisi
-ta/-te

1.3.3 *Extensional suffixes.* Extensional suffixes can be distinguished from inflectional suffixes in several ways. Extensional suffixes alter or extend the meeting of the verb without changing its time reference or grammatical function, while inflectional suffixes change the tense or aspect without altering the semantic content. The tonal behaviour of the two kinds of affix is different. While inflectional suffixes often impose gramatically conditioned tonal changes on the verb (see Goldsmith 1979), the kinds of tonal changes seen with extensional suffixes are typical of those seen when independent words become adjacent. Extensional suffixes can occur in clusters and with an inflectional affix, but there may be only one inflectional affix per verb. Further, extensional suffixes always appear inside any inflectional affix with which they occur. Examples of verbs with extensional affixes are given in (12).[5]

(12) *Extensional suffixes*

gba-kiri run-up and down	→	gbakiri	'run up and down'
nwụ-chu die- prematurely	→	nwụchu	'die prematurely'
bi- kọ live-assoc	→	bikọ	'live together'
bi- kọ- rị- ta live-assoc-applic-direction 'live together to one another's advantage'	→	bikọrịta	

Most extensional suffixes do not harmonise with the verb root. (In these cases, discussed more fully below, an inflectional suffix will harmonise with the extensional suffix to which it is adjacent.) There is, however, a class of extensional suffixes that do harmonise. About 16% of the 88 extensional suffixes listed in Emenanjọ (1978) show harmonic variants. A few of these are listed in (13a), and some examples of the alternations are given in (13b):

(13) a. *Harmonic extensional suffixes*

-ba/-be (or -wa/-we)	'begin to'
-ba/-be	'at, against'
-bụ/bu	'formerly'
-gbà/-gbè	'together with'
-rị/-ri (or rV)	'applicative'
-sịsị/-sisi	'continuously'
-ta/-te	'motion towards'

b. *Alternations*

ị+zụ+*ta*	→ị-zụ-*ta*	'to buy for'
'inf, buy, towards'		
i+zu+*ta*	→i-zu-*te*	'to meet with'
'inf, meet, towards'		
ọ+gwụ+*wa*+la	→ọ-gwụ-*wa*-la	'it is beginning to finish'
'3SG, finish, begin, perf'		
o+jè+*wa*+re	→o jè-*wè*-rè	'he began going'
'3SG, go, begin, indic'		

Emenanjọ notes that the suffixes that harmonise vary from dialect to dialect, and that, even within a dialect, one form may be preferred over another and used invariantly by some speakers.

These harmonic extensional suffixes do not systematically differ from other extensional suffixes phonetically, semantically or morphologically. There are extensional suffixes homophonous to these that do not harmonise: for example, *-be* 'from' and *-gbe* 'upwards'. The suffix *-di*, which means, like *-bụ/-bu*, 'formerly', does not harmonise. These suffixes are not specially marked as to which classes of words they can combine with. The difference between the harmonic and non-harmonic extensional suffixes must be lexically marked. Those that harmonise fall into a class with the inflectional affixes. Those that do not seem to form a compound-like entity with the verb root. The next section turns to a description of compounds, and to the affinity between extensional suffixes and the constituents of a compound.

1.4 Compounds

Although Igbo morphemes may consist of only one or two syllables, words may be much longer. Compound words may be composed of verbs, nouns or even entire phrases. These are many such compounds, fully incorporated into the lexicon:

(14) a. *Verbal compounds*

bu+fè	→bufè	'carry across'
'carry, cross'		
gba+ghà+lụ	→gbaghàlụ	'leave alone, forgive'
'run, pass, make'		(Williamson 1972)
kụ+fu	→kụfu	'kick away'
'strike, lose'		
tụ+pụ+fè	→tụpụfè	'throw out across'
'throw, go out, cross'		
go+pụ	→gopụ	'buy up, buy out'
'buy, go out'		(Williamson 1972)
gha+gbu	→ghagbu	'cheat, trick'
'turn, hurt'		(Williamson 1972)

b. *Nominal com*

àlụ+m+di	
'marriage, h	
di+ike	
'master, stre	
ṅhù+m+ek	
'presentation	
ọmị+iko	
'well (water)	

c. *Phrasal comp*

à-mà+m+ih	
'know, some	
o-mè+na+à	
'it happens, i	
ọ-gà+na+ir	
'it goes, towa	

These examples show th freely combine, harmon However, harmony doe tional affixes attached to of two verb stems. Th element, and the inflecti second element:

(15) *Compound verb*

[−ATR]

ànyị	[a	[[kụ
1PL	infl-	strik
'we have kicked		

[−ATR]

ibè	[à	[[gha]
I.	infl-	turn-
'Ibe cheated me		

An inflectional affix will extensional affix to whi inflectional suffix *-rọ/-* tensional suffix *-kọ̀*, whi verb root. (The repetiti means of expressing em

(16) fàa bi- kọ̀-
3PL live- assoc-
'they really live

b. *Nominal compounds*

àlụ + m + di	→ àlụmdi	'marriage'[6]
'marriage, husband'		(Clark 1990)
di + ike	→ dike	'man of strength'
'master, strength'		
ǹhù + m + ekpe	→ ǹhùmekpe	'plea for pardon'
'presentation, plea'		(Clark 1990)
ọmị + iko	→ ọmìiko	'mercy'
'well (water), cup'		

c. *Phrasal compounds*

à-mà + m + ihe	→ àmàmihe	'wisdom'
'know, something'		
o-mè + na + àlà	→ òmenààlà	'tradition'
'it happens, in, (the) land'		
ọ-gà + na + iru	→ ọ̀gàniiru	'progress'
'it goes, toward, forward part'		(Clark 1990)

These examples show that while [+ATR] and [−ATR] morphemes may freely combine, harmony does not apply between the parts of a compound. However, harmony does apply from compounded verb stems to inflectional affixes attached to the verb. The examples in (15) show compounds of two verb stems. The inflectional prefix (*a-/e-*) agrees with the first element, and the inflectional suffixes (*-Vla/Vle* and *-gọ/-go*) agree with the second element:

(15) *Compound verbs with inflectional affixes*

[−ATR] [+ATR]

ànyị [a [[kụ] [fù]] ole] ya
1PL infl-strike-lose-perf it
'we have kicked it away'

[−ATR] [+ATR]

ibè [à [[gha] [gbu]] go] m
I. infl-turn- hurt- past 1SG
'Ibe cheated me' (Williamson 1972)

An inflectional affix will receive the ATR specification of the verb stem or extensional affix to which it is adjacent. In the example in (16), the inflectional suffix *-rọ/-ro* ('indicative') agrees with the invariant extensional suffix *-kọ*, while the prefix *a-/e-* ('participial') agrees with the verb root. (The repetition of the verb in participial form is a common means of expressing emphasis.)

(16) fàa bi- kọ- *rọ* *è-* bi- kọ n'-ebe ahụ
3PL live-assoc-*indic* *prtcp*-live-assoc in-place that
'they really live together there'

An extensional affix thus resembles the second element of a compound verb in the position that it occupies (inside the inflectional affix) and in its behaviour with respect to harmony (it does not harmonise with the initial verb stem, but an inflectional affix will harmonise with it). Emenanjo (1978: 124) discusses the 'tonal, morphological, and semantic affinities' of extensional suffixes and verbs. Many of these suffixes are in fact completely homophonous with independent verbs that have only slightly different meanings, for example, *-ga* 'beyond' and *ga* 'pass' or *-ru* 'towards' and *ru* 'reach'. Unlike independent verb stems, however, extensional affixes are restricted to second or third position. They might well be referred to as bound roots.[7]

With respect to harmony, both compound verbs and verbs with extensional suffixes behave as though their constituents formed two separate words.

1.5 Independent words

No syntactic environment requires harmony among separate words. Harmony does not apply:

(17) a. *between subject and verb*

chikē	a-	zụ-	ọla	ụlọ	ahụ	ụzọ	è-	ri-	ele	ji
C.	infl-	buy-	perf	house	that	U.	infl-	eat-	perf	yam
'Chike has bought that house'						'Uzo has eaten yams'				

b. *between verb and object*

ụnụ	jè-	rè	ahịa		àdaà	chọ-	rọ	egō
2PL	go-	indic	market		A.	want-	indic	money
'you went to the market'					'Ada wants money'			

c. *between the multiple objects of a verb*

o	nyè-	lù	idu	àkwa	o	nyè-	lu	àda ihe
3SG	give-	past	I.	eggs	3SG	give-	past	A. thing
's/he gave Idu some eggs'					's/he gave something to Ada'			

d. *between a noun and its modifiers or specifiers*

ihe ọcha	nkịtà ojiī
thing white	dog black
'a white thing'	'a black dog'
ihe à	ụlọ niile ahụ
thing this	building all those
'this thing'	'all those buildings'

A mismatch

e. *between comp objects*

kà chikē
when C.
'when Chike

nà m̀miri
prep water
'on the wate

f. *between auxil*

ùlumma nà
U. pr
'Ulumma is

To review the evidence,
(i) within non-compo
(ii) from a verb stem
pronouns';
(iii) from a verb stem
Harmony does not appl
(i) from a verb stem t
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prosodic domains derive

2 Analysis

2.1 Morphological do

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roots, stems, extended
structure of the lexicor
structure of the verb is
(18b). Parentheses indic

e. *between complementisers, conjunctions or prepositions and their objects*

kà chikē bịà- rà
when C. come-indic
'when Chike came'

tupu ụtụtụ echi
before morning day
'before tomorrow'

nà m̀miri
prep water
'on the water'

ji nà edè
yam conj cocoyam
'yam and cocoyam'

f. *between auxiliary and main verbs*

ùlumma nà èri ji
U. prog eat yam
'Ulumma is eating yam'

àda gà igo ji
A. fut buy yam
'Ada is going to buy yam'

To review the evidence, harmony applies:

(i) within non-compound nouns;

(ii) from a verb stem to all inflectional prefixes, including 'dependent pronouns';

(iii) from a verb stem to all inflectional and some extensional suffixes.

Harmony does not apply:

(i) from a verb stem to most extensional suffixes;

(ii) between the constituents of a compound, whether they are nominal, verbal or from other syntactic categories;

(iii) between any independent words, including nouns, main verbs, auxiliary verbs, modifiers, determiners, prepositions and complementisers.

It is clear from these facts that morphology and phonology interact to determine the domains in which vowel harmony applies. §2.1 will delineate the morphological derivation of Igbo words. §2.2 will then present an account of the operation of the rule of vowel harmony, using prosodic domains derived from the morphological constituents.

2 Analysis

2.1 Morphological domains and derivations

This analysis will argue for four types of lexical constituents in Igbo: roots, stems, extended stems and fully inflected words. The basic structure of the lexicon assumed here is that of Lieber (1980). The structure of the verb is illustrated in (18a), the structure of the noun in (18b). Parentheses indicate optional elements:

(18) a. *Verbs*

$$\left[\begin{matrix}\text{inflectional}\\ \text{prefix}\end{matrix}\ \left[\left[\left[\begin{matrix}\text{verb}\\ \text{root}\end{matrix}\right]\ \left(\left[\begin{matrix}\text{verb}\\ \text{root}\end{matrix}\right]\right)\right]\left(\begin{matrix}\text{extensional}\\ \text{suffix}\end{matrix}\right)\right]\ \begin{matrix}\text{inflectional}\\ \text{suffix}\end{matrix}\right]$$

b. *Nouns*

[prefix [noun root]]

Traditional analyses describe verb stems as being monosyllabic and noun stems as bisyllabic. Clark (1990) argues, however, that most if not all morphemes in Igbo, including nouns, are monosyllabic and that all initial vowels are themselves prefixes.[8] Evidence that disyllabic nouns are composed of a stem and a prefix comes from paradigms in which a single morpheme may appear as either a noun or as an inflected verb depending on the prefix added, for example (Clark 1990: 7):

(19)	u-cè	'mind'	i-cè	'to think'
	è-nyò	'mirror'	i-nyò	'to observe'
	i-bu	'load'	i-bu	'to carry'
	à-bụ	'song'	i-bụ	'to sing'

Clark argues that the nominal prefixes are part of a now defunct classificatory system, similar to the class prefixes in other West African languages. The prefix vowels and their tones now have no meaning and, synchronically, each noun must specify both the vowel quality and the tone of the prefix it will take. These prefixes are no longer productive. Loan words, for example, do not receive prefixes (e.g. *motò* 'car'), and some commonly used nouns have lost their prefixes, or never had them (e.g. *jí* 'yam' and *dí* 'husband'). However, considering these initial vowels as prefixes explains the otherwise accidental generalisation that nearly all nouns begin with vowels or syllabic nasals while all uninflected verbs begin with consonants. This approach also simplifies the description of disharmonic nouns (§1.2). If all initial vowels are prefixes, the initial vowels of disharmonic nouns may be analysed as instantiations of two prefixes (one high-toned and one low) marked as extraprosodic in the lexicon. Since alternations such as those in (19) are common, it may be assumed that Igbo monosyllabic roots are undifferentiated as to morphological category. Initial vowels function as stem markers for nouns, while verb roots undergo a zero-derivation. Partial lexical entries for the components of the noun *ucè* 'mind' and the verb *cè* 'think' are shown in (20):

(20) root: [cè] 'thinking'
[u [—]]
stem markers: [u [ ]]$_N$ [θ[ ]]$_V$,

Compounding takes place at the stem level. The syntactic categories must be visible to the compounding rule so that nouns are compounded

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(21) *Compoundin*
[stem] [stem

Nominal and verb
level. Compounds n
extensional or inflec
allowed; the order s
extensional suffixes a

(22) a. *stem-suffix*
tụ- wa
throw-be
'begin to t

c. *stem-stem-*
tụ- pụ-
throw-go
'begin to t

(23) a. e- bu-
infl- carry-
'does not

c. e- bu-
infl- carry-
'does not c

Although extensiona
stems in complex verb
(24) has six extensiona

(24) i- *me*-hù-
inf- *do*- aroun
'to shake this

This ability to concat
frames of extensional su
as in (25a), subcategor
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with nouns and verbs with verbs. Further, in nominal compounds, the prefix is present on both elements (e.g. *nhù + ekpe → nhù-m-ekpe* 'plea for pardon'). The rule of compounding will take two stems of the same syntactic category and combine them into a larger constituent. Because compounding may be recursive (verbs composed of three elements are common) the category label of the new constituent will be the same as that of its parts.[9] The compounding rule is given in (21). The part of the rule specifying identical syntactic categories is omitted:

(21) *Compounding*
[stem] [stem] → [[stem] [stem]]

Nominal and verbal compounding cannot take place later than the stem level. Compounds may not be composed of verbs that already include extensional or inflectional suffixes. The order stem-stem-suffix-suffix is allowed; the order stem-suffix-stem-suffix is not, as shown in (22) for extensional suffixes and in (23) for inflectional suffixes:

(22) a. *stem-suffix*

tụ- wa
throw-begin
'begin to throw'

b. *stem-suffix*

ọ- pụ̀- ra
infl-go out-indic
's/he went out'

c. *stem-stem-suffix-suffix*

tụ- pụ̀- wa- ra
throw-go out-begin-for
'begin to throw out for'

d. **stem-suffix-stem-suffix*

*tụ-wa-pụ̀-ra

(23) a. e- bu- ghi
infl-carry-not
'does not carry'

b. e- fè- ghi
infl-cross-not
'does not cross'

c. e- bu- fè- ghi
infl-carry-cross-not
'does not carry across'

d. *e-bu-*ghi*-fè

e. *e-bu-*e*-fè-ghi

Although extensional suffixes may not be interspersed with independent stems in complex verbs, they may be added onto each other. The verb in (24) has six extensional suffixes:

(24) i- *me*-hù- bè- sị- kènè- gòdù-rù yà nke à
inf-*do*-around-away-about-really-until-appl him thing this
'to shake this thoroughly for him'

This ability to concatenate must be captured in the subcategorisation frames of extensional suffixes. If this subcategorisation frame was specified as in (25a), subcategorising for the simple stem and producing a new morphological category, an extended stem, no recursion would be pos-

sible. If, on the other hand, the frame was specified as in (25b), subcategorising for the simple stem domain and producing a new domain of the same type, recursion would be allowed, but the output of extensional suffixation would serve as input to the compounding rule, producing an illicit ordering (e.g. (22d)). It must be assumed, therefore, that extensional suffixes subcategorise for the extended stem domain, as in (25c).[10] A default rule (26) converts all stems into extended stems if no specific extensional affix is added:

(25) *Subcategorisation of extensional affixes*
a. *[[stem] —]$_{ext}$
b. *[[stem] —]$_{stem}$
c. [[ ]$_{ext}$ —]$_{ext}$

(26) *Default*
[stem] → [[stem]]$_{ext}$

This default rule will apply to both nouns and verbs.

Like extensional suffixes, inflectional suffixes may attach to a simple, compound or extended verb. They differ from the extensional suffixes in that there may be no recursion of inflection, and no extensional suffixes may attach outside them. Further, the presence of an infinitive or participial prefix precludes the appearance of an inflectional suffix. Having both prefixes and suffixes subcategorise for the extended stem domain and produce a word domain, as shown in (27), captures these facts nicely. Either a prefix or a suffix may attach, but not both.

(27) *Subcategorisation of inflectional affixes*

a. infinitive and participial prefixes	[— [stem]$_{ext}$]$_w$
b. suffixes	[[stem]$_{ext}$ —]$_w$

The subject markers differ from the infinitive and participial prefixes in that a subject marker must appear if there is an inflectional suffix. In no case may there be two prefixes. Subject prefixes, therefore, must be restricted to attaching only to words that have tense. (27) may be revised as (28):

(28) *Subcategorisation of inflectional affixes* (revised)

a. infinitive and participial prefixes	[— [stem]$_{ext}$]$_w$
b. suffixes	[[stem]$_{ext}$ —]$_w$
c. subject prefixes	[— [+tense]$^{+tense}_{w}$]$_w$

The requirement that there be one and only one subject market and one and only one tense will be enforced by the syntax.

Because nouns do not undergo any inflection, a second default rule (29) changes all nominal stems into words. The phrasal compounding rule[11]

operates on the word
syntax:

(29) *Default*
[N stem] → [

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2.2 A prosodic ana

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(30) *Link ATR*

The application of (3
indicated with capital

(31)

a. *UR*

b. *link ATR*

operates on the word domain, and it is the word domain that enters the syntax:

(29) *Default*
$[\text{N stem}] \rightarrow [[\text{N}]]_w$

The distribution of the different kinds of verbal and nominal elements has motivated four types of morphological constituents in Igbo: root, stem, extended stem and word. §2.2 will discuss how the evidence from vowel harmony motivates a mapping from morphological constituent to phonological domain.

2.2 A prosodic analysis of the domain of vowel harmony

The mechanism of spreading of the ATR feature may be described simply and straightforwardly. One may assume an underlying representation of vocalic features as shown in (1), with only one value of each feature present. Roots that surface with a [+ATR] value have that specification underlyingly; those that surface with a [−ATR] value have their specification filled in by default. It is simpler to assume that the ATR feature is floating, associated with the morpheme, rather than linked to a specific vowel. As the vast majority of morphemes have only a single vowel there is little empirical evidence for or against pre-association, except that in the few polysyllabic nouns the choice of the vowel to which the specification is attached underlyingly would be arbitrary. Inflectional affixes have no underlying ATR specification, but receive their value either by default or spreading, depending on the root with which they are combined.

The harmony rule may be stated simply as in (30), as a rule that links the ATR feature to vowels in a one-to-many relationship. This linking rule will apply whenever its structural description is met, while the filling in of default ([−ATR]) values will be left until the end of the lexicon.

(30) *Link ATR*

The application of (30) is illustrated in (31). Underspecified vowels are indicated with capital letters.

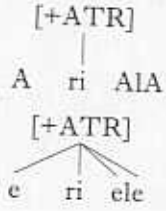
(31)

	a- zụ- ọla	è- ri- ele
	infl-buy-perf	infl-eat-perf
	'has bought'	'has eaten'
a. *UR*		[+ATR]
	zU	rI
b. *link ATR*		[+ATR]
	—	|
		ri

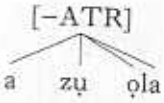
c. *affixation*

	A zU OlA	A ri AlA

d. *link ATR*



e. *default*



f. *SR* a-zụ-ọla —

è-ri-ele

The more challenging task is to describe the domain of the ATR spreading rule. Each of the environments discussed in §1.5, both those where harmony applies and those where it does not, must be accounted for. It is clear that the domain of vowel harmony does not directly correspond to any of the morphological constituents motivated in §2.1. Because harmony applies from stems to inflectional affixes, the domain of harmony would have to be the word domain in order to include them. Yet harmony does not apply between compounds, which are part of the word domain. As was argued above, the distribution of inflectional and extensional affixes (always at the edges, never between the two elements of a compound) indicates that compounded stems form a single morphological domain. Yet the phonological evidence indicates that compounds form two domains.

Such a mismatch between the morphological and prosodic status of compounds has been reported for Sanskrit (Selkirk 1980), Dutch (Booij 1985), Hungarian, Turkish and Italian (Nespor & Vogel 1986), Malayalam (Sproat 1986) and Indonesian (Cohn 1989). It is a strong argument for the necessity and independence of prosodic structure. If only the morphological structure was present, and was the only constituency available to the phonological rules, there would be no way to derive a single domain for the morphology but two for the phonology. However, if both kinds of constituents are available we would expect there to be cases where the two structures do not match. Igbo compounds may be added to the list of such cases.

The ATR linking rule as written in (32) reflects the fact that harmony applies on a prosodic domain, labelled ω. It is convenient to think of the ω-domain as a prosodic word because it is, at least by the end of the lexical derivation, roughly word-sized, although it does not correspond exactly with either the morphological word or the prosodic word as it has been defined in other analyses.

(32) *Link ATR*

—

è-ri-ele

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The mechanism for creating this prosodic domain must be specified. Because harmony is a lexical rule, the domain in which it applies must be present in the lexicon: the boundary between the two halves of a compound would no longer be visible in the postlexical phonology. Prosodic structure in the lexicon has been argued for by Booij (1985) and Inkelas (1989).

The phonology of Igbo provides evidence that information about prosodic constituency is present in the lexicon alongside information about morphological constituency. Both kinds of information must be present because the morphological and phonological domains are not the same. Under this analysis, a prosodic domain created early in the lexical component will persist throughout the lexical processes and will extend into the postlexical component. There is no need for a prosodic derivation accompanying the morphological derivation, as proposed in Inkelas (1989). The prosodic domain may be enlarged by the addition of affixes, but no other changes in the prosodic structure are required.

Igbo roots are lexically specified to form ω-domains. The morphological domain is not changed; rather, the two types of structure are co-present. This is shown in (33):

(33) morphological constituency prosodic constituency
[root] $[\ ]_\omega$

It may seem strange to refer to an entity such as an underived root as a 'word'. The label is appropriate, however, because the same domain will persist throughout the derivation, and into the postlexical phonology. There is no need in Igbo to refer to different levels of lexical prosodic categories.

Morphologically, as was shown in (20), the nominal prefixes attach to roots and form stems. Prosodically, however, they must form part of the ω-domain. Inkelas (1989: 142) has argued that this is the default behaviour of affixes: attaching to a prosodic constituent α and forming a larger constituent of the same type. This property can be captured in terms of a prosodic subcategorisation frame, as shown in (34):

(34) *Subcategorisation of nominal prefixes*
morphological constituency prosodic constituency
$[— [\text{root}]]_{\text{stem}}$ $[— [\ ]_\omega\ ]_\omega$

As (34) is the default subcategorisation, the prosodic frame of these harmonising nominal affixes does not have to be specified as part of the lexical entry. In the unmarked case, prefixes are integrated into a following prosodic word. Harmony then applies on the ω-domain. Prefixes will carry no lexical specification for ATR, and will receive a [+ATR] value by spreading from the root, or [−ATR] by default. Non-harmonic affixes, on

the other hand, require a special specification, indicating that they do not become part of the harmony domain.

(35) *Subcategorisation of non-harmonic nominal affixes*

morphological constituency	prosodic constituency
$[— [\text{root}]]_{\text{stem}}$	$— [\ ]_{\omega}$

These prefixes, then, are marked in the lexicon as extraprosodic by means of a special prosodic subcategorisation frame. Again, it should be noted that the morphological structure remains unchanged. Instead of a restructuring in the morphological constituency, information about a second type of domain structure, which may not correspond to the first, is made available.

The formation of a new morphological constituent does not trigger the creation of a new phonological constituent. This is seen in compounding. Each verb or noun stem has been assigned the prosodic category ω by rule (33). Compounding combines the stems into a single morphological unit, but the prosodic structure is unaltered, and the prosodic domains remain separate. This is shown in (36):

(36) *Compounding*

morphological constituency	prosodic constituency
[stem] [stem] → [[stem] [stem]]	$[\text{stem}]_{\omega}\ [\text{stem}]_{\omega}$

Thus harmony is prevented from applying between the members of a compound.

Disharmonic nouns may also become parts of compounds. When a noun with a disharmonic prefix is used as the second half of a compound, the prefix still surfaces with a [−ATR] value. Two examples of this are *ọkụkụ-abuke* 'a small fowl' and *osisi-anyike* 'wood of an axe, axe handle' (both from Williamson 1972). It was argued above that the disharmony in the noun stem can be accounted for by assuming that the prefix, due to a special prosodic subcategorisation, is outside of the harmony domain. In a compound, however, the prefix is no longer peripheral, and thus it cannot continue to be extraprosodic. As the prefix is not deleted, it must, by the principle of exhaustive parsing (Selkirk 1986), be incorporated somehow into the prosodic structure. Yet because the prefix remains disharmonic, the vowel, if it has not yet been assigned [−ATR], cannot be incorporated into the domain of an adjacent stem, where it would be subject to harmony. One solution would be to assume a rule that, to satisfy exhaustive parsing, creates a domain for any stray material. This approach is similar to that taken by Selkirk & Shen (1990), who propose that function words that are prevented from attaching to an adjacent prosodic word by the presence of a stronger boundary form their own prosodic word domain. Such a rule is independently motivated in Igbo by the behaviour of function words, which form independent prosodic domains, with no harmony between a function word and its object. As function

words do not start out as stems, a default domain-formation rule will assign them their prosodic status.

Alternatively, one might assume cyclic default rules (Kirparsky 1989). If the [−ATR] value is filled in on the prefix before the compound is formed, incorporating the vowel into an adjacent ω-domain will not cause any change. The data here is insufficient to choose between the two approaches. In the interest of avoiding derivations more complicated than necessary, cyclic default rules will not be assumed here.

Inflectional affixes, as was shown in (15), harmonise with a verb stem to which they are adjacent. Inflectional affixes have the same default prosodic subcategorisation as the nominal affixes. They become part of the prosodic constituent to which they are attached by the morphology. Like the nominal prefixes, inflectional affixes have no lexical specification for ATR:

(37) *Subcategorisation of inflectional affixes*

	morphological constituency	prosodic constituency
a. infinitive and participial prefixes	$[— [verb]]_w$	$[— [\ \ ]_\omega\ ]_\omega$
b. suffixes	$[[ext\ stem] —]_w$	$[— [\ \ ]_\omega\ ]_\omega$
c. subject prefixes	$[— [V\ +tense]]_w$	$[— [\ \ ]_\omega\ ]_\omega$

Again, this is the default prosodic subcategorisation for affixes. In the labelling of the brackets, however, this analysis departs from Inkelas (1989), who, in order to differentiate affixes and clitics, argues that affixes will not subcategorise for the word domain. Unlike the word domain in the analysis proposed by Inkelas, however, the ω-domain is the only lexical prosodic domain in Igbo.

The non-harmonising extensional suffixes must, like verb stems in compounds, form their own prosodic domain apart from the stem. Harmonising extensional suffixes, like inflectional affixes, are incorporated into the ω-domain. The difference between the two types of extensional suffix must be lexically specified. As was argued in §1.3.3, no consistent distinctions can be made in the morphological or semantic structure of the harmonic and disharmonic extensional affixes. That the difference between them is arbitrary is shown by the fact that speakers differ as to the category to which some affixes are assigned. In the account being developed here, we must assume that the harmonic affixes are marked in the lexicon to form a single prosodic domain with the verb stem, while the disharmonic affixes form their own domain. Their lexical subcategorisation frames would be as in (38):

(38) a. *non-harmonic extensional affixes*

morphological constituency	prosodic constituency
[[stem] —]	[ ]$_\omega$

b. *harmonic extensional affixes*

morphological constituency	prosodic constituency
[[stem] —]	[[ ]$_\omega$ —]$_\omega$

A precedent for specifying the prosodic constituency of a lexical item is found in Zec & Inkelas (1990), in their discussion of clitics in Serbo-Croatian. They argue that while most function words in Serbo-Croatian are clitics, two prepositions, *ali* and *pa*, function instead as hosts, and thus must be underlyingly specified to form independent prosodic words.

Concatenations of extensional affixes show that their independent prosodic constituency must be assigned underlyingly, rather than by a rule such as the default rule motivated for disharmonic prefixes and for function words. If a late default rule motivated by exhaustive parsing were to create a prosodic constituent for the extensional affixes, they would all be grouped into a single constituent. The extensional affixes attached to a stem may differ in their ATR value, however, indicating that they must be separated by domain boundaries. This was illustrated by the verb in (24), repeated as (39), where a [−ATR] suffix appears surrounded by [+ATR] syllables:

(39) i- *me*-hù- bè- ṣị- kènè- gòdù-rù yà nke à
inf-*do*-around-away-about-really-until-appl him thing this
'to shake this thoroughly for him'

If all the extensional suffixes formed a single domain, *ṣị* would be subject to harmony from the other suffixes in the domain, and would receive a [+ATR] value.[12]

Additionally, only the non-harmonic suffixes may carry an underlying specification for ATR. Like all inflectional affixes, the harmonising suffixes must be unspecified. Otherwise, the situation would arise in which a [+ATR] suffix would combine into a phonological word with a [−ATR] root, spreading its [+ATR] value. This situation does not arise: [−ATR] verb roots retain their value when they combine with [+ATR] extensional suffixes, as in *ị-gba-kirị* (in (12)), which combines the root meaning 'run' with a directional suffix 'up and down'.

Extensional affixes thus share properties both of verbs and of affixes. Like affixes, they are morphologically dependent. Yet they are historically derived from verbs, and like independent verbs they may be specified for ATR and in most cases form independent prosodic domains. Given their intermediate and unstable status, it is not surprising that some lexical marking is necessary to specify which properties a given extensional suffix may have.

The derivations of a compound and an extended verb with inflectional affixes are given in (40) and (41):

(40) *Derivation of a compound verb*

	morphological constituency	prosodic constituency
I. *UR*	[+ATR] [ghA] [gbU]	
formation of prosodic domains (33)	[+ATR] [ghA] [gbU]	[+ATR] $[ghA]_\omega$ $[gbU]_\omega$
link ATR (32)		[+ATR] $[ghA]_\omega$ $[gbu]_\omega$
II. *morphological compounding* (36)	[+ATR] [[ghA] [gbu]]	—
link ATR (32)		—
default domain assignment (26)	[+ATR] [[ghA-gbu]]	
III. *inflectional affixation* (37)	[+ATR] [A [[ghA-gbu] gO]]	
formation of prosodic domains (37)		[+ATR] $[A\ [ghA]_\omega]_\omega$ $[[gbu]_\omega\ gO]_\omega$
link ATR (32)		[+ATR] $[A\ [ghA]_\omega]_\omega$ $[[gbu]_\omega\ go]_\omega$
default		[−ATR] [+ATR] $[a\ [gha]_\omega]_\omega$ $[[gbu]_\omega\ go]_\omega$
IV. *SR*		à-gha-gbu-go 'has cheated'

(41) *Derivation of a verb with an extensional suffix*

		morphological constituency	prosodic constituency
I.	*UR*	[gbA]	
	formation of prosodic domains (33)	[gbA]	$[gbA]_{\omega}$
	link ATR (32)		—
	verbal derivation (20)	$[[gbA]]_{stem}$	
	default domain assignment (26)	$[[gbA]_{stem}]_{ext}$	
II.	*suffixation* (38)	[+ATR]	
		[[gbA] kIrI]	
	formation of prosodic domains (38)		[+ATR] $[gbA]_{\omega}$ $[kIrI]_{\omega}$
	link ATR (32)		[+ATR] $[gbA]_{\omega}$ $[kiri]_{\omega}$
III.	*inflectional affixation* (37)	[+ATR] [I [gbA-kiri]]	
	formation of prosodic domains (37)		[+ATR] $[I\ [gbA]_{\omega}]_{\omega}$ $[kiri]_{\omega}$
	link ATR (32)		—
	default		[−ATR] [+ATR] $[i\text{-}gba]_{\omega}$ $[kiri]_{\omega}$
IV.	*SR*		ị-gba-kìrì 'to run up and down'

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l suffix

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constituency

$[gbA]_{\omega}$

—

[+ATR]

$[gbA]_{\omega}$ $[kIrI]_{\omega}$

[+ATR]

$[gbA]_{\omega}$ $[kiri]_{\omega}$

[+ATR]

$[I\ [gbA]_{\omega}]_{\omega}$ $[kiri]_{\omega}$

—

[−ATR] [+ATR]

$[i\text{-}gba]_{\omega}$ $[kiri]_{\omega}$

ị-gba-kìrì
'to run up and down'

These derivations show that the domain-based approach developed in this section makes the correct predictions of where harmony will and will not occur.

In order to make sense of the domains over which vowel harmony operates, the ω-domain, a phonological entity which is not coextensive with the morphological word, is needed. The rule of vowel harmony itself does not have to be constrained by specification of the morphological environments where it applies: to some suffixes but not all, within nouns but not between two compounded stems. Rather, its domain is fixed as ω. No direct reference to syntax is necessary. The operation of vowel harmony is constrained by the structure of words in Igbo and their combinatorial properties as specified in phonological subcategorisation frames in the lexicon.

It was also shown that only one lexical prosodic domain is needed in Igbo. This is a departure from Inkelas (1989), where it is argued that morphological derivation will trigger phonological derivation. The derivation of additional domains in Igbo, however, would be at best superfluous.[13] In the absence of evidence to the contrary, this independence of morphological and prosodic structure would be the default case: changes in one domain do not necessarily cause changes in the other.

Further evidence of this proposed prosodic constituency is found in the rule of vowel assimilation. In assimilation as well, the morphological and prosodic domains do not coincide. The rule of assimilation makes reference to the same prosodic constituent as does vowel harmony.

3 Supporting evidence: vowel assimilation

Because most Igbo words begin and end in vowels, vowels frequently become adjacent across word boundaries. While in careful speech both vowels are pronounced, in fluent speech a rule of progressive assimilation applies, so that the first vowel takes on the quality of the second. Emenanjo notes that 'failure to assimilate or to assimilate correctly ... marks a halting and laboured style characteristic of non-native learners/speakers' (1978: 25). In all but the most rapid speech the duration and tone level of both vowels are retained. If the first vowel is non-high (/e a o ọ/) assimilation takes place regardless of the quality or tone level of the following vowel. If the first vowel is high (/i ị u ụ/), assimilation is conditional: /u/ and /ụ/ assimilate only in rapid speech; /i/ and /ị/ may become glides if the following vowel is on the same tone level. Some examples of assimilation of high vowels are given in (42):

(42) a. *High back vowels*

ewu ìse	→ ewíise *or*	'five goats'
'goat, five'	ewu ìse	
okwū ego	→ okweego *or*	'talk about money'
'talk, money'	okwu ego	
ọnụ anụ	→ ọnaanu *or*	'mouth of an animal'
'mouth, animal'	ọnụ anu	
o-bùrù ego	→ o bùrèego *or*	's/he carried money'
'3SG-carry-past, money'	o bùrù ego	

b. *High front vowels*

isi ewu	→ isyewu	'head of a goat'
'head, goat'		
ùdiri ụlọ	→ ùdiryụlọ	'type of house'
'type, house'		
ànyị e-je-ghi	→ ànyeejeghi	'we did not go'
'1PL, infl-go-not'		

Because the assimilation of high vowels is conditional while the assimilation of non-high vowels is obligatory in fluent speech, the rest of this section will use only the non-high subset for illustration. A more thorough examination of the factors, including vowel height, that influence the application of vowel assimilation, especially across stronger syntactic boundaries, can be found in Zsiga (in preparation).

3.1 Noun stems and verb stems

Assimilation takes place only across word boundaries. This makes assimilation a juncture rule, in the terminology of Selkirk (1980, 1986). In fact, vowels are seldom adjacent within a word, due to the overwhelming preponderance of CV syllables, but when vowel sequences do occur, both vowels retain their quality.

A small class of verbs and nouns take the form CVV, as shown in (43). Of these, some contain identical vowels underlyingly[14] (43a), and some contain a high vowel (whose assimilation would be conditional even across word boundaries (43b)), but a few words do contain sequences that would unconditionally undergo assimilation if the rule operated within the domain of the word (43c):

(43) a. jèe 'go'
bàa 'enter'

b. bịa 'come'
hie 'tie'
abụọ 'two'

c. awaị 'porridge'
maị 'wine'

In each of these cases two vowels are pronounced.

3.2 Inflectional affixe

Vowel sequences withi
boundaries. Although m
(44), and thus contain
sequences do ocur. One
some words takes a redu
form *-ala/-ele* (45). Red
because in reduplication
assimilation the quality

(44) o-me-ele 's/h
o-zà-ala 's/h

(45) o-sò-ele 's/h
ọ-chọ-ala 's/h
o-si-ele 's/h

Examples of non-ide
When they do occur, ho

3.3 Extensional affixe

Emenanjọ (1978) lists no
initial, these morphemes

3.4 Independent word

Examples of vowel assin
Assimilations between th
(46). Igbo word order is

(46) a. *Between subje*

àda e- bu-
A. infl- car
'Ada is not c

chikẽ à- sị
C. infl- sa
'Chike did n

ha e- je-
3PL infl- go-
'they did not

3.2 Inflectional affixes

Vowel sequences within words occur more often across morpheme boundaries. Although many vowel-initial suffixes are reduplicative, as in (44), and thus contain identical vowels by definition, unassimilated sequences do ocur. One example is the past perfective suffix, which in some words takes a reduplicated vowel (as in (44)), but in other words the form *-ala/-ele* (45). Reduplication can be distinguished from assimilation because in reduplication the quality of the first vowel is repeated while in assimilation the quality of the first vowel is lost.

(44) o-me-ele 's/he has done' gò-o 'buy!'
o-zà-ala 's/he has swept' bò-ọ 'cut up!'
zà-a 'sweep!'
chè-e 'think!'

(45) o-sò-ele 's/he has followed'
ọ-chọ-ala 's/he has desired'
o-si-ele 's/he has cooked'

Examples of non-identical vowels within words are not numerous. When they do occur, however, the two vowels will not be assimilated.

3.3 Extensional affixes

Emenanjọ (1978) lists no vowel-initial extensional affixes. Being consonant-initial, these morphemes are not candidates for vowel assimilation.

3.4 Independent words

Examples of vowel assimilation are found in all syntactic environments. Assimilations between the major constituents of the sentence are shown in (46). Igbo word order is SVO.

(46) a. *Between subject and verb*

àda e- bu- ghi ìtè → àdeebughi ìtè
A. infl- carry- not pot
'Ada is not carrying a pot'

chikẽ à- sị̄- ghị asị → chikãasị̄ghị asị
C. infl- say- not saying
'Chike did not tell a lie'

ha e- je- ghi → heejeghi
3PL infl- go- not
'they did not go'

b. *Between verb and object*

ọ- zà- rà ụlọ	→	ọzàrụ̀ụlọ̀
3SG-sweep-indic house		
's/he swept the house'		
ị- chọ̀- rọ́ egō	→	ịchọ̀rèegō
2SG-want-indic money		
'you want money'		
o- sò- rò ezè	→	osòrèezè
3SG-follow-indic chief		
's/he followed a chief'		
o- gò- rò àlà	→	ogòrààlà
3SG-buy-indic land		
's/he bought some land'		

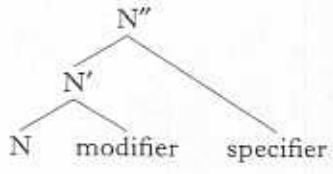
c. *Between the multiple objects of a verb*

o- nyè- lù àda ihe	→	onyèlààdiihe
3SG-give-indic A. thing		
's/he gave Ada something'		
o- nyè- lù ọfọ àkwa	→	onyèlu ọfaàkwa
3SG-give-indic O. eggs		
's/he gave Ofo some eggs'		

Assimilations in these environments are possible but not obligatory. Assimilations between major constituents seem to occur only when the constituents are short and simple. If the subject is a complex noun phrase, for example, assimilation between subject and verb is less likely (Zsiga in preparation).

Assimilation also occurs within the major syntactic constituents. The structure of the Igbo noun phrase is shown in (47), and examples of assimilation within the noun phrase are given in (48):

(47)



(48) a. *noun–adjective*

ihe ọma	→ ihọọma	'white thing'
ihe ukwu	→ ihuukwu	'big thing'
ụlọ ukwu	→ ụlùukwu	'big house'
nkịtā ojiī	→ nkịtǭọjiī	'black dog'

A mismatch

b. *noun–specifi*

nwokē à	
ihe à	
eze àhụ	
ụlọ à	
ihe ìse	

c. *longer NPs*

nkịtà ọcha	
dog white	

Three or four words assimilated.

In the 'associative c nouns. Tonal changes

(49) *Associative con*

ihe ọzọ	'th
ụlọ ubi	'hc
ahà ihe	'na
ụlọ àla	'ho
egọ àyọ̀lọ̀	'm

With respect to assi prosodic entities, with tions, and prepositions

(50) *Function words*

ka ọ- pụ	
when 3SG-go	
'when s/he got	
ma o- nwe-	
but 3SG-have	
'but s/he has n	
màkà okwu	
about talk	
nà ime ụlọ	
in inside ho	
iwe na ọnụma	
na ị-zụ-rụ ihe	
nà ùbi	
nà ụ̀tụ̀tụ̀	

b. *noun–specifier*

nwokē à	→ nwokaà	'this man'
ihe à	→ ihaà	'this thing'
eze àhụ	→ ezaàhụ	'that chief'
ụlọ̀ à	→ ụlàà	'this house'
ihe ìse	→ ihiìse	'five things'

c. *longer NPs*

nkịtà	ọcha	ọma	ụnụ̀ →	nkịtọ̀ọchọọmụụnụ̀
dog	white	beautiful	your	'your beautiful white dog'

Three or four words may be run together, with all of the vowels assimilated.

In the 'associative construction', nouns may be used to modify other nouns. Tonal changes indicate the meaning 'X1 of X2'.

(49) *Associative construction*

ihe ọzọ	'thing, other'	→ ihọọzọ	'another thing'
ụlọ̀ ubi	'house, farm'	→ ụlùubi	'farmhouse'
ahà ihe	'name, thing'	→ ahìihe	'name of a thing'
ụlọ̀ àla	'house, land'	→ ụlààla	'bungalow'
egọ àyọ̀lọ̀	'money, cowries'	→ egaàyọ̀lọ̀	'cowry currency'

With respect to assimilation, function words behave as independent prosodic entities, with assimilation between complementisers, conjunctions, and prepositions and their objects:

(50) *Function words*

ka ọ- pụ̀- rụ̀ èzi → kọọpụ̀rèèzi
when 3SG-go out-indic outside
'when s/he got outside'

ma o- nwe- ghi onye → moonweghoonye
but 3SG-have-not someone
'but s/he has no-one'

màkà okwu à → màkòokwu a 'about this talk'
about talk this

nà ime ụlọ̀ → niimụụlọ̀ 'inside the house'
in inside house

iwe na ọnụma → iwe nọ̀ọnụma 'anger and misery'
na ị-zụ-rụ ihe → niịzụrụ ihe 'and to buy things'
nà ùbi → nùùbi 'on the farm'
nà ụtụtụ̀ → nùụ̀tụtụ̀ 'in the morning'

The preposition *na* is exceptional in that it takes on both the quality and the tone of the following vowel. It is usually written only as *n'*. The vowel timing-slot is retained, however, and the /a/ surfaces when the preposition precedes a consonant-initial noun: *nà motò* 'in the car', *nà jí* 'on the yam'. In these cases the vowel is low-toned, but this value may be supplied by rule or by default, and the vowel may be underlyingly toneless. The preposition is the only case of assimilation where tone as well as vowel quality spreads.

Like function words, auxiliary verbs behave as prosodically independent, and assimilation takes place between main and auxiliary verbs:

(51) àda ga- egò ji → àda geegò ji 'Ada will buy yams'
A. fut-buy yam

ụnụ́ akà- èli- ro ji → ụnụ́ akèèliro ji
2PL neg.past-eat-indic yam
'you have not eaten yam'

ọ- na- èri nri → ọ nèeri nri 's/he eats'
3SG- habit-eat food

In this case, the analysis of auxiliary verbs as independent words is supported by the syntax: in some constructions, the inflectional suffixes will appear on the auxiliary, not the main verb. In (52), the indicative and negative indicative suffixes (*-rà* and *-ghí*) are attached to the auxiliary verbs (*nà* 'habitual' and *ga* 'future') rather than to the main verbs, which appear in participial or infinitive forms. The order prefix-suffix-root would of course be impossible, so an analysis of the auxiliaries as prefixes is ruled out.

(52) ụnụ́ nà- rà a- zà ụlọ́
2PL habitual-indic partic-sweep house
'you were sweeping the house'

ọ- ga- ghị́ è- me ya
3SG-will-neg partic-do it
's/he is not going to do it'

m̀mirí gà- rà i- zò
rain will-indic inf-fall
'rain is going to fall'

The operation of vowel harmony (as was noted in §1.5) also supports the analysis of auxiliaries as independent words. While the dependent pronouns and inflectional suffixes agree with the auxiliary verb in ATR value with the auxiliary verb (as shown in (52): *ọ ga ghị́*), there is no vowel harmony between auxiliary and main verb (as shown in (51): *ga egò*). This would indicate that the auxiliary forms a single prosodic domain with its inflectional affixes, but

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careful speech, vowe
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main and auxiliary ve

3.5 Compounds

While there is no vowe
assimilation does occu

(53) ife ọma →
'thing, good'
amà echi →
'not known, t
ọmị́ iko →
'well water, c
onye ọcha →
'person, white
amã osu →
'distinguishing
ọgà na iru →
'it goes, toward
inye aka →
'to give, hand'

Again, phonological ru
separate words.[15]

3.6 Analysis

We have seen that assir
Compare the within-w
sequences when they o
example *chọ̀rọ̀ egō* 'wan
becoming *ulàà*, and *na ịz*
'look-perf', *sò-ele* 'follow
While the instances of
numerous, an assimilatec
do occur. Assimilation a

(i) between independe
modifiers and determine

(ii) between the consti
Harmony does not apply

(i) within stems;

(ii) from verb roots to

forms a separate domain from the main verb. Assimilation then operates at this domain boundary. The effects of harmony would not necessarily be wiped out by assimilation: while assimilation does not apply in very careful speech, vowel harmony does, so that a slow and careful pronunciation of the examples above indicates vowel harmony to the appropriate affixes, but neither vowel harmony nor assimilation between main and auxiliary verb.

3.5 Compounds

While there is no vowel harmony between the two elements of compounds, assimilation does occur:

(53) ife ọma → ifọọma 'name: a good thing'
'thing, good'
amà echi → amèechi 'name: tomorrow (is) unknown'
'not known, tomorrow'
ọmị iko → ọmìiko 'mercy'
'well water, cup'
onye ọcha → onyọọcha 'Whites'
'person, white'
amā osu → amōosu 'witch'
'distinguishing mark, one consecrated to a deity'
ọgà na iru → ọ̀gàniiru 'progress'
'it goes, toward, forward'
inye aka → inyaaka 'help' (n.)
'to give, hand'

Again, phonological rules mark the two elements of a compound as separate words.[15]

3.6 Analysis

We have seen that assimilation applies between words, but not within. Compare the within-word sequences in (43) and (45) to the same sequences when they occur across word boundaries in (46)–(50): for example *chọ̀rọ̀-egō* 'want money' becoming *chọ̀rèego*, *ụlọ̀ à* 'house this' becoming *ulàà*, and *na ịzụrụ* 'and misery' becoming *nịịzụrụ*, while *chọ̀-ala* 'look-perf', *sò-ele* 'follow-perf' and *awaị* 'porridge' remain unassimilated. While the instances of vowel sequences within words are not very numerous, an assimilated pronunciation is always prohibited in those that do occur. Assimilation applies:

(i) between independent words: nouns, main verbs, auxiliary verbs, modifiers and determiners, and function words;
(ii) between the constituents of a compound.

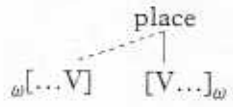
Harmony does not apply in these cases. Assimilation does not apply:

(i) within stems;
(ii) from verb roots to inflectional affixes.

Harmony does apply here.[16] The environments in which assimilation occurs are the inverse of those in which harmony occurs.

The domain that was relevant for harmony will be the same one that is relevant for assimilation, except that the rule will make reference to the domain boundaries. The same ω-domain that was present at the level of inflectional affixation remains relevant at the level where words combine. There is no evidence that morphological and syntactic derivation and concatenation have triggered comparable changes in the prosodic category. The behaviour of compounds is crucial in this analysis: the same boundary that was posited between the elements of a compound to prevent harmony must remain visible at the later level to allow assimilation. Again, the word must be prosodic, not morphological, for the same reasons as argued above: although compounds count as a single word with respect to the syntax, they count as two words with respect to this phonological rule.

(54) *Vowel assimilation*



Although more research into higher level prosodic constituents in Igbo is needed, it seems reasonable, because assimilation occurs between major constituents only when they are simple, to assume that this rule is restricted to the phonological phrase.

These two rules, vowel assimilation and vowel harmony, have provided evidence for a mismatch between morphological and prosodic constituents. Only if both types of constituent are present can the mismatch be resolved. The prosodic account, in positing a single domain to which both harmony and assimilation make reference, provides a unified analysis of these two complementary rules.

4 Two values for ATR

An alternative account of the vowel harmony data, not making reference to prosodic domains, was proposed in Zsiga (1988).[17] If one assumes that there is no independent prosodic structure and that the domain of harmony is coextensive with the syntactic word, a different mechanism must be used to block harmony within compounds and from stems to extensional affixes. Harmony may be blocked by the specification of both values of ATR in the lexicon. What is lost in this approach is the interesting connection with the vowel assimilation.

In order to account for the vowel harmony data, Zsiga (1988) argued for the specification of both [+ATR] and [−ATR] values in Igbo roots. The

proposed lexical specifications for different morphological categories are given in (55):

(55) *Lexical specifications*

harmonic roots and invariant extensional suffixes:	[+ATR] [−ATR] | | C V (C V) C V (C V)
inflectional affixes:	((V) C) V
disharmonic roots:	[−ATR] [+ATR] | | V C V
harmonising extensional suffixes:	(C V) C V

All roots and most extensional suffixes would be lexically specified for either plus or minus ATR on one vowel, with this feature then spreading to the other vowels within the morpheme. Inflectional affixes would be left unspecified for ATR. Disharmonic roots would be exceptional in having both vowels specified (although it was not pursued in the 1988 paper, an extraprosodicity solution to these roots is not ruled out in this approach), and harmonising extensional suffixes would be exceptional in remaining unspecified. If both values of ATR are specified in this way, a simple rule of spreading can be employed, only slightly different from the rule in (30) and not specifying any particular domain:

(56) *Spread ATR (non-prosodic version)*

[αATR]
V V V

Spreading of the ATR value between two elements of a compound is prevented by the blocking effect of the opposite ATR specification of the other element, as shown in (57):

(57) *Blocking due to specification of [−ATR]*

a-	kụ-	fu- ole
infl-	strike-	lose-perf
'has kicked away'		

[−ATR] [+ATR]
A kụ fu OlA

Both values, [+ATR] and [−ATR], will spread. This is to account for certain compounds, such as those in (58), where a bisyllabic [−ATR] root combines with a [+ATR] root. If [−ATR] did not spread at the morpheme level from the first vowel to the second of a root like *alụ* nothing would prevent the spread of [+ATR] onto that vowel at the compounding level. This would result in **alumdi*. If the first vowel is

assumed to be a prefix, this would indicate that the feature would attach to the second vowel and spread to the first, but a form like *bịa*, which occurs as both the first and second member of a compound, shows that spreading of [−ATR] must be assumed no matter which vowel is chosen.[18]

(58)

	[−ATR] spreading	*no [−ATR] spreading*	
a.	[−ATR] [+ATR] alU - mdi	[−ATR] [+ATR] * alU - mdi	alụmdi 'marriage'
b.	[+ATR] [−ATR] si - bIa	[+ATR] [−ATR] * si - bIa	sibịa 'come from' (Williamson 1972)
c.	[−ATR] [+ATR] biE - chi	[−ATR] [+ATR] * biE - chi	bịachi 'come regularly' (Williamson 1972)

To block spreading of [+ATR] in the case of *sibịa*, the [−ATR] feature must either spread itself (as shown in (58b)), or be specified on the first vowel of *bịa*. In the case of *bịachi* (58c), however, the second vowel would have to be specified if no [−ATR] spreading is assumed. If specification of both ATR values is to be used to block feature spreading between members of a compound, it must be assumed that both values will spread.

Spreading of both values of a feature, however, is not attested in other ATR languages, and has not been found to be necessary in other types of vowel harmony systems. The grammar of Igbo would be simpler if only one value of ATR needed to be specified, and only that one value spread. Further, specification of both values of ATR does nothing to explain why assimilation occurs in compound words. The only explanation of why assimilation does not occur between roots and affixes but does occur between two roots in a compound is that in the former case the structural description of the rule is not met, while in the latter it is. If the structural description includes the phonological word boundary, with the phonological word domain defined as it needs to be for the rule of vowel harmony, the application within compounds follows straightforwardly. While both accounts require information to be specified in the lexicon, either prosodic structure or the predictable [−ATR] value, the prosodic account is to be preferred because it provides a unified account of the domains of the application both of harmony and of assimilation.

5 Conclusion

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NOTES

* I'd like to thank Jen
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with patience and ge
ported by a NSF gr

[1] The mechanism for
will be suggested in

[2] This prefix is low-to
verbs.

[3] The disyllabic plural
dent form. A [+AT
do not alternate with

[4] In some cases, neith
appear on verbs follo
affirmative indicative
non-pronominal nour
the prefix in this envi
indicative affirmative
tone at the end of the
vowels not distributec
deleted.

[5] In (12) and (14) verb

[6] Clark analyses the
Emenanjọ, on the oth
person pronoun.

5 Conclusion

This paper has examined in detail the domains of application of two phonological rules in Igbo: vowel harmony and vowel assimilation. The two rules conspire to delimit the domain of the prosodic word: harmony applies only within words, assimilation only between words. There is no environment where both rules may apply. It was shown that the one domain necessary for the description of vowel harmony persists throughout the lexical derivation (where harmony applies) and into the postlexical phonology (where assimilation applies). This clear delimitation of a prosodic domain has brought to light a mismatch between what counts as syntactic and prosodic constituents. The two elements of a compound, as well as a verb root and extensional suffix, count as two constituents prosodically but a single constituent syntactically. The application of the harmony rule might be explained without reference to prosodic domains, by allowing the underlying specification and spread of both + and − values of the ATR feature, which would then block harmony between the two elements of a compound. This approach, however, is theoretically costly and does nothing to explain the fact that assimilation occurs between the two compounded elements, when it cannot occur within a word elsewhere. Only the prosodic approach, where a prosodic structure is built in addition to the syntactic structure, gives a simple and complete account of the complementary behaviour of these two rules.

NOTES

* I'd like to thank Jennifer Cole, Brian McHugh and Draga Zec, who gave me a great deal of help and encouragement, and who let me make my own mistakes. I'd also like to thank Esther Obiora, Nkeche Obiora and Okechukwu Oko, who with patience and generosity provided the data for §3. This research was supported by a NSF graduate fellowship to the author.

[1] The mechanism for marking extraprosodicity is not crucial here. An account will be suggested in §2.2.

[2] This prefix is low-toned with high-toned verbs and high-toned with low-toned verbs.

[3] The disyllabic plural pronouns *ànyị́* (1PL) and *ụnụ̀* (2PL) do not have a dependent form. A [+ATR] form – *unù* – appears as a dialectal variant, but the two do not alternate within a given dialect.

[4] In some cases, neither a pronoun nor a prefix appears. For example, prefixes appear on verbs following some auxiliary verbs but not others. In addition, the affirmative indicative tense does not show this prefix even when the subject is a non-pronominal noun phrase: *àdaà bù ìtè* 'Ada carries (a) pot'. The absence of the prefix in this environment might be explained, however, by the fact that the indicative affirmative tense is specially marked by a doubled vowel with a falling tone at the end of the subject noun phrase. As Igbo prohibits sequences of three vowels not distributed over three syllables, it is possible that the vowel prefix is deleted.

[5] In (12) and (14) verbs are cited in uninflected form.

[6] Clark analyses the medial 'm' as a semantically empty linking element. Emenanjọ, on the other hand, analyses these medial nasals as part of the 1st person pronoun.

[7] I will continue to use the traditional term 'extensional affix', however, in order to distinguish these constituents from other verbal constituents with a different restricted distribution. Some verb roots are restricted to occurring only in compounds, and then in some cases only in first and in some cases only in second position. These true bound roots always occur inside any extensional affixes, and so must be distinguished from them.

[8] In some cases the meanings of the constituent morphemes of trisyllabic or longer words are no longer transparent (see Clark 1990: ch. 6).

[9] It is not clear whether the embedding produced by applying the compounding rule recursively is justified semantically, or whether three or more elements may be conjoined simultaneously. It does seem that for extensional suffixes a recursive application is most appropriate, but nothing crucial rests on these assumptions.

[10] This is functionally equivalent to assigning compounding and extensional suffixation to different levels of the derivation.

[11] The exact formulation of this rule is problematic. There may be some recursion from the syntax into the lexicon (see Kiparsky 1982).

[12] Examples such as this one show that an analysis of harmony domains in terms of a minimal foot structure (Itô 1990) is inappropriate for Igbo. A single syllable may form its own harmony domain. Other examples of single-syllable disharmonic affixes are given in (12).

[13] Although tonal rules have not been examined here, I know of no rules that would dictate a different and more complicated domain structure in the lexicon.

[14] If a rule has applied in these words, no alternations reveal it.

[15] It must be noted that because of the morphological structure of the language – nouns do not take inflectional affixes, and verbs are consonant-initial – examples of a single word showing both assimilation and harmony do not exist.

[16] Because all extensional affixes begin with consonants, they can furnish no information about the domain of assimilation.

[17] Clark (1990) also proposes a non-prosodic account of Igbo vowel harmony, using instead level ordering and lexical marking, as well as underlying (or early) application of both values of ATR. Her analysis differs crucially, however, from the one being developed here, in the categories to which affixes are assigned. Given this difference in the interpretation of the morphological facts, the phonological approaches of the two analyses are not directly comparable.

[18] Researchers differ over whether the first vowel of *bịa* is underlyingly a glide or a vowel. It must be considered a vowel if it is assumed that the only possible syllable types are CV and V. In at least some surface forms, the word is definitely bisyllabic. For these inflections, at any rate, the *ị* must occupy a vowel slot whose ATR value must be determined.

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