Vowel Harmony in Yoruba, Wolof and Lango*

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1 Introduction

The changes in theoretical constitution of Universal Phonology that we have witnessed over the past 20 years have been brought about primarily (i) by a considerable extension of the empirical domain of the investigation, and (ii) by a careful scansion of interactions among postulated sub-theories of phonology. The most remarkable candidate theories that organize Universal Phonology would undoubtedly be Autosegmental and Metrical Phonology, both of which define relevant representational aspects of phonology. Derivational aspects involving interface relations with other modules of grammar, i.e., syntax and morphology, have been dealt with by Lexical and Prosodic Phonology.

Optimality Theory has abandoned the conception "derivation" in phonology, which asks for wholesale examination of interface relations among sub-modules of phonology. It should be noted that Archangeli and Pulleyblank (1994) proposed a new paradigm of phonology Grounded Phonology and applied its methodological assumptions to phenomena of vowel harmony in Lango to integrate their observation into the whole framework of Optimality Theory. Universal theory of phonology is assumed there to incorporate an interface principle that functions to evaluate the trade-off relationships between parametric and grounding optimization scales:

(1) Feature Optimality Hypothesis (henceforth, FOH)

Parametric factors and grounding factors offset each other.

[Archangeli and Pulleyblank (1994:407)]

Thus, if parametric factors are optimal, vowel harmony applies in a manner that is

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2) Lango is a Nilotic language spoken in Uganda, which is located at the northern coast of Lake Victoria. The number of native speakers is estimated to be approximately 300,000. Noticeable attributes of Lango phonology are (a) several types of vowel harmony and (b) strengthening and weakening of consonants.
almost free of stipulations on grounding factors. In their analysis of phenomena of vowel harmony in Lango, Archangeli and Pulleyblank formalized six rules of vowel harmony that internalize nine mutually independent parametric stipulations, including Function, Type, Direction, and Iteration of autosegmental operations. Grounding factors are realized as grounded conditions on Arguments and Targets of autosegmental operations, which state universally preferred configurations of phonological features.

It is crucial to observe that Archangeli and Pulleyblank's analysis of vowel harmony in Lango is attempted on the basis of assumptions (i) that the unmarked specification of the parameter Direction is "left to right," and (ii) that phenomena of vowel harmony are generally regarded as spreading operations of featural specifications. The assumption (i) may prove to be specific to the type of harmony that occurs word-internally. If we adopt (ii) and assume that phenomena of vowel harmony are tokens of an assimilatory autosegmental process, then the assumption (i) should not be taken to be natural, because major processes of assimilation have hitherto been identified as right to left operations. Therefore I should like to scan possibilities that lend support to an assumption that is opposite to (i): the unmarked specification of the parameter Direction is "right to left." An alternative interface principle (Trade-off Principle of Prosodicity and Groundedness) will be formulated to account for the degree of markedness of a given autosegmental operation.

The present paper will proceed as follows. §2 will present the overall architecture of the theory of Grounded Phonology proposed by Archangeli and Pulleyblank. §3 will try to identify the domain in which the autosegmental featural operations are unmarked and will submit an hypothesis that the alleged parameter Direction is a factor derived from the specification of the domain where phonological operations apply. §4 will reformulate the featural spreading operations of vowel harmony and will unify them into "spread a" that embeds parameters of Domain and Direction of application. An interface principle will be proposed to evaluate the trade-off relationships between parametric (prosodic) factors and grounding factors in §5.

2 Grounded Phonology

The theory of Grounded Phonology is constituted of the following modules: (i) principles of Autosegmental Phonology, (ii) Combinatorial Specification, (iii) Grounded (Path) Conditions, and (iv) Parametric Rules.

2.1 Autosegmental Phonology

Archangeli and Pulleyblank adopt a fairly standard set of primitives of phonological theory: (i) Feature Geometry, (ii) Node Generation Convention, (iii)
Prosodic Anchors, (iv) Locality Condition, and (v) Obligatory Contour Principle. Feature Geometry is a theory of phonological features that aims to capture the notion “natural class of phonological features.” It is generally assumed within the field of investigation that features are organized into hierarchies the apices of which are connected to timing slots. The naturalness of sets of features can be translated into formal simplicity.3) Node Generation Convention is a mechanism that correctly aligns various feature specifications: A rule or convention assigning some F-element \( a \) to some anchor \( \beta \) creates a path from \( a \) to \( \beta \).4) Prosodic Anchors are sub-syllabic constituents that define sub-syllabic phonological properties of timing: moras, syllable-head moras, and nonhead moras. Locality Condition governs tier-internal and cross-tier relations within representations:5) Phonological relations respect Adjacency and Precedence. Obligatory Contour Principle is a “negative” condition which prohibits a sequence of identical elements within a tier.

2.2 Combinatorial Specification

The concept of Combinatorial Specification presupposes that phonological segments (i.e., phonemes) are composed of subsegmental units, which are called phonological features. Features have been argued to contribute to linguistically significant generalizations. What is somewhat amazing in this connection is the significance of the role that the notion of segments, though it is derivative, has played in the standard strands of research in Generative Phonology. In order to explicitly formalize the role, Archangeli and Pulleyblank introduced the concept Combinatorial Specification.

Combinatorial Specification depends crucially on two primitive notions:

(2) Combinatorial Specification
   a. F-elements
   b. Association status

F-elements are primitives of the theory of Feature Geometry:

(3) F-elements
   a. Positive and negative feature specifications
   b. Class nodes

The property of (2b) refers to whether an F-element is free (i.e., unassociated) or

3) As for the line of argument for simplicity, readers are referred to Halle (1964).
4) The notion “path” is informally defined as follows: “Any set of associated nodes, features, or prosodic categories such that no more than one token of any node, or prosodic category is included in the set” (Archangeli and Pulleyblank (1994:21)).
5) Adjacency is imposed on tier-internal rules, representations, and conditions, while Precedence is imposed on cross-tier rules, representations, and conditions.
2.3 Grounded Path Conditions

Formally, if the phonology of an individual language includes $n$ F-elements, the number of possible combinations of these elements is $2^n$. Archangeli and Pulleyblank (1994:169) introduced the notion “Path Condition” to appropriately restrict the number of segments that are realized in the language. If a given path condition is grounded, it is called a “grounded path condition.” The condition is grounded, if it directly reflects physical correlates of the F-elements involved in its statement. To cite an example, the path condition “if [+nasal] then [+voiced]” is grounded, because it reflects physical correlates: (i) velic opening allows air to pass freely and (ii) the configuration of speech organs is conducive to periodic vocal cord vibration.  

2.4 Parametric Rules

Archangeli and Pulleyblank (1994:283ff) proposed a system of autosegmental operations that internalizes the following five parameters:

(4) Parameters of Autosegmental Operation
a. Function: INSERT / DELETE
b. Type: PATH / F-ELEMENT
c. Direction: LEFT TO RIGHT / RIGHT TO LEFT
d. Iteration: ITERATIVE / NONITERATIVE
e. Argument and Target Requirements

Autosegmental operations are parameterized by (4).

3 Direction and Domain of Autosegmental Operations

6) The notion of “Grounded Path Condition” is apparently a significant alternative to Kiparsky's (1985) Structure Preservation. But the effects of Structure Preservation in Archangeli and Pulleyblank's (1994) Grounded Phonology have to be somehow stipulated, particularly in the statement of some path conditions.

7) Strength Condition on Spreading (Takahashi (1996:135)):
A given featural specification of a terminal node dominated by a ROOT X may optionally be spread onto a ROOT Z if and only if X is stronger than Z phonologically.

b. Underspecification of feature values contributes to the segmental relative weakness.

c. If two root nodes X and Z may dominate mutually distinct specifications, the root X is stronger, if X dominates a set of features that includes:
   i. [+stiff v.c.]  ii. [+nasal]  iii. [+high]

8) Relativized Condition on the Direction of “Spread a” (Takahashi (1996:135)):
Spread any terminal feature specification rightward within a phonological word. Otherwise, spread it leftward.
This condition overrides the Strength Condition on Spreading.
Archangeli and Pulleyblank (1994:290) give the parameter (4c) two values: left to right and right to left. They go on to assume the default specification of the parameter to be "left to right." I have argued that the autosegmental operation of featural spreading is governed (i) by the relative strength relation among segments, and (ii) by the specification of domain of application. Archangeli and Pulleyblank's specification of default values of direction of autosegmental operation will predict that the major type of assimilation in language is progressive, not regressive. This is clearly counterfactual.

Readers may notice that the majority of the data that Archangeli and Pulleyblank analyzed comes from several types of vowel harmony in languages. A careful inspection of the data will reveal that the phenomena of progressive vowel harmony occur word-internally. The occurrence of types of regressive vowel harmony is not restricted to the phonological domain of a word (the numbers in square brackets indicate the pages where Archangeli and Pulleyblank refer to the phenomenon in question):

(5) a. Progressive Vowel Harmony
   Igbo [2], Tiv [58, 37], Haya [96], Chukchi [146], Kinande [207], Wolof [320], Lango [396, 403]
   b. Regressive Vowel Harmony
   Igbo [2], Yoruba [87, 287, 319], Pulaar [135, 190], Javanese [138], Kinande [202, 207], Chaha [316, 318], Menomini [377]

It is not a desirable move to postulate two types of rules of vowel harmony. Rather, directions of vowel harmony may be derived from the definition of the domain of application of the operation Spread α. I would like to pursue this idea in the following sections.

4 Spread α and types of vowel harmony in Yoruba and Wolof

Archangeli and Pulleyblank postulate six rules of vowel harmony in the phonology of Yoruba and Wolof. Relevant data are cited below:

Igbo: ó- [zó] -rô "he did"
Pulaar: [peeci] vs. [peêcôn] "fente PL/DIM.PL"
Eastern Javanese: [ombo] "drink" vs. [bobot] "weight"
Kinande: e-mi-ti mi-ki-û [ëmiti miki:hl] "short trees"
   e-mi-ti [ëmiti] "trees"
   mi-ûki [miki:hl] "short"
Chaha: No object With object
   dànàgà dànàgà "hit"
   tu:ckên [tu:ckinaw] "he nudges him"
   tu:ckënih:w [tu:ckinihaw] "he nudges him in the body"
of Lango. The apparent inadequacy of cumbersome multiplication of phonological rules can be canceled out by an optimality-theoretic hypothesis on trade-off relationships noted in (1). I will argue in this section that the direction of autosegmental spreading involved in vowel harmony is not a truly primitive specification: it is derived from the stipulation of the domain of rule application.

I have argued in Takahashi (1996) that the six rules of vowel harmony assumed by Archangeli and Pulleyblank may be unified into an operation governed by the Strength Condition and Relativized Condition on the Direction of Spread \( a \). The significant assumptions are (i) vowel harmony in Lango is not restricted to the phonological word and they apply at the phrasal level, and (ii) relevant portions of the feature specifications at the lexical levels may be left unspecified in terms of two default rules:

(6) Default Rules
a. \([+\text{high}] \rightarrow [+\text{ATR}] / [\_\_\_\_\_\_\_\_, +\text{vocalic}, -\text{consonantal}]\]
b. \([+\text{back}] \rightarrow [-\text{ATR}] / [\_\_\_\_\_\_\_\_, +\text{vocalic}, -\text{consonantal}]\]

By Underspecification, relevant specifications of \([+/\text{-ATR}]\) in underlying representations will be omitted.\(^{10}\)

Before going on to present a detailed analysis of vowel harmony in Lango, I would like to discuss the cases that might be argued to motivate language-specific stipulations on the directionality of autosegmental operations: \([-\text{ATR}]\) Spread in Yoruba and Wolof.\(^{11}\) Archangeli and Pulleyblank observe that the directional “asymmetry in Yoruba is the mirror image of the comparable asymmetry in Wolof.”

4.1 Vowel Harmony in Yoruba

The basic vowel system within the framework of Grounded Phonology is laid out in (7):\(^{12}\)

(7) Yoruba Vowel system
a. F-elements: \(-\text{HI}, +\text{LO}, +\text{BK}, [-\text{ATR}]\)
b. RTR / HI Condition: If \([-\text{ATR}]\) then \([-\text{high}]\)

The combinatorial specification of vowels are:

(8) Combinatorial Specification
\[ i \ u \ e \ o \ \varepsilon \ \alpha \]

10) The default rules in (6) can be translated into grounded path conditions.
11) Yoruba is a Niger-Congo language spoken in Nigeria, and Wolof is a language of the West Atlantic subgroup of the Niger-Congo language family spoken in Senegal and Gambia.
12) Feature specifications included in the boxes are free F-elements.
By the Representational Simplicity, the low vowel /a/ has no [-ATR] specification underlyingly.\(^\text{13}\)

There is no need to assume that [-ATR] Spread in Yoruba is regressive. The four cases Archangeli and Pulleyblank cite are:

\[(9) \begin{align*}
\text{[ate]} & \quad \text{"hat"} \\
\text{[aʃo]} & \quad \text{"cloth"} \\
\text{[ɛ`kpa]} & \quad \text{"groundnut"} \\
\text{[ɔ`jà]} & \quad \text{"market"}
\end{align*}\]

Vowel harmony in (9) could be regarded as instances of leftward spreading: The low vowel /a/ has no [-ATR] to propagate and the mid vowels /ɛ ɔ/ could be the trigger of [-ATR] Spread.

4.2 Vowel harmony in Wolof

The system of vowels in Wolof is assumed to be as follows (Archangeli and Pulleyblank (1994:226)):

\[(10) \begin{align*}
a. & \quad \text{F-elements: } +\text{HI}, +\text{LO}, +\text{BK}, -\text{ATR} \\
b. & \quad \text{Path Conditions:}
\begin{align*}
\text{If } +\text{HI} & \text{ then not } +\text{LO} \\
\text{If } +\text{LO} & \text{ then not } +\text{HI}
\end{align*} \\
c. & \quad \text{Combinatorial Specifications:}
\begin{align*}
\text{i} & \quad \text{e} & \quad \varepsilon & \quad \text{a} & \quad \text{o} & \quad \text{ɔ} & \quad \text{u} \\
+\text{HI} & \quad +\text{LO} & \quad +\text{HI} & \quad +\text{HI} & \quad +\text{LO} & \quad +\text{BK} & \quad +\text{BK} & \quad +\text{BK} \\
-\text{ATR} & \quad -\text{ATR}
\end{align*}
\end{align*}\]

Vowel harmony in Wolof can be accounted for if we assume that it is a lexical process and does not apply at the postlexical level. The data in (11) (Archangeli and Pulleyblank (1994:85)) seem to involve a syntactic element -aale [aale]:

\(^{13}\) Representational Simplicity (Archangeli and Pulleyblank (1994:102)): The value of a representation is the inverse of the number of
\begin{enumerate}
\item terminal F-elements
\item associations to terminal F-elements.
\end{enumerate}
(11) [yobbuwaale] “to carry away also”
    [gennaale] “to go out also”
    [wɔɔwaale] “to call also”
    [jamaale] “to pierce also”

If a syntactic boundary intervenes between trigger and target of vowel harmony, the autosegmental operation cannot be performed to effect spreading of feature specifications.

The suffix -ēl ~ -al “for” exhibits progressive harmony of [+/-ATR]:

(12) a. [jɔndal] “buy for”
    b. [waxal] “speak for”

The behavior of [+ATR] in (12a) can be dealt with if we assume that the suffix is attached at some lexical level of the Wolof grammar. Within our assumption, [+ATR] is unspecified lexically. Therefore in the lexicon [∅ATR] and [-ATR] are evaluated by the Strength Condition: [-ATR] is stronger than [∅ATR]. At the postlexical level, [+ATR] will be introduced by a default rule, and there are cases in which [+ATR] is spread in the domain of a word (Archangeli and Pulleyblank (1994:228)):

(13) [sofoorə̃m] “his / her driver”
    cf. [tɔɔləm] “his / her field”

There seems to be no reason for assuming any language-specific constraints on the process of vowel harmony in Wolof: in our analysis, the directionality of vowel harmony can be derived from the stipulations on the level and domain of the process.

5 Vowel Harmony in Lango and an Interface Principle between Prosodicity and Grounding Factors

The system of vowels in Lango is assumed to include stipulations on (i) F-elements and (ii) Path Conditions:

(14) Lango Vowel System
    a. F-elements: +HI, -BK, +ATR
    b. Path Conditions: If [+ATR] then [+HI]
    If [+ATR] then [-BK]

I will take up six rules of vowel harmony in Lango in turn: three regressive vowel harmony rules and three progressive vowel harmony rules.
Three regressive vowel harmony rules spread [+ATR] at the postlexical level:

(15) Three Types of Regressive Vowel Harmony
a. VC [+HI]
   [i] pi  "for"  piwú  "for you"
b. VC(C)i
   [ɛ] dɛk  "stew"  dêkkì  "your stew"
c. VCC [+HI]
   [u] lùt  "stick"  lùtwú  "your stick"

The three cases in (15) can all be accounted for by "Spread [+ATR] leftward". The directionality of the spreading operation can be derived from the stipulation that it applies at the phrasal level: i.e., PP and NP.

Two grounded path conditions function as parameters of "Spread [+ATR] leftward" to appropriately constrain the argument (i.e., trigger) and target of the operation:

(16) Grounded Path Conditions on "Spread [+ATR]"

a. VC [+HI]
   argument: if [+ATR] then [+HI]
   target: if [+ATR] then [+HI]

b. VC(C)\textit{i}
   argument: if [+ATR] then [+HI]
   target: if [+ATR] then [+HI]

c. VC(C) [+HI]
   argument: if [+ATR] then [+HI]
   if [+ATR] then [-BK]

I added subscripts, \(\alpha\) and \(\beta\), to the element "C" to denote (i) that the sequence in (16b) "C\(\alpha\).C\(\beta\)" is a geminate and (ii) that the sequence in (16b) "C\(\alpha\).C\(\beta\)" consists of two non-identical consonants. The sequence in (16a) "VC [+HI]," and that in (16b) "VC(C)\textit{i}" are prosodically equivalent: i.e., there intervene one skeletal slot between the argument and target. Two skeletal slots intervene between them in (16c). Thus the trade-off relationships between parametric stipulations and grounded path conditions would better be captured by (17):

(17) Trade-off Principle of Prosodicity and Groundedness (TPG)

Prosodic strength and grounding factors offset each other.

The phonological sequence between the argument and target is prosodically strong if the number of the skeletal slots between them increases. The intervening sequence in (16c) is stronger than those in (16) a and b. Therefore two grounded path conditions have to be referred when the generalized autosegmental operation "Spread \(\alpha\)" is
applied.

Three progressive vowel harmony rules are formulated in Archangeli and Pulleyblank:

(18) Three Types of Progressive Vowel Harmony
a. \([+ATR]\)CV
   wót “son”         wódó “my sone”

b. \([+ATR]\)C,C,V
   àtín “child”      àtínná “my child”

c. \([-ATR]\)C,C,V
   lwókkó “to wash”

In (18) b and c, a geminate sequence intervenes between the argument and target. Thus by TPG, some grounding factor should be evoked when “Spread α” applies:

(19) Grounded Path Conditions
a. \([+ATR]\)CV
   No path conditions

b. \([+ATR]\)C,C,V
   Argument: if \([+ATR]\) then \([+HI]\)

c. \([-ATR]\)C,C,V
   Argument: if \([-ATR]\) then \([+BK]\)
   Target: if \([-ATR]\) then \([-HI]\)

The feature specification \([-ATR]\) will be introduced postlexically by Underspecification.

6 Summary

I have so far argued (i) that the directionality of the process of vowel harmony is derived from the domain of rule application, and the relative segmental strength of the argument (trigger) and target of autosegmental operation, and (ii) that the trade-off relationships between parametric and grounding optimization scales are appropriately captured by an interface principle Trade-off Principle of Prosodicity and Groundedness. Thus by assumption (i) I have rejected the idea that the unmarked value of the direction of vowel is “left to right.” The assumption (ii) presented a possibility of revised optimization scales: i.e., prosodic strength and grounded path conditions.

References


Davis, Stuart (1996) "Optimality Theory and Output Configurations in Phonology," A lecture delivered at Tohoku University, August 1, 1996.


