Vowel Harmony and Vowel-to-Vowel Coarticulation in Three Dialects of Yorùbá

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I explore the similarities between phonological vowel harmony and phonetic vowel-to-vowel coarticulation by examining the vowels in three dialects of Yorùbá: Standard Yoruba, Moba, and Akure. While they all exhibit some degree of ATR vowel harmony, only Akure exhibits a vowel harmony in the high vowels. I compare the acoustic characteristics of the vowel harmony in the high vowels of Akure, with the coarticulatory properties in parallel environments in the non-harmonizing dialects. In Akure, the high vowel pairs exhibit a large difference in F1 between the +ATR and -ATR vowels as expected; in SY and Mòbà, where there is no phonological split, the high vowel pairs also exhibit a split in F1 in the same direction as the contrast found in Àkùrè, though crucially much smaller and less distinct. These findings support the conclusion that vowel harmony has its origins in vowel-to-vowel coarticulation.

1 Introduction

I examine the parallels between vowel harmony and vowel-to-vowel coarticulation in three dialects of Yorùbá (Benue-Congo, Niger-Congo): Standard Yorùbá (SY), Mòbà Yorùbá, and Àkùrè Yorùbá. In Àkùrè, high vowels harmonize to successive vowels, while in the other dialects, the high vowels do not harmonize. I show how the phonetic patterns of coarticulation in high vowels where there is no harmony, resemble the phonological patterns of harmony in Àkùrè. I have found that the acoustic effects of coarticulation are in the same direction, though with a much smaller magnitude, as the acoustic effects of the phonological harmony; the phonetic effects are found in the same group of vowels that undergoes vowel harmony; and, both the coarticulatory effects and the vowel harmony occur across consonants. These findings are consistent with the view that vowel harmony emerges from coarticulation.

After sketching the vowel harmony systems of the three dialects in §2, I describe the experiment designed to determine the patterns of coarticulation in the three dialects (§3). The results are described in §4, followed by a discussion in §5.

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2 Yorùbá Vowel Harmony

Àkùrẹ and Mòbà Yorùbá are in the Central Èdè branch of Yoruboid along with Ìjèṣà, Èkìti, Ìfè, and others; Standard Yorùbá is in the North West Èdè branch, with Òyó, Ègbá, and Ôshùn (Capo 1989). Àkùrẹ is spoken in Àkùrẹ, Òndó state; Mòbà, in Òtún-Èkìti, Èkìti state; and SY, in Èbànàn, and increasingly throughout Yorùbáland in Nigeria.

There are seven underlying oral vowels in each of the three dialects, as shown in (1).

(1)  

\[
\begin{array}{ccc}
\text{high} & i & u^1 \\
\text{mid} & e & o & +ATR \\
\text{low} & \varepsilon & \varnothing & -ATR \\
\end{array}
\]

The vowels may be split into two sets based on the feature Advanced Tongue Root (ATR): +ATR (i, u, e, o) and −ATR (ε, ϕ, a). In ATR languages such as Akan and Ìgbo, +ATR vowels have expanded pharyngeal volume compared to their −ATR counterparts (see Stewart 1967, Ladefoged 1968, Lindau 1979, among others). Some degree of vowel cooccurrence restrictions typifies these languages. Because the characteristics of Yorùbá vowel harmony (especially in Àkùrẹ Yorùbá) resemble those of ATR languages, I follow Akinlabi (forthcoming) and Archangeli and Pulleyblank (1989) in using the labels [+ATR] and [−ATR]; however, it has not been established whether the articulatory characteristics typically associated with ±ATR are present in some or all dialects of Yorùbá, since the articulation of Yorùbá vowels has not been instrumentally investigated.

I will describe the relevant features of vowel harmony in the three dialects, first describing harmony to prefix clitics, and then, cooccurrence restrictions within the word. In the acoustic experiment presented here, I am concerned only with patterns within the word; however, the general harmony patterns help to illustrate the word level patterns. For further discussion of Yorùbá vowel harmony, see Bamgboṣe (1967), Awobuluyi

\footnote{Using the standard Yorùbá orthography, I mark [−ATR] midvowels with an underdot. I also mark with an underdot the high vowels that are [−ATR] on the surface.}
(1967), Archangeli and Pulleyblank (1989), Akinlabi (forthcoming), and references found therein.

2.1 Ákùrè

Of the three dialects I examine, Ákùrè exhibits the most robust harmony. Singular subject pronouns harmonize with vowels in the following word, as we see for the third person singular, ó/ó, in (2). Before +ATR vowels (i, u, e, o) the pronoun is realized as ó; before –ATR vowels (e, ò, a), the pronoun is realized as ó.

(2) ó dé ‘s/he arrived’ ó jó ‘s/he danced’ ó kí ‘s/he greeted’
    ó jè ‘s/he eats’ ó lò ‘s/he went’ ó á ‘s/he came’

The harmony involves both mid vowels and high vowels, as we see in (3) and (4). Like mid vowels, high vowels not only undergo harmony by surfacing as distinct allophones (4a, b), but they also trigger harmony to their left (4a, b).

(3) ó r’oko ‘s/he saw the farm.’
    ó r’òkò ‘s/he saw the car.’

(4) (a) ó r’ulé ‘s/he saw the house.’
    ó r’úgbá ‘s/he saw the calabash.’
    (b) ó tú ti jó ‘it has burnt again’ from Bamgbose (1967)
    ó tú ti bè ‘it has burst again’ from Bamgbose (1967)

Note that what we see above in (4a, b) is cross height harmony, which typifies ATR harmony systems. In this case, a high vowel [u] lowers a mid vowel /o/ to a phonetically lower mid vowel [ò]; that is, a high vowel acts as a trigger to lower a vowel that is already lower than itself.

2.2 Mòbà

Like Ákùrè, Mòbà has right-to-left harmony to prefix clitics:

(5) é dé ‘s/he arrived’ é jó ‘s/he danced’ é kí ‘s/he greeted’
    é jè ‘s/he eats’ é lò ‘s/he went’ é á ‘s/he came’
Mid vowels participate in vowel harmony as shown in (6). However, unlike Akùrẹ, high vowels do not participate in harmony—they are opaque to it, neither undergoing nor triggering vowel harmony. The high vowels do not have –ATR allophones (as will be phonetically verified later). Both high vowels, /i/ and /u/, are preceded by +ATR allophones to their left (7).

(6)  é r’oko  ‘s/he saw the farm.’
    é r’okọ  ‘s/he saw the car.’
(7)  é r’ulé  ‘s/he saw the house.’
    é r’ugbá  ‘s/he saw the calabash.’
    é tú ti jé  ‘it has burnt again’  from Bamgbose (1967)
    é tú ti bé  ‘it has burst again’  from Bamgbose (1967)

2.3 Standard Yorùbá

Although Standard Yorùbá is often said to exhibit vowel harmony, it has no harmony to prefix clitics (8), (9).²

(8)  ó dé  ‘s/he arrived’  ó jó  ‘s/he danced’  ó kí  ‘s/he greeted’
    ó jẹ  ‘s/he eats’  ó lọ  ‘s/he went’  ó wá  ‘s/he came’
(9)  ó r’oko  ‘s/he saw the farm.’
    ó r’okọ  ‘s/he saw the car.’
    ó r’ilé  ‘s/he saw the house.’
    ó r’igbá  ‘s/he saw the calabash.’

SY does exhibit cooccurrence restrictions within the word, as described in the next section. As in Mòbà, there is no evidence of high vowel participation in vowel harmony.

2.4 Lexical Cooccurrence

Yorùbá exhibits cooccurrence restrictions for adjacent syllables within the lexical word, as shown in Table 1, where the words shown are indicative of robust patterns in the languages.
<table>
<thead>
<tr>
<th>Ìkùrè</th>
<th>Mòbà</th>
<th>SY</th>
<th>gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>[ekpo]</td>
<td>[ekpo]</td>
<td>[ekpo]</td>
</tr>
<tr>
<td>(b)</td>
<td>[òbè]</td>
<td>[òbè]</td>
<td>[òbè]</td>
</tr>
<tr>
<td>(c)</td>
<td>[ulè]</td>
<td>[ulè]</td>
<td>[ilè]</td>
</tr>
<tr>
<td>(d)</td>
<td>[ìjì]</td>
<td>[ìjì]</td>
<td>[ìjì]</td>
</tr>
<tr>
<td>(e)</td>
<td>[ùsè]</td>
<td>[ìfè]</td>
<td>[ìfè]</td>
</tr>
<tr>
<td>(f)</td>
<td>[ùgbà]</td>
<td>[ùgbà]</td>
<td>[ìgbà]</td>
</tr>
<tr>
<td>(g)²</td>
<td>[ɛùrè]</td>
<td>[ewùrè]</td>
<td>[ewùrè]</td>
</tr>
<tr>
<td>(h)</td>
<td>[etu]</td>
<td>[etu]</td>
<td>[etu]</td>
</tr>
</tbody>
</table>

Table 1. Lexical Cooccurrence patterns (from Bamgbose 1967, Fresco 1970)

In all three dialects, we see cooccurrence restrictions in the mid-vowels in (a) and (b): adjacent mid vowels must agree in their ATR values. In (c) through (f) we see that only Ìkùrè has harmony extending to the high vowels. For example, in (d), the /i/ is realized as a –ATR phone [j] only for Ìkùrè. All cooccurrence restrictions can be seen as applying from right-to-left; for example, in all dialects, mid vowels before /a/’s are always –ATR, while mid vowels after /a/ may be either +ATR or –ATR, as shown in (10) for Mòbà.

(10) eja, ‘fish’ òba, ‘king’ *oCa, *eCa
    apè, ‘type of pot’ asò, ‘clothing’ apó, ‘quiver’ agbe, ‘type of bird’

2.5 Summary of Vowel Harmony Characteristics

In Ìkùrè and Mòbà, the distributional pattern found within the lexical word is the same as that found in harmony to the prefix clitics; this comparison cannot be made for SY since it lacks harmony to the prefix clitics. The high (and mid) vowels in Ìkùrè participate in vowel harmony: they have ±ATR allophones, which trigger ATR harmony.

² Note, there are no initial /u/s in SY—initial /u/s in other dialects have become /i/s in SY.  
³ (g) and (h) are here for the reader’s interest; they are not directly relevant to this paper. In (g), for Mòbà and SY, the –ATR of the rightmost vowel does not spread to the high vowel, so the word may contain a +ATR mid vowel. But in Ìkùrè, the –ATR spreads through the high vowel, and to the preceding mid vowel. (h) shows that only in Ìkùrè does a high vowel trigger ATR harmony.
to the left. In the other two dialects, only mid vowels have ±ATR allophones, the high vowels do not trigger ±ATR allophones to their left. So crucially, the high vowels participate in harmony only in Àkûrê. Finally, the low vowel /a/ always triggers –ATR harmony in environments where harmony is typically found. A summary of the characteristics is shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Distributional constraints on ATR</th>
<th>Harmony to Prefix Clitics</th>
<th>Mid-vowel Split [e, o, ə, ɔ]</th>
<th>High-vowel Split [i, u, j, ü]</th>
<th>Right-to-left ATR Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Àkûrê</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mòbà</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>no</td>
<td>✓</td>
</tr>
<tr>
<td>SY</td>
<td>✓</td>
<td>no</td>
<td>✓</td>
<td>no</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 2. Summary of vowel harmony characteristics for Àkûrê, Mòbà, and Standard Yorùbá.

3 Experiment

If phonological vowel harmony emerges from phonetic effects, then we should find that the phonological patterns resemble phonetic ones. A vowel’s articulatory realization, and thus its acoustic realization, is influenced by, among other things, the realization of adjacent vowels—this is vowel-to-vowel coarticulation (see Ohman 1966, Manual 1990, and others). Both harmony and coarticulation involve an influence of characteristics from one vowel onto a neighboring vowel. The effect is larger and generally more perceptible with harmony than with coarticulation. In this experiment, I examined both effects to determine to what extent they are similar. My hypothesis is that coarticulation should look like vowel harmony, though the phonetic effects should be much smaller and less robust than the phonological ones.

I investigated the acoustics of vowel harmony and coarticulation in VCV tokens (words and non-words) in the three Yorùbá dialects. Of interest in this paper are the high vowels—in Àkûrê the high vowels have ±ATR allophones, but in Mòbà and SY, they do

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4 The behavior of [a] in Yorùbá is typical for ATR languages; even in languages such as Akan, where /a/ has allophones, both variants trigger –ATR harmony.
not (as noted above). I expected to find that in Mòbà and SY, the effects of coarticulation resembled the harmony found in Àkùrè, as exemplified for /i/ in Figure 1.

![Diagram](image)

**Figure 1.** Schematic of Predicted F1 value for vowels in Àkùrè’s *ike* and *ike*, and in Mòbà and SY’s *ike* and *ike*.

On the left side, we see a schematic illustration of predicted F1 values for the vowels in *ike* and *ike* in Àkùrè: the F1s for each vowel pair are very different. On the right side, we see the expected F1 values for the vowels of *ike* and *ike* for Mòbà and SY. While the [e]/[e] pair should resemble its Àkùrè counterpart, the high vowel pair was expected to show only a small difference, with the [i] having a higher F1 before −ATR [e] than before +ATR [e]. The difference in the articulation of [i] before −ATR vowels versus before +ATR vowels is not necessarily part of a speaker’s knowledge, rather it is in some way the result of anticipating the articulation of the following vowel.

**3.1 Methodology**

10 native speakers for each of the three dialects were recorded. Here, I report on two speakers per dialect. The speakers read a list of words with the form VCV, which included all allowable vowel combinations in their dialect. The words had the general shape in (11).
(11) \[ V1 \quad - \quad C \quad - \quad V2 \]
\[
\{i, e, ë, a, œ, o, u\} \quad - \quad \{k, b\} \quad - \quad \{i, e, ë, a, œ, o, u\}
\]

Some combinations, such as eCe, ëCe, œC ë, and ëCo (where C is /k/ or /b/), are not allowed in any of these dialects, and so these combinations were not included in the list. Other combinations are present in some dialects but not others. For example, Mòbà and SY speakers were given forms of the shape eCu and ëCu, both allowable forms in those dialects; Ìkùrè speakers were given only the former, since words of shape ëCu are not found in Ìkùrè. I controlled for tone and intervocalic consonant: the words all had mid tones on the first and second syllable; the intervocalic consonants used were /b/ and /k/.

Due to the difficulty of finding minimal sets with the same tone and intervocalic consonants, I included nonsense words as well as real words; indeed, most of the words on the list are not real words.

The words were pronounced in the carrier phrase listed in (12).

(12)  
Standard Yorùbá:  ó  f'  ike  s'òkè.

Mòbà:  è/ë  f'  ike  s'òkè.

Ìkùrè:  ó/ö  f'  ike  s’okè.

3sg  put  word  on top

'S/he put ike on top.'

The carrier phrase differs minimally from dialect to dialect, as shown. (Note the pronouns and the tone of oke differ.) The sentences were written in Yorùbá orthography. Four repetitions of each target word and carrier phrase were recorded, of which three were measured.

The recordings were made in Nigeria with a Sony WM-D6C Professional Walkman and a Shure SM10A head-mounted microphone, and were digitized on a Sun SparcStation at a sampling rate of 11,025 kHz. Measurements were made using the Entropic Signal Processing Systems (ESPS) Waves+* speech analysis software system. Formants and bandwidths were measured using the xspectrum feature of Xwaves using
an LPC spectra, with a 20 ms. window and an order of 14. Other measurements were
taken using FFT spectra, LPC spectra, spectrograms, and pitch tracking programs, using
scripts developed by Eric Evans and me.

3.2 Acoustics of ATR Vowels

ATR vowel pairs typically differ in the first formant (F1), with a +ATR vowel having
a lower F1 than its −ATR counterpart (Halle and Stevens 1969, Lindau 1978, Hess 1992,
Fulop 1996, and others). F1 Bandwidth has also been associated with ±ATR in some
languages, with a +ATR vowel having a lower F1 Bandwidth than its −ATR counterpart
the vowels from one speaker of Akan to determine which was the most reliable correlate
with the phonological ATR distinction. She considered F1, F1 bandwidth, vowel
duration, as well as two spectral measures: difference in peak amplitude of F1 and F2,
and the difference in amplitude between the second and first harmonic. Although she
found that the F1 Bandwidth was correlated with ATR, she found that F1 was a more
reliable correlate. The other three measures were not correlated with ATR.

Following Hess (1992), as well as Watkins (1998), I made these measurements for the
midpoint of each V1:
• F1, F2, F3
• F1, F2, and F3 Bandwidths
• F0
• Vowel Duration
• Various Spectral Measures (from Watkins (1998))
  • Amp(H1) – Amp(H2)
  • Spectral Tilt: Max Amplitude between 0-1000 Hz minus Max Amplitude between
    2500-3500 Hz.
  • Amp(F1) – Amp(H1)

5 Tone is marked in Yorùbá orthography—` indicates a high tone; , a low tone; and mid tones are
unmarked.
4 Results

Consistent with other studies discussed above, I found F1 to be the most reliable phonetic correlate to \( \pm \text{ATR} \) distinctions, and so I report only on this measurement here. Each chart below (Figure 2-Figure 7) represents one speaker, comparing each vowel before \(+\text{ATR}\) versus \(-\text{ATR}\) mid vowels. I limit the comparison to vowels before mid vowels, since mid vowels differ only in one feature, ATR. The first bar (labeled small ‘i’) represents the F1 average for /i/ when followed by the \(+\text{ATR}\) mid vowels, /e/ and /o/. The capital ‘I’ shows the average F1 for /i/ before the \(-\text{ATR}\) midvowels, /ɛ/ and /ɔ/. The same is true for the other vowels, so that the small [a], for example, is the a of ake, ako, abe, abo, and the capital [A] is for a in akɛ, akɔ, abɛ and abɔ.

4.1 Àkùrè

Looking at the results from the Àkùrè speakers, in Figure 2 and Figure 3, first note that the two mid vowel pairs are clearly distinct; the differences between [ɛ] and [ɛ], and [o] and [ɔ], are large and statistically significant for both speakers. For speaker Ak2, the differences were 204 Hz and 174 Hz for front and back vowels, respectively [p < .001 for both]. For speaker Ak6, the differences were 115 Hz and 131 Hz for front and back vowels, respectively [p < .001 for both]. These differences were expected, since these phones are distinct phonemes.
**Figure 2.** F1 Averages at V1 midpoint for Àkúrê speaker “Ak2”; the small letters show the average of the vowels before +ATR /e/ and /o/; the capital letters show the average before –ATR /ɛ/ and /ɤ/. (Bars mark one standard deviation. ** indicates a statistical significance of p < .01 using a t-test; * indicates p < .05.)

**Figure 3.** F1 Averages at V1 midpoint for Àkúrê speaker “Ak6”; the small letters show the average of the vowels before +ATR /e/ and /o/; the capital letters show the average before –ATR /ɛ/ and /ɤ/. (Bars mark one standard deviation. ** indicates a statistical significance of p < .01 using a t-test; * indicates p < .05.)

For the Àkúrê high vowels, +ATR and –ATR variants also have significantly different F1 averages. For speaker Ak2, we find a difference of 129 Hz for the front vowels and 85 Hz for the back vowels, both significant [p < .001 for both]. For Ak6, the difference is smaller: 39 Hz for the front vowels and 65 Hz for the back vowels; still,
t-tests show significance differences \([p < .01\), for front vowels, \(p < .001\) for back vowels\]. These findings show that there are categorical differences between these phones in Àkùrè, consistent with phonological generalizations, since we know that high vowels participate in the vowel harmony as triggers, as well as targets. For the Àkùrè low vowel, the difference between \([a]\) before E and O versus \([a]\) before e and o is small \([not significant for Ak2, with \(p > .05\); slightly significant for Ak6, with \(p < .05\)]. In summary, in Àkùrè we see distinct differences in the vowel pairs described to be phonologically distinct, either as phonemes \(in the mid vowels\) or as allophones \(in the high vowels\).

### 4.2 Mòbà

For Mòbà mid vowel pairs, shown in Figure 4 and Figure 5, the results are similar to Àkùrè: the differences between e and E, and o and O, are large for both speakers and statistically significant \([p < .001\) for both speakers, both vowel pairs\].

![Figure 4](image)

**Figure 4.** F1 Averages at V1 midpoint for Mòbà speaker “Mb8”; the small letters show the average of the vowels before +ATR /e/ and /o/; the capital letters show the average before −ATR /E/ and /O/. (Bars mark one standard deviation. **indicates a statistical significance of \(p < .01\) using a t-test; * indicates \(p < .05\).)
As in Ákùrè, these differences are expected for distinct phonemes. In the Mòbà high vowels, we do not expect a large difference since there is no ±ATR phonological split in high vowels, and in fact the observed difference is smaller than for Ákùrè. For speaker Mb8, the differences were 19 Hz and 2 Hz for front and back vowels respectively [p > .05 for both]. For speaker Mb9, the differences were 32 Hz for front vowels [significant, p < .01] and 5 Hz for back vowels [not significant, p > .05]. In each high vowel pair, for each speaker, the direction of the difference is the same as for the Ákùrè allophonic pairs. For the low vowel /a/, the difference is 13 Hz for speaker Mb8 [not significant, p > .05], and 22 Hz for speaker Mb9 [slightly significant, p < .05].

4.3 Standard Yorùbá

SY mid vowels pattern like Mòbà and Ákùrè, with large differences and statistical significance [p < .001 for both speakers, both vowel pairs]. For the single high vowel /i/, SY speakers, like Mòbà speakers, show a small difference in the same direction as found for the Ákùrè allophonic pairs. For speaker SY1, the difference was 20 Hz; for speaker SY8, the difference was 5 Hz [both not significant with p > .05]. For the low vowel /a/,
the difference is 22 Hz for speaker SY1 and 8 Hz for speaker SY8 [both not significant with p > .05].

Figure 6. F1 Averages at V1 midpoint for SY speaker “SY1”; the small letters show the average of the vowels before +ATR /e/ and /o/; the capital letters show the average before −ATR /E/ and /O/. (Bars mark one standard deviation. ** indicates a statistical significance of p < .01 using a t-test; * indicates p < .05.)

Figure 7. F1 Averages at V1 midpoint for SY speaker “SY8”; the small letters show the average of the vowels before +ATR /e/ and /o/; the capital letters show the average before −ATR /E/ and /O/. (Bars mark one standard deviation. ** indicates a statistical significance of p < .01 using a t-test; * indicates p < .05.)
4.4 Comparison of Average Values

Mid vowels patterned similarly in all speakers of three dialects. In the high vowels, Àkùrè showed the large robust differences we expected of allophones. In the high vowels for speakers of Mòbà and SY, the differences found are much smaller, but in the same direction as those found for Àkùrè. With the exception of Mòbà speaker Mb9’s /i/, none of the differences for Mòbà and SY were statistically significant. In order to ascertain that the direction of the differences is statistically significant, I pooled together the data for the four speakers of the Mòbà and SY dialects. Using an ANOVA to measure statistical significance (with two-factors, subject and ATR of V2), I found that for the F1 of V1 of /i/ in iCeo versus iCEO showed a highly significant effect for ±ATR of V2 [F(1, 20), p < .01]. /i/ and /u/ together also showed a significant effect for ±ATR of V2 [F(1, 5), p < .05]. So although t-tests for individual speakers show that the direction of the coarticulation in high vowels for Mòbà and SY is in general not significant, the results of the ANOVA show that it is significant when all the speakers are pooled, indicating that the coarticulation pattern we have observed is a general pattern of these speakers.

4.5 Individual Token Values

Until now, we have been looking at averages of F1. In the next few figures, we will look at F1 values for individual tokens. Figure 8 shows the F1 values for the first vowel midpoint for individual tokens of ike (shown as ikE) and ike for the six speakers of the three dialects. Each mark indicates a single token.

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6 Because SY does not have initial /u/, and there were only two speakers of Mòbà at this point in the study, an ANOVA for /u/ was not performed.
Figure 8. F1 values of individual tokens at the midpoint of V1 for *ike* (*iKE*) and *ike* for speakers of Àkùrè (Ak2, Ak6), Mòbà (Mb8, Mb9), and Standard Yorùbá (SY1, SY8).

From these charts, two clear generalizations emerge. First, for the Àkùrè speakers (Ak2 and Ak6), we can see that, as expected, +ATR [i] and –ATR [j] are categorically different, with no overlap between them; this contrasts with the Mòbà and SY speakers, who show considerable overlap in the two types of tokens shown. That is, the high vowels of Àkùrè exhibit a qualitatively different pattern than those of Mòbà and SY; Àkùrè high vowels are clearly distinct, enough to be considered as different phones—consistent with their description as allophonic variants—while Mòbà and SY are not. Second, the high vowels of Mòbà and SY, do exhibit a trend in the same direction as the Àkùrè vowels, with vowels preceding +ATR vowels having lower F1s than vowels preceding –ATR vowels. The ANOVA results from above (Section 4.4) corroborate this pattern. This same general pattern is also seen (with a few exceptions⁷) in Figure 9 for *iko* versus *ikọ*, and in Figure 10 for *uke* versus *ukẹ*.

⁷ The exceptions seen here will be considered further in future work when more speakers have been investigated.
Figure 9. F1 values of individual tokens at the midpoint of V1 for *iko* (*ikO*) and *iko* for speakers of Akūrē (Ak2, Ak6), Mōbā (Mb8, Mb9), and Standard Yorūbá (SY1, SY8).

Figure 10. F1 values of individual tokens at the midpoint of V1 for *uke* (*uke*) and *uke* for speakers of Akūrē (Ak2, Ak6), Mōbā (Mb8, Mb9), and Standard Yorūbá (SY1, SY8). SY words cannot start with /u/.

5 Discussion of findings

By examining the acoustics of high vowels in three dialects of Yorūbá, I have shown that while Akūrē has phonological vowel harmony in the high vowels, Mōbā and SY do not—the patterns of phonology and phonetics differ in terms of degree (amount of F1 difference) and robustness. However, the patterns of coarticulation in Mōbā and SY resemble in direction the patterns of harmony in Akūrē. The phonological patterns must
be part of a speaker’s grammar; however the coarticulatory patterns, at least in part, are not. While vowel-to-vowel coarticulation is certainly rooted in the physical interaction between the articulations of neighboring vowels, part of this coarticulation may be under the control of the speaker. In fact, in the data presented here, we observe a difference between the coarticulation of vowels in Mòbà versus SY, with Mòbà exhibiting greater coarticulation, suggesting that the degree of coarticulation is language specific, and thus under speaker control.\(^8\)

The findings presented here suggest that ATR vowel harmony, like other phonological phenomena, has its origin in extra-grammatical phonetic effects (see Hyman 1976, Ohala 1995 and elsewhere, and Myers 1997); in this case, the vowel harmony in Àkùrè may have emerged from coarticulation in an earlier stage of Yorùbá.

In further studies, I will address these open questions: to what extent coarticulation occurs across word boundaries; how does progressive coarticulation compare with anticipatory coarticulation; and to what extent dialects differ in their degree of coarticulation.

6 References


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\(^8\) Interestingly, the coarticulatory patterns shown for high vowels in Mòbà and SY, are also found for the low vowel /a/ in all three dialects. All else being equal, we might expect that /a/ would exhibit phonological properties such as those found with high vowels. Future studies will examine this vowel closely.


