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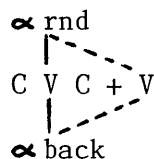
## UNDERSPECIFICATION AND VOWEL HARMONY IN IGBO

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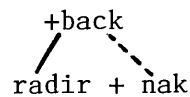
The data in Igbo vowel harmony involve us in the current debate in phonological theory concerning the status of underspecification. The theory of underspecification allows us to leave "blanks" for some feature values in the lexical representation of morphemes, if those values are predictable from other rules or principles. This ability has been very useful in the description of vowel harmony systems. For example, in Turkish, where suffix vowels always agree with root vowels in backness and roundness, we can assume that suffixes do not "come with" any specification for those features, but that they are filled in by a rule of feature spreading from the the root. In a language like Hungarian, we can explain the fact that certain vowels fail to block the spread of a feature by stating that the "transparent" vowel is not specified for the relevant feature at the time harmony applies.

## (0) A. Turkish Vowel Harmony



sanat+i	güj +ü	kurd+u	ip+i
"art poss."	"power poss."	"worm poss."	"rope poss."

## B. Hungarian Vowel Harmony



"eraser dat."

If we allow predictable features to be left out of the underlying representation, however, the question arises whether all predictable features must be unspecified, or if only some predictable features may be unspecified.

In the strongest form of the theory, "radical" underspecification (as proposed by Archangeli 1984 and Archangeli and Pulleyblank 1986), no predictable features may be specified in the lexicon, to the extent that only one value of any feature, either plus or minus but not both, may be present in the underlying representation. Radical underspecification is certainly attractive as a theory. It is highly constrained, and phonology is of course concerned with predicting whatever it is possible to predict. The question I want to raise, however, is whether the theory of radical underspecification is too strong, that is, are there languages where we must assume that both values of a feature are present underlyingly, even though one value is predictable? I believe that Igbo is such a language. I will argue that the data in Igbo vowel harmony force us to conclude that radical underspecification cannot be maintained in that language.

Figure 1 shows the Igbo vowel system. My data is taken primarily from Emenanjo 1978, and all examples are from his work unless otherwise noted. Tones are suppressed throughout.

## (1) Igbo Vowel System

A.	+ATR		-ATR					
	i	u	i̇	u̇				
	e	o	a	ȯ	NB: a = /æ/			
B.	i	i̇	u	u̇	o	ȯ	e	a
high	+	+	+	+				
back	-	-					-	-
ATR	+		+		+		+	

Igbo is a Nigerian language of the Kwa family. Like the related language Akan, Igbo has a harmony system involving the feature ATR: advanced tongue root. Four of the vowels are pronounced with the tongue root stiffened or "advanced," the other four with the tongue root relaxed. In the native orthography, -ATR vowels are written with a dot beneath the letter, except for "a" (which indicates the front vowel /æ/). In the "e" and "a" pair, lowering is a secondary phenomenon, dependent on relaxation of the tongue root (Ladefoged, 1968).

In Fig. 1B we see that in a radically underspecified matrix we need only three features, and only one value of each feature, to distinguish all eight vowels. I will argue, however, that this information is insufficient to derive the data.

Figure 2 shows that, in general, +ATR and -ATR vowels cannot co-occur in Igbo morphemes.

### (2) Morpheme Internal Harmony

-ATR		+ATR	
ɸḍɪṛɪ	"type"	uchichi	"night"
uẓo	"road"	ozu	"corpse"
aḳpi	"scorpion"	ube	"pear"
ọji	"kola nut"	obi	"heart"
uka	"discussion"	ero	"mushroom"
aja	"sacrifice"	ele	"deer"
aḥiri	"line"	ire	"tongue"

I say they cannot "in general" co-occur because there is a small class of disharmonic roots involving "a." Some examples of these are given in Fig. 3.

### (3) Disharmonic Roots

adu	"bitter kola"	aku	"traditional door"
akpo	"roof of the mouth"	akpe	"soap box"
afe	"shirt"	alo	"thought"

These roots are exceptional in that in the vast majority of cases, "a" occurs only in -ATR roots, and in that the exceptions vary from dialect to dialect. No other -ATR vowels, however, co-occur with +ATR vowels in a morpheme.

These disharmonic roots will be difficult to account for in a theory with only one underlying value for ATR. +ATR must be prevented from spreading to the -ATR vowel, without marking it as -ATR in the lexicon. Morpheme internal harmony in the normal case must be accounted for by some sort of spreading, because the alternative, a morpheme structure constraint

prohibiting the co-occurrence of +ATR and -ATR within morphemes, is not available to a theory of radical underspecification. For such a constraint to be meaningful, both values would have to be available. I will return to the problem of harmony within morphemes after presenting more of the data.

In addition to operating within roots, harmony applies from roots to inflectional affixes. The term "inflectional" (I borrow these class names from Emenanjo) indicates affixes that express the tense of the verb or a particular verbal construction. Examples are shown in Fig. 4.

(4) Harmony to Inflectional Affixes

i- / i-	i + si	i + si
"infinitive"	"to say"	"to cook"
o- / o-	o + si	o + si
"agentive"	"the teller"	"the cook"
a- / e-	a + si	e + si
"participial"	"saying"	"cooking"
-a / -e	si + a	si + e
"imperative"	"tell!"	"cook!"
-ghi / ghi	0 sighi	0 sighi
"negative indicative"	"he did not say"	"he did not cook"
-Vla / -Vle	0 siala	0 siele
"perfective"	"he has said"	"he has cooked"

As can be seen from the last two examples, harmony also applies to "dependent pronouns": subject pronouns that immediately precede the verb in simple constructions. I won't comment on the syntax of these pronouns, but simply note that when they occur, they harmonize. Two more examples are given in Fig. 5.

(5) Harmony to Dependent Pronouns

i siri	"you (sg) said"	i siri	"you (sg) cooked"
a siri	"someone said"	e siri	"someone cooked"

Harmony does not apply, however, to compound words. -ATR and +ATR morphemes may freely combine, as shown by the examples in Fig. 6.

(6) Compounds

ku + fu = kufu  
 "strike" "lose" "to kick away"

tu + pu + fe = tɔpɔfe  
 "throw" "go out" "cross" "throw out across,  
 scatter"

gha + gbu = ghagbu<sup>+</sup>  
 "turn" "hurt" "cheat"

go + pu = gopu<sup>+</sup>  
 "buy" "go out" "buy up"

omi + iko = omiko<sup>+</sup>  
 "water" "cup" "mercy"  
 (elision rule deletes "i")

<sup>+</sup>from Williamson 1972

Harmony also does not apply to "extensional" suffixes. These alter or extend the meaning of the verb without changing its time reference. They can occur in many different verbal constructions, always inside the inflectional affixes. Fig. 7 gives examples of extensional suffixes. As the last example, "bikorita," shows, another distinguishing property of extensional suffixes is that they often occur in clusters.

(7) Extensional Suffixes

gba + kiri  
 "run" "up and down"

nwu + chu  
 "die" "prematurely"

bi + ko  
 "live" "assoc."  
 "live together"

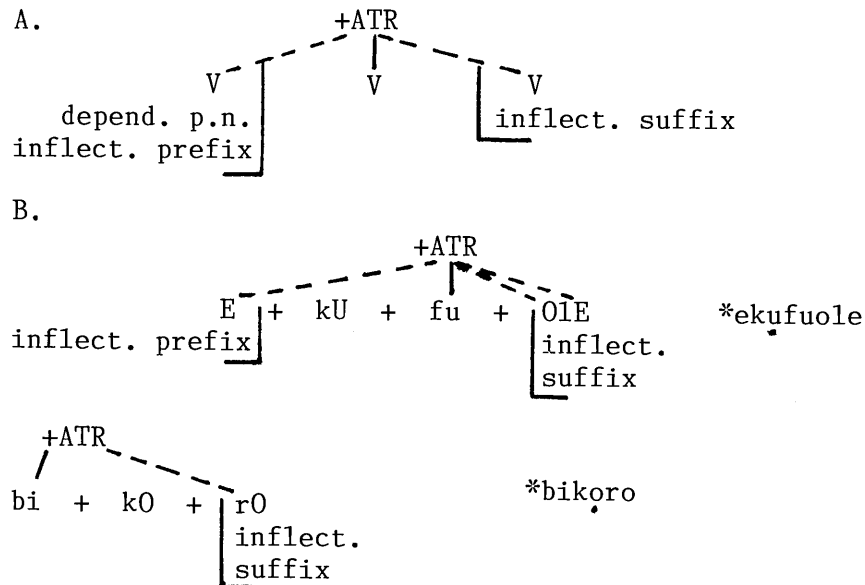
bi + ko + ri + ta  
 "live" "assoc." "appl." "direct."  
 "live together to one another's  
 advantage"

Extensional and inflectional affixes can co-occur, and of course compound verbs take inflectional affixes. In these cases, illustrated in Fig. 8, harmonizing prefixes agree with the first member of a compound or extended verb, harmonizing suffixes with the second. In the first two examples we see the verbal prefix agreeing with the -ATR first member of a compound, the suffix with the +ATR second member. In the third example, a +ATR root combines with a -ATR extensional suffix, and we see that the indicative suffix is -ATR, while the verbal prefix is +ATR. Repeating the verb in this construction is a common way to express emphasis.



-ATR vowel in an extensional suffix or compound, as shown in Fig. 11B. In fact, the -ATR morphemes must block the spread of the harmonic feature. Another drawback to the rule in 11A is that it does nothing to explain harmony within roots.

## (11) Morphological Constraints



A better way to account for these morphological constraints might be to seek an explanation within the framework of lexical phonology, where the different types of affixation would be sorted out into different levels, to which phonological rules apply cyclically. We might define four levels in Igbo phonology: 1) morpheme internal processes, 2) compounding and extensional affixes, 3) inflectional affixes, and 4) post-lexical processes. Obviously, however, simply dividing things up into levels and having harmony apply cyclically will not derive the correct results: harmony would still fill in +ATR on the underspecified half of compounds like "kufu." Correct results could be derived if we stipulate two things: 1) Harmony does not apply at level two, and 2) Default rules apply at the end of each cycle (except the morpheme internal cycle--allowing default rules at that point would be equivalent to a fully specified lexical representation for all morphemes). Two sample derivations are given in Fig. 13.

Consider the derivation of "igbakiri," "to run up and down." It consists of the harmonizing prefix "i/i," the -ATR verb root "run," and a +ATR bisyllabic extensional suffix "up and down." At level one, we see the spreading of the +ATR feature to the second vowel of "kiri." At level two "gba" and "kiri" are joined, but harmony is prohibited at that level, so default rules fill in -ATR at the end of the cycle. The importance of allowing the default rules to apply cyclically is seen at level three, where

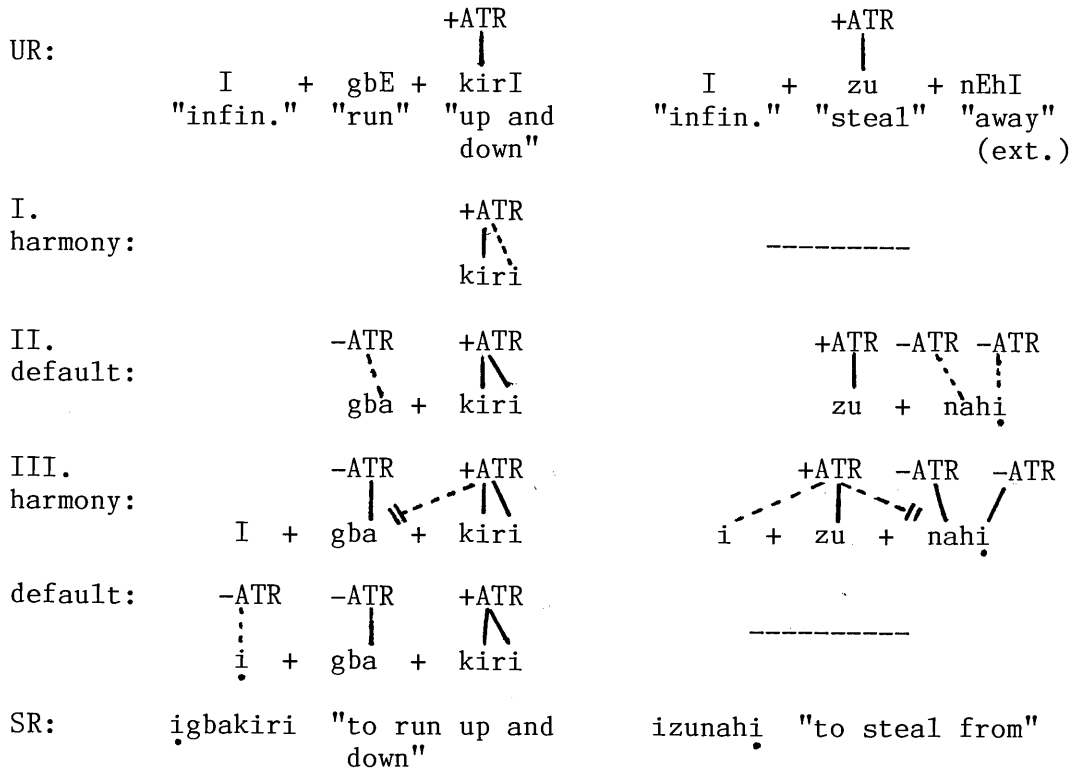


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harmony again applies, and the -ATR specification on "gba" is needed so that it will not receive +ATR itself, and so it can block the spreading of +ATR to the prefix. Default rules then fill in the prefix's -ATR specification.

(12) Derivations



Thus, by prohibiting harmony at level two, the correct results for these forms can be derived. The ability to turn rules on and off as needed, however, is unprincipled and entails a significant increase in the power of the theory.

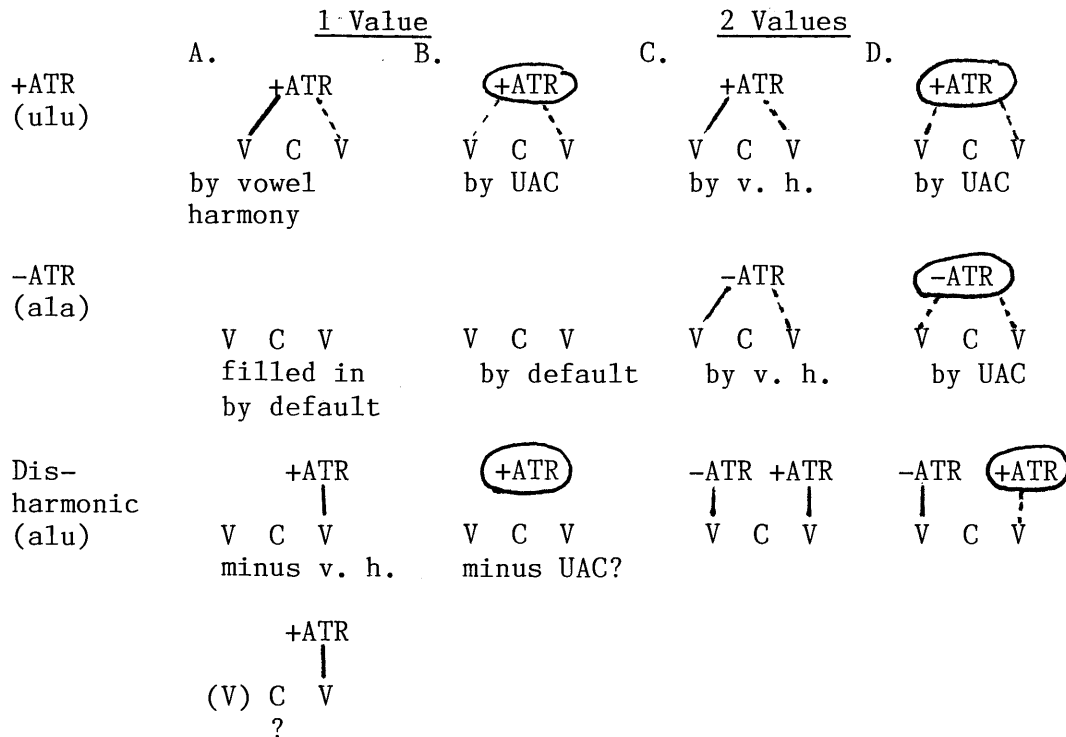
It might be noted at this point that the problem of the rule turning on and off only obtains if we assume that it is a rule of vowel harmony that accounts for agreement within morphemes. Instead of positing a linked feature that spreads by rule (as in "kiri" in Fig. 12), we might assume that each morpheme is associated with a single floating autosegment which associates by the universal association convention to all the vowels in the morpheme simultaneously, as in Fig. 13. The vowel harmony rule would then not have to "turn off" for level two, but would simply not begin applying until level three.

(13) UAC



The problem with this approach, however, is that if one assumes both association by the UAC and only a single underlying value for ATR, one can't account for the disharmonic roots. In fact, there seems to be no simple explanation of these roots within a theory of radical underspecification. As was mentioned earlier, some sort of spreading must be involved in vowel harmony within roots, and the problem is to keep the +ATR feature from spreading to the -ATR vowel. We can't appeal to structure preservation, as there are many cases of the a/e alternation. If we assume, as in Fig. 14A, that +ATR is linked to one vowel in the root and spreads by rule, the disharmonic roots must be marked as not allowing the application of that rule, an ugly and stipulative solution. It might be possible to somehow mark the first vowel as outside the domain of vowel harmony, but in that case as well, one assumes a rule whose domain can be discussed. These vowels are not "extrametrical" to the whole phonology: they participate, for example, in tonal rules. If the ATR is floating, however, as in Fig. 14B, one cannot prevent attachment to both vowels. One could hardly mark the morpheme "minus universal association conventions." C and D show alternatives for a theory with two values.

## (14) Accounting for Disharmonic Roots



If we choose radical underspecification, then, we must choose spreading by rule within the morpheme in order to give any account of the disharmonic roots. And if the rule applies at the morpheme level, we must introduce the powerful stipulation that the rule

can turn off only for level two. Furthermore, additional evidence shows that prohibiting harmony from the level of compounds and affixes is inadequate on empirical grounds as well.

As stated above, and as the examples in Figs. 7, 8, and 12 show, harmony does not--in most cases--apply to extensional suffixes. There is, however, a class of exceptions: about 15%, depending on the dialect, of extensional suffixes do harmonize. Some of the extensional suffixes which harmonize in the dialect described by Emenanjo are given in Fig. 15.

(15) Some Harmonic Extensional Suffixes

ba / be (or wa/we) "begin to"  
 ba / be "at, against"  
 bu / bu "formerly"  
 gba / gbe "together with"  
 ri / ri (or rV) "applicative"  
 sisi / sisi "continuously"  
 ta / te "directional, motion towards"

These suffixes do not systematically differ from other extensional suffixes phonetically, semantically, or morphologically. There are extensional suffixes homophonous to these that do not harmonize: for example, "be" meaning "from" and "gbe" meaning "upwards." The suffix "di" which means, like bu/bu, "formerly," does not harmonize. These suffixes are not specially marked as to which classes of words they can combine with. Figure 16 shows some examples of alternations in the extensional suffixes. In "ibikorita" we see that "ri" and "ta," harmonizing suffixes, agree with the nonharmonic suffix "ko."

(16) Alternations in Extensional Suffixes

i	+	zu	+	ta		izuta		
"infin."		"buy"		"directional"		"to buy for"		
i	+	zu	+	te		izute		
"infin."		"meet"		"directional"		"to meet with"		
0		gwu	+	wa	+	la	0 gwuwala	
"3p sg."		"finish"		"begin"		"perf."	"it has begun to finish"	
0		je	+	we	+	re	0 jewere	
"3p sg."		"go"		"begin"		"indic."	"he began to go"	
i		bi	+	ko	+	ri	+	ta
"infin."		"live"		"assoc."		"applic"		"directional"
								ibikorita
								(as in Fig. 7)

The lexical phonological solution (illustrated in Fig. 12) proposed to account for the nonharmonic suffixes cannot account for the harmonic ones. We cannot derive "jewere," as shown in Fig. 17. If harmony does not apply at level two, where the suffix *we/wa* is added, default rules will fill in *-ATR* at the end of the cycle. This feature will then block the spread of *+ATR* onto the inflectional suffix, which will, in its turn, receive the default value, producing the incorrect \**jewara*.

(17)	+ATR 				
UR:	je	+	wE	+	rE
					gwU + wE + lE
I.					
harmony:	-----				-----
II.					
default:	+ATR		-ATR		
		+			
	je		wa		
					-ATR    -ATR
					gwu    +    wa
III.					
harmony:	+ATR		-ATR		
		+		+	rE
	je		wa		
					-----
default:					
	+ATR		-ATR		-ATR
		+		+	
	je		wa		ra
					-ATR    -ATR    -ATR
					gwu    +    wa    +    la
SR:	*jewara				gwuwala

In order to preserve both the level ordering approach and radical underspecification, one would have to posit two levels of extensional suffixes, one at which harmony applies and one at which it does not. I find no other evidence in Igbo to support such a division. While my analysis relies on separating the extensional and inflectional affixes, I argue that this distinction is principled on morphological and semantic grounds, while a distinction within the extensional suffixes is not.

From the arguments discussed: the stipulative and messy morphological constraints, the difficulty in accounting for disharmonic roots, the need to empower the theory to turn rules on and off, and the inability to derive the harmonizing extensional suffixes, I conclude that an underlying representation in which only one value of ATR is represented, that is, a radically underspecified representation, is insufficient to derive the data in Igbo. On the other hand, a representation in which both *+ATR* and *-ATR* are lexically specified allows a straightforward and accurate

derivation of all the forms.

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, and harmonizing extensional suffixes would be exceptional in remaining unspecified. In this way all idiosyncratic information remains in the lexicon.

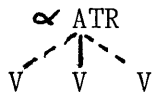
(18) Lexical Specifications

Harmonic roots and invariant extensional suffixes:	+ATR ↓ C V C V	-ATR ↓ C V C V
Inflectional affixes:	C V C V	
Disharmonic roots:	-ATR ↓ V	+ATR ↓ C V
Harmonizing extensional suffixes:	C V C V	

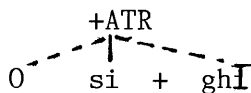
Note that I am not arguing that there can be no underspecification in Igbo, only no radical underspecification: that we must allow both values of ATR in the underlying representation. To use other terms, ATR in Igbo must be an equipollent, not a privative, feature.

If we allow both values of ATR to be specified in this way, we can return to a version of our maximally simple rule of harmony, as in Fig. 19. Several derivations are shown in Fig. 20, involving the simple inflectional affixes, as well as harmonic and non-harmonic extensional suffixes.

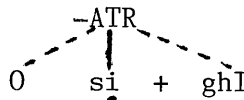
(19)



(20)



0 sighi "he did not cook"



0̣ sighi "he did not say"

$\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{E} + \text{ku} + \text{fu} + \text{OIE} \end{array}$   
 akufuole "has kicked away"

$\begin{array}{c} \text{+ATR} \quad \text{-ATR} \\ \diagdown \quad \diagup \\ \text{I} + \text{bi} + \text{ko} + \text{rI} + \text{tE} \end{array}$   
 ibikorita "to live together to one another's advantage"

$\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{I} + \text{gba} + \text{kirI} \end{array}$   
 igbakiri "to run up and down"

$\begin{array}{c} \text{+ATR} \quad \text{-ATR} \\ \diagdown \quad \diagup \\ \text{I} + \text{zu} + \text{nahI} \end{array}$   
 izunahi "to steal from"

$\begin{array}{c} \text{+ATR} \\ \diagdown \quad \diagup \\ \text{je} + \text{wE} + \text{rE} \end{array}$   
 jewere "began to go"

$\begin{array}{c} \text{-ATR} \\ \diagdown \quad \diagup \\ \text{gwu} + \text{wE} + \text{IE} \end{array}$   
 gwuwala "has begun to finish"

I argue that both values, plus and minus ATR, will spread. This seems to be the only way to account for certain compounds, for example those in Fig. 21, 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 "alu" nothing would prevent the spread of +ATR onto that vowel at the compounding level, where we now allow harmony. This would result in \*alumdi. I can not be sure to which vowel in the root the feature would attach, but a form like "bia" shows that we must assume spreading of -ATR no matter which vowel we choose.

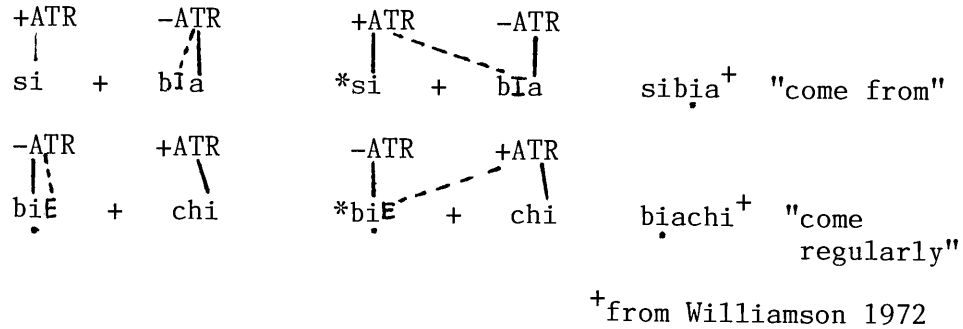
(21)

$\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{omI} + \text{ikO} \end{array}$ 
 $\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{*omI} + \text{ikO} \end{array}$ 
 omiko<sup>+</sup> "mercy"

$\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{alU} + \text{mdi} \end{array}$ 
 $\begin{array}{c} \text{-ATR} \quad \text{+ATR} \\ \diagdown \quad \diagup \\ \text{*alU} + \text{mdi} \end{array}$ 
 alumdi "marriage"

$\begin{array}{c} \text{+ATR} \quad \text{-ATR} \\ \diagdown \quad \diagup \\ \text{kwu} + \text{kEta} \end{array}$ 
 $\begin{array}{c} \text{+ATR} \quad \text{-ATR} \\ \diagdown \quad \diagup \\ \text{*kwu} + \text{kEta} \end{array}$ 
 kwukata<sup>+</sup> "talk too much"

$\begin{array}{c} \text{-ATR} \\ \diagdown \quad \diagup \\ \text{biE} \end{array}$  ?
  $\begin{array}{c} \text{-ATR} \\ \diagdown \quad \diagup \\ \text{bIa} \end{array}$  ?



In an attempt to maintain radical underspecification in Igbo, we tried to account for the exceptions to vowel harmony through morphological constraints on rules, and through a lexical phonological approach. In order to derive the Igbo data, the theory of radical underspecification requires an extremely powerful rule component and ad hoc morphological distinctions. A small enrichment in the lexicon, however, produces a simple and elegant account.

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