AN OPTIMALITY ANALYSIS OF OWORO VOWEL HARMONY

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Abstract
Oworo, spoken by some people in the North-West of Lokoja Local Government Area, Kogi Slate of Nigeria, is one of the Yoruboid languages yet to be systematically and comprehensively phonologically researched. This study examines the vowel harmony of Oworo using the optimality theoretical (OT) framework with a view to establishing the descriptive and explanatory adequacies of OT for Oworo data. The work shows the application of OT to Oworo data giving a new perspective to the phonological process of Oworo vowel harmony. Different from previous generative theories, OT does not derive phonetic representation from underlying representation via a set of rules. Rather, for any particular word, many forms are generated at the outset, and the job of the theory is to select from the many forms only that form that indeed occurs in the language. Using OT, a systematic, comprehensive analysis of Oworo vowel harmony is achieved, thus solving the unresolved problems of earlier theories adequately. This is because linguistic well-formedness is a matter of comparison or competition among candidate output forms. The analysis of vowel harmony presented has shown that constraints are neither imposed on inputs nor on the mapping between inputs and outputs. This study reveals that right-edge harmony can be violated in Oworo vowel harmony system. Harmony targets the rightmost "eligible" anchors and not necessarily the "rightmost" anchor absolutely. The study has been able to establish the descriptive and explanatory adequacies of OT account of vowel harmony for Oworo data, over previous generative theories.

Conventions
OT Optimality Theory
// Phonemic slashes
[] Phonetic brackets
ATR Advanced Tongue Root

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Oworo is a Yoruboid language spoken by some people in North-West Local Government Area of Lokoja, Kogi State, Nigeria. Oworo refers to both the language and the speakers. This paper examines the vowel harmony system of Oworo, using the optimality theoretical framework.

Vowel harmony has generally been conceived as a phonological state in which the vowels in a given domain share or harmonize for a particular feature. Height, rounding, backness, nasality or tongue root configuration can form the basis for a harmonic system. Simply put, vowel harmony is a process in which a particular vowel assimilates to another vowel in some feature specification (Vago 1973). It is also the property of vowel harmony that the vowels of the language fall into at least two groups such that it is logically possible to have:

[-high] versus [+high] (Yoruba [Bamgbose 1967])
[-round] versus [+round] (Yawelmani [Archangeli 1984])
[-back] versus [+back] (Yoruba [Awobuluyi 1967])
[-nasal] versus [+nasal] (Guarani [Goldsmith 1976])
[-ATR] versus [+ATR] (igbo, Oworo, Wolof, Twi etc.)

In essence vowels of one set co-occur with each other to the exclusion of those in the other set. While languages share the common characteristics of constraining vowel co-occurrence, they differ in varying degrees in the way vowel harmony is implemented in their systems. In most West African languages the advancement of the tongue root forms the phonetic basis for vowel co-occurrence in a word, Turkish has vowels co-occurring on the basis of backness or roundness.

Oworo sets are:

1. **SETA, [+ATR]**
   
   \[
   \begin{array}{c}
   i \\
   u \\
   e \\
   o \\
   a
   \end{array}
   \]

2. **SETS, [-ATR]**
   
   \[
   \begin{array}{c}
   i \\
   u \\
   e \\
   o \\
   a
   \end{array}
   \]
In this paper, for the sake of concreteness, we present substantial evidence in vowel harmony to show or illustrate how work in OT has shifted our perspective on this issue. This paper considers the vowel harmonic nature via linear, autosegmental and optimality theories.

Evidence for Vowel Harmony in Oworo

Oworo has seven phonemic vowels: i, e, o, u, e, a, ɔ. Oyebola (2003) showed the underlying [ATR] feature values of the Yoruba vowels [i, u, a, ɔ] which, on the surface, are apparently neutral. This also applies for oworo vowels. Accordingly, [i, u] are underlingly [+ATR] while [a] is underlingly [-ATR]. Therefore, the seven oworo vowels can be grouped: [i e o u] - advanced [+ATR]; [ɛ ɔ] - retracted [-ATR]. Only the mid vowels have advanced and retracted counterparts. Oyebola (2003) showed why vowel [a] in V₂ position does not occur with [+ATR] mid vowels. For instance consider the oworo data (2) below:

2a.  [ɔyà] ‘wife’  
     [ɔma] ‘child’  
     [ɔba] ‘king’  
     [ekà] ‘guinea corn’  
     [ɔra] ‘body’  
     [ɛşa] ‘tobacco’  
     [ɔda] ‘shoe’

\*b  [oyà] ‘wife’  
     [oma] ‘child’  
     [oba] ‘king’  
     [eka] ‘guinea corn’  
     [ora] ‘body’  
     [esha] ‘tobacco’  
     [sha] ‘shoe’

In the examples (2a) and (2b) above, it is clear that vowel [a] in V₂ position does not co-occur with the [+ATR] vowels. In the examples (3a) and (3b) below, all the vowels of the words share the same [ATR] features of their groups respectively.

3  

<table>
<thead>
<tr>
<th>[+ATR]</th>
<th>[-ATR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>èwo</td>
<td>kólé</td>
</tr>
<tr>
<td>ëhoo</td>
<td>erò</td>
</tr>
<tr>
<td>onojò</td>
<td>ìhèrè</td>
</tr>
<tr>
<td>ìpọ̀o</td>
<td>ènje</td>
</tr>
<tr>
<td>ìrógò</td>
<td>ìkò</td>
</tr>
</tbody>
</table>

Vowel Harmony in oworo prefixes

When the prefixes are to be affixed in oworo, they take on the [ATR] feature values of the roots. This is exemplified in data (4) below:
The data in (2) to (4) discussed above have shown evidence of vowel harmony in Oworo, both within and across morphemes.

**Segmental Analysis of Vowel Harmony**

Within the linear approach in the account of vowel harmony, two rules are postulated. One of the rules is a morpheme structure condition (MSC) that will account for harmony within root or stem. The MSC does not change segments; it is normally expressed in statement form along the line of If ... then condition'.

5. If #V....#
   ↓
   [+ATR]
Then #V....#
   [+ATR]

The second type of rule normally applies in the analysis of vowel harmony involving phonological rules which take care of harmony across morpheme boundaries. Such phonological rules, unlike MSC can change segments.

For vowel harmony within the stem, the MSC is assumed whereby vowels within a stem are expected to agree to the feature [ATR]. If the initial vowel within the stem is [+ATR], vowels in the sequence must be [+ATR]. The same will apply to a stem with an initial [-ATR] vowel. For harmony across morpheme, boundary, the phonological rule below is postulated:

A vowel takes on the ATR feature of the vowel that surrounds it. This rule is not specific on the changing element with regard to height, roundness, frontness and so on. It simply claims that a vowel will assume the [ATR] feature value of the initial
vowel of the stem i.e. vowels of the prefixes and the stem are expected to agree in [ATR]. For instance, consider the following Oworo data:

\[7a. \text{/epo # igi/} \rightarrow \text{epogi} \quad \text{‘bark (of tree)’}\]
\[\quad \text{bark} \quad \text{tree}\]

\[b. \text{/iko#ojo/} \rightarrow \text{ikojo} \quad \text{‘rainy season’}\]
\[\quad \text{time} \quad \text{rain}\]

\[c. \text{/iko#ourd/} \rightarrow \text{ikoru} \quad \text{‘night’}\]
\[\quad \text{time} \quad \text{night}\]

One of the major disadvantages of the segmental approach to vowel harmony is the inadequacy of a unified description of "irregular harmony system" resulting from mixed vowel roots and non-alternating affixes especially non-alternating suffixes as seen in the data (7) above. It cannot account for the spread of harmony across morpheme boundary.

**Autosegmental Analysis**

Segmental analysis of vowel harmony within the generative phonology theory runs into several problems that render it inadequate. A segmental account of vowel harmony reveals that vowel harmony operates on domains larger than the segments.

The autosegmental application to vowel harmony treats the spread of feature across segmental boundaries. This is shown, for instance, in the spreading of the [-ATR] features of 3 and e in the following Oworo words:

\[8a. \text{çgede} \quad \text{‘banana’}\]
\[b. \text{ç#lç} \quad \text{‘you wet’}\]
\[c. \text{ç#jeun} \quad \text{‘you ate’}\]
\[d. \text{k3#t5} \quad \text{‘it’s not rig’}\]

In the data (8), the spreading of 3 and £ is realizable across word boundary. Given the autosegmental framework, one contentious issue is the directionality of linking. Some phonologists take the universality of linking to be left-to-right mapping as a phenomenon while others proposed right-to-left mapping to block out every non-occurring forms. For example, association lines linked from right-to-left in
Oworo vowel harmony have this nature of spread;

This leads to an un-unified analysis for forms such as below. To link from right-to-left, some words will not conform to this rule because the left vowel does not always have the same [ATR] value as the vowel on the right where the mapping starts from.
As solutions to the problems rose, and an alternative to dependency on rules, our analysis in OT is chosen because of it solves these problems adequately.

Optimality Analysis

In a rule-based theory of phonology, the input (UR| form is converted to an output (surface) form by the application of specific procedures, often ordered with respect to one and another. In OT, solution is provided without the use of rules. In this section, solution to the contentious issue of directionality of linking in the previous theories is provided. OT shows that right-edge vowel harmony can be violated. Harmony targets the rightmost "eligible" anchor and not necessarily the "rightmost" anchor absolutely. It also gives concrete evidence as to how to universally account for the direction of spread in vowel harmony. Spreading is not a parametric choice, whereby each language chooses to go either from left - to - right or from right -to - left, making constraints language - specific, but that constraints are universal and can be generated and ranked differently. In the case of Oworo, right and left alignment constraints for the feature [ATR] are defining conditions for harmony.

Constraints under Vowel Harmony
11 a. Alignright (Feature, Right, Domain, Right). The right edge of any harmonic feature F is aligned with the right edge of the harmonic domain D.

b. Alignleft (Feature, Left; D, Left): The left edge of any harmonic feature F is aligned with the left edge of the harmonic domain D.

c. (Alignright) Root (-Atr Root, Right: Root, Right): The right edge of any [-ATR] root specification is aligned with the edge of the root.

d. Alignleft (- Atr, Left; Atrdomain, Left): The left edge of any [-ATR] specification is aligned with the left edge of the ATR DOMAIN

e. Recoverability of Feature - Element (RECF): An F - element must be
f. **Recoverability of Path** (RECP): A path between an F-element and an anchor must be morphologically affiliated.

g. **Parse**: An F-element a must be dominated by an appropriate node in the prosodic tree.

h. **HI/ATR Condition**: If [+ high] then [+ATR], not [-ATR].

i. **LO / ATR CONDITION**: If [+ low] then [-ART], not [+ATR].

### The Data

Oworo has seven vowels: i e o u - advanced [ATR]; e a D - retracted [RTR]. Only the mid vowels have advanced and retracted counterparts. Not surprisingly, only words containing mid vowels show 'perfect' harmony:

#### Mid vowels in Oworo

<table>
<thead>
<tr>
<th></th>
<th>Advanced</th>
<th>Retracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>[gbere]</td>
<td>'pass by'</td>
<td></td>
</tr>
<tr>
<td>[erɛ]</td>
<td>'mud'</td>
<td></td>
</tr>
<tr>
<td>[echo]</td>
<td>'seed'</td>
<td>[ahɛɛ] 'wind'</td>
</tr>
</tbody>
</table>

It is assumed that [-ATR], and not [+ATR], is the active harmonic feature. In addition, it is assumed that the output of trie phonological component is restricted to recordings of the specifications of [-ATR]. That is, all vowels unspecified for [-ATR] are assigned a phonetic interpretation of advancement (Archangeli and Pulleyblank 1994). Within an optimality framework that does not impose conditions on underlying representations, it is not possible in the most restrictive of theories to disallow specifications of [+ATR] entirely.

In OT, harmony is a direct result of "generalized alignment". That is, a feature appears throughout some harmonic domain because of constraints requiring alignment with the edges of the domain. Such alignment may be expressed as in (13a) below:

#### 13a The violations of alignment

Together, the two constraints that derive harmony as in (13a) above have trie following interpretation. Considering the three representations given in (13a) above for a retracted root like 'Dya', that is, a root that contains a [-ATR] specification in its lexical entry, if the [-ATR] specification of the root is linked to both vowels, then it
is successfully aligned with both right and left edges. If it is linked to the first vowel only, or to the second vowel only, then one of the two constraints is violated (indicated by an asterisk in the appropriate column). In the case of advanced root, no [-ATR] specification is lexically present; hence all vowels are surfaced as advanced.

Explanations of example (13a) also hold here in (13b). Vowels in a root that have no specifications surface uniformly as advanced. In roots with a [-ATR] specification, right and left - edge alignment causes the specified value to appear uniformly throughout the relevant domain. Harmony is thereby achieved. In a derivational theory, an algorithm can be applied to inputs to derive in a step - by - step fashion an output form. In OT, the class of potential outputs is considered, with one form selected as the optimal output corresponding to a particular input.

The constraints to account for recoverability in order to make UR and surface forms identical as proposed by Pulleyblank (1994) are ranked and exemplified below:
For the underlying form that does not include a [-ATR] specification (i.e. (14a) above), any output form that includes such a specification violates RECF (candidates with a recoverability violation are shaded in (14a). Where the underlying form includes a free [-ATR] specification, i.e. (14b), any output from where such a specification is associated violates RECP. Left to themselves, RECF and RECP would cause all outputs to be identical to their inputs. In a case like (14a), this is indeed the correct result (indicated by the index finger), but for a case like (14b), identity would incorrectly predict a form where [-ATR] floats, instead of the correct form where the feature is in fact linked and distributed throughout the harmonic domain. To correct this, PARSE constraint is proposed. PARSE disallows the floating of features, requiring that all features in the output be linked.
It is only the candidates that are not linked in any way with the [-ATR] feature that truly violate this constraint. To choose the optimal candidate of this group, RECP, RECF and PARSE must interact with some other constraints in this ranking order:

PARSE » [ALIGNR] ROOT » RECF » ALIGNL » RECP

(Note that constraint ranking is indicated graphically in a tableau by left - to - right ordering).

In (16) above, RECF is violated with any candidate where a feature is inserted, that is, where a feature appears in the output that is not morphologically motivated. This constraint is irrelevant for the particular candidates of (16b), but rules out all but one form in (16a). For (16a), this means that a unique (optimal) output candidate [roko] has been identified. With regard to (16b), alignment constraints are crucial. [ALIGNRJRT rules out a form where [-ATR] does not appear on the rightmost vowel, while ALIGNL rules out a form where [-ATR] does not appear on the leftmost vowel. ([ALIGNRJRT is irrelevant for similar candidates in (16a) because the [-ATR] value there is not a root value, it is not underlyingly present).
The discussion in (16) holds for (17).

All these analyses show that very general constraints, recoverability and parsing, interact with constraints on alignment to derive a pattern of vowel harmony.

Findings

From the data examined, we discovered that different from previous generative theories, OT does not derive phonetic representation from underlying representation via a set of rules. Rather, for any particular word, many forms are generated at the outset, and the job of the theory is to select from the many forms only that form that indeed occurs in the language. An example of solved problem of rules is extrinsic ordering which now can be avoided. It is shown that rather than focusing on the associative properties of the harmonic domain feature as in earlier phonological theories, OT focuses on properties of the domain of harmony. As regards the ATR vowel harmony of oworo, it is seen that right-edge harmony can be violated. Harmony targets the rightmost "eligible" anchors and not necessarily the "rightmost" anchor absolutely. In other words, violation of a constraint is not a direct cause of ungrammaticality, nor is absolute satisfaction of all constraints essential to the grammar's output. Instead what determines the best output of a grammar is the least costly violation of the constraints.
make use of rule application. Our analyses have also shown that very general constraints interact with constraints on alignment to derive a pattern of vowel harmony. The data from Oworo show that the choice of OT in the treatment of vowel harmony is most appropriate. OT's viewpoint of UG is fundamentally different from that of classical rule-based generative theory, where UG is defined as a set of inviolate principles and rule schemata (or parameters). OT defines UG as a set of universal constraints, and a basic alphabet of linguistic representational categories. In its interactions, it is limited to a single device: constraint ranking.

Concluding Remarks
An adequate analysis of Oworo phonology can be done by using OT. This is because linguistic well-formedness is a matter of comparison or competition among candidate output forms (none of which is perfect). There is universality in directionality. That is spread in Oworo is from left-to-right, and grammatically so. This is possible because the grammar of a language is a ranking of constraints. Ranking may differ from language to language, even if the constraints do not. Linguistic constraints are ranked and violable. Higher ranking constraints can compel violation of lower ranking constraints. Violation is minimal, however. Also, even low-ranking constraints can make crucial decisions about the winning output candidate. The analyses of vowel harmony presented have shown that constraints are neither imposed on inputs nor on the mapping between inputs and output.

References


Goldsmith, J. (1990), Autosegmental and Metrical Phonology. Oxford:


