Vowel hiatus resolution in Kikuyu[1]

Jackson Kuzmik & Mary Paster
Pomona College

1. Introduction

This paper describes vowel hiatus resolution (VHR) in Kikuyu (E.51, Kenya), presenting new data to fill gaps in previous descriptions (especially the very comprehensive Armstrong 1940; see also Mugane 1997) and address divergence from those descriptions. We present a rule-based account; for an OT analysis of aspects of this system, see Kuzmik (2020).

(1) **Kikuyu vowel features**

	/i/	/e/	/ɛ/	/a/	/ɔ/	/o/	/u/
[±high]	+	-	-	-	-	-	+
[±low]	-	-	-	+	-	-	-
[±ATR]	+	+	-	-	-	+	+
[±back]	-	-	-	+	+	+	+
[±round]	-	-	-	-	+	+	+

A variety of factors determine the surface form when vowels come together across a word or morpheme boundary (see Casali 2011 for discussion of the various factors that influence VHR outcomes across languages):

(2) **Factors in Kikuyu VHR outcomes**

V_1 quality & length
V_2 quality & length
presence/quality/length of V preceding V_1
presence/type of C (velar vs. non-velar) preceding V_1
V vs. C following V_2
presence/quality/length of V following V_2
presence/type of C (nasal vs. oral) following V_2
boundary type between V_1 and V_2 (morpheme vs. word)

We will discuss these factors later but will start by focusing on VHR in a subset of possible contexts: V_1+V_2 across a word boundary where V_1 is preceded by a non-velar C and V_2 is followed by an oral C.

2. Description of vowel hiatus resolution patterns

The table below summarizes the surface forms corresponding to input V_1+V_2 combinations in this context (gray shaded boxes indicate surface forms that differ from Armstrong's description):

(3) **Short V_1 + Short V_2**

V_1↓ V_2→	i	e	ɛ	a	ɔ	o	u
i	ii	ie	iɛ	ia	iɔ	io	iu
e	ei	ee	eɛ	ea	eɔ	eo	eu
ɛ	ɛi	ɛɛ	ɛɛ	ea	eɔ	eo	eɔi
a	ai	ɛɛ	ɛɛ	aa	ɔɔ	ɔɔ	ɔi
ɔ	ɔi	oɛ	oɛ	ɔa	ɔɔ	ɔɔ	ɔi
o	oi	oe	oɛ	oa	oɔ	oo	ou
u	ui	ue	uɛ	ua	uɔ	uo	uu

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Below are examples of combinations of short vowels that undergo a quality change in this context. The slow speech form is given on the left and fast speech on the right. We assume that slow speech reflects the underlying form in terms of V quality, though not in all details (e.g., tone).

(4) **V_1+V_2 combinations that undergo quality change (slow speech → fast speech)**

a.	ɛ+e → ɛɛ	ŋɔ́ɔ́bɛ́ ɛ̀ɣɛ́ðìɛ̀	→	ŋɔ́ɔ́bɛ́ɛ́ɣɛ̀ðìɛ̀	'the cow went'
		jɔ̀rɔ̀gɛ́ étékà	→	jɔ̀rɔ̀gɛ́ɛ́tékà	'Njoroge, answer!'
b.	ɛ+a → ea	dɔ̀ɔ̀nìrɛ́ áðùùrì	→	dɔ̀ɔ̀nìréáðúúrì	'I saw the elders'
		dòkààrɛ̀kɛ̀ áhóótɛ̀	→	dòkààrɛ̀kɛ̀àhóótɛ̀	'don't let her get hungry'
		dɛ̀ɛ̀tìrɛ́ átùmía	→	dɛ̀ɛ̀tìréátùmía	'I called the women (rem. past)'
		rɛ̀kɛ̀ áðìɛ̀	→	rɛ̀kéáðìɛ̀	'let him go'
c.	ɛ+ɔ → eɔ	kàmààdɛ́ ɔ́hà	→	kàmààdéɔ́hà	'Kamande, tie!'
		kàmààdɛ́ ɔ́ya	→	kàmààdéɔ́ya	'Kamande, lift!'
d.	ɛ+o → eo	ɔ̀ʃɔ́ɔ́kɛ́ ótòɛ̀jɛ̀	→	ɔ̀ʃɔ́ɔ́kɛ̀ɔ̀tòɛ̀jɛ̀	'then shave us'
		nààwɛ́ óɣékúúdékáɣɛ́	→	nààwéóɣékúúdékáɣɛ́	'and you continue tying...'
e.	ɛ+u → eɔi	jɔ̀rɔ̀gɛ́ úɣà	→	jɔ̀rɔ̀géɔ́ìɣà	'Njoroge, say something!'
		kàmààdɛ́ úɣà	→	kàmààdéɔ́íɣà	'Kamande, say something!'
f.	a+e → ɛɛ	nyààbùrá étékà	→	nyààbùréétékà	'Nyambura, answer!'
		wáʃíírá ètékà	→	wáʃíírɛ̀ètékà	'Waciira, answer!'
g.	a+ɛ → ɛɛ	nyààbùrá ɛ̀hɛ́rà	→	nyààbùréɛ́ˡhɛ́rà	'Nyambura, stand aside!'
		wáʃíírá ɛ̀hɛ́rà	→	wáʃíírɛ́ɛ́ˡhɛ́rà	'Waciira, stand aside!'
h.	a+ɔ → ɔɔ	tààtà ɔ́ya	→	tààtɔ́ɔ́ya	'Aunt, lift!'
		nyààbùrá ɔ́hà	→	nyààbùrɔ́ɔ́hà	'Nyambura, tie!'
i.	a+o → ɔɔ	tààtà óyó	→	tààtɔ̀ɔ̀yó	'this aunt'
		nyòògò yá ɔ̀ʃòrò	→	nyòògò yɔ́ɔ́ʃòrò	'porridge pot'
		mòðɛ́nyà ɔ́ʃìɔ̀	→	mòðɛ́nyɔ̀ɔ̀ʃíɔ́	'that day'
		nà òrɛ́ɛ́hɛ̀	→	nɔ̀ɔ̀rɛ́ɛ́hɛ̀	'and bring...'
j.	a+u → ɔi	tààtà úɣà	→	tààtɔ́ìɣà	'Aunt, say something!'
		bùrá úrà	→	bùrɔ́ìrà	'rain, come down!'
k.	ɔ+e → oɛ	móɣɔ́ étékà	→	móɣóétékà	'Mũgo, answer!'
		gèkɔ̀nyɔ́ étékà	→	gèkɔ̀nyóétékà	'Gĩkonyo, answer!'
l.	ɔ+ɛ → oɛ	gèkɔ̀nyɔ́ ɛ́hɛ́rà	→	gèkɔ̀nyóɛ́hɛ́rà	'Gĩkonyo, stand aside!'
		bɔ̀ɣɔ̀ ɛ́hɛ́rà	→	bɔ̀ɣòɛ́hɛ́rà	'Mbogo, stand aside!'
m.	ɔ+o → ɔɔ	mòtàrɔ́ óʃíɔ̀	→	mòtàrɔ́ɔ́ʃíɔ́	'that drain'
		gèkɔ̀nyɔ́ óhèɣà	→	gèkɔ̀nyɔ́ɔ́hèɣà	'Gĩkonyo, be smart!'
n.	ɔ+u → ɔi	gèkɔ̀nyɔ́ úɣà	→	gèkɔ̀nyɔ́ˡíɣà	'Gĩkonyo, say something!'
		bɔ̀ɣɔ̀ úɣà	→	bɔ̀ɣɔ́íɣà	'Mbogo, say something!'

Note that there are some differences from Armstrong. First, Armstrong states (p. 23) that *ɔ+a* yields *oa*, though the example she provides is actually an *ɔ+aa* input sequence: *aɣeeta waðiɔm**ɔ aa**ke* → *aɣeeta waðiɔm**oaa**ke* 'and he invited his greatest friends...' Our speaker replicated this example with *ɔ+aa* → *ɔa* (*àɣèètá wáðíɔ̀m**ɔ̀ áá**ke* → *àɣèètá wáðíɔ̀m**ɔ̀à**ke*; see below for more on V+V: sequences). For our speaker, *ɔ+a* yields *ɔa*:

(5)	ɔ+a → ɔa	mòɣɔ̀ áyá	→	mòɣɔ̀àyá	'these Mũgos'
		mòɣɔ̀ àrìà	→	móɣɔ́árìà	'Mũgo, speak!'

Second, where our speaker changes *ɛ+o* sequences to *eo*, Armstrong reports *eɔ*. Some forms from our speaker (replicated from (4d)) are given below:

(6)	ɛ+o → eo	ɔ̀ʃɔ́kɛ́ ótòɛ̀jɛ̀	→	ɔ̀ʃɔ́kɛ̀ɔ̀tɔ̀ɛ̀jɛ̀	‘then shave us’
		nààwɛ́ óɣékúúdɛ́káɣɛ́	→	nààwéóɣékúúdɛ́káɣɛ́	‘and you continue tying...’

Compare with Armstrong’s examples (p. 20):

(7) a. **Armstrong’s examples with ɛ+o → eɔ**

ndaaɣorir**ɛ o**ta omwɛ →	ndaaɣorir**eɔ**tɔɔmwɛ	‘I bought one bow’
mocɛɛr**ɛ o**yo →	mocɛɛr**eɔ**yo	‘this rice’
rɛɛhɛ moɣat**ɛ o**mwɛ →	rɛɛhɛ moɣat**eɔ**mwɛ	‘bring one loaf’
toh**ɛ o**hɔɔrɛri na ðaayo →	toh**eɔ**hɔɔrɛri na ðaayo	‘grant us tranquility and peace’

b. **Forms replicated by our speaker with ɛ+o → eo**

ndààɣòrìr**é ó**tà ómwé →	ndààɣòrìr**èó**tɔ̀ɔ̀mwé	‘I bought one bow’
mòʃɛ́ɛ́r**è ó**yó →	mòʃɛ́ɛ́r**èò**yó	‘this rice’
rɛ̀ɛ̀hé mòɣàt**è ó**mwé →	rɛ̀ɛ̀hé mòɣàt**èò**mwé	‘bring one loaf’
tóh**é ò**hɔ́ɔ́rérí nà ðààyò →	tóh**éó**hɔ́ɔ́rérí nà ðààyò	‘grant us tranquility and peace’

Another difference is that Armstrong states (p. 24) that [oɔ] is ‘in most cases impossible’ (occurring only in forms where [o] is the passive suffix), so *o+ɔ* surfaces as [uɔ]. The examples she cites are single words (infinitive prefix + stem), including the following (replicated with our speaker and with tone marking added):

(8)	o+ɔ → uɔ	/ko-ɔya/	→	kùɔ̀yá	‘to lift’
	(within words)	/ko-ɔha/	→	kúɔ̀há	‘to tie up’

Across word boundaries, *o+ɔ* surfaces unchanged for our speaker (but optionally undergoes glide formation; see below):

(9)	o+ɔ → oɔ	gèʃɔ̀rò ɔ́hà	→	gèʃɔ̀rò ɔ́hà ~ gèʃɔ̀rwɔ́ɔ́hà	‘Gĩcũrũ, tie!’
		wàjíkó ɔ́yà	→	wàjìkóɔ́yà ~ wàjìkwɔ́ɔ́yà	‘Wanjikũ, lift!’

A final discrepancy in combinations of short vowels is that for our speaker, *o+u* and *e+u* sequences surface as *ou*, *eu* rather than undergoing mid V raising as reported by Armstrong:

(10)	a.	o+u → ou	wàjìkó úɣà	→	wàjíkóúɣà	‘Wanjikũ, say something!’
			kèmààrò úɣà	→	kèmààròúɣà	‘Kĩmarũ, say something!’
	b.	e+u → eu	gèʃóhè úɣà	→	gèʃóhèúɣà	‘Gĩcũhĩ, say something!’
			kèvàkè úmà	→	kèvàkèúmà	‘Kĩbakĩ, come out!’

As with *o+ɔ*, for *o+u* Armstrong provides examples (p. 24) where this sequence does change (to *uu*) within words, as it does for our speaker within words (examples in (11a) are replicated from Armstrong with tone marking added). Additionally, though Armstrong provides examples of *e+u* changing to *iu* both within and across words, we only find evidence for this change within words (11b):

(11)	a.	o+u → uu	/to-uɣ-ir-ɛ/	→	tùùɣírɛ́	‘we said (today)’
		(within words)	/ko-uɣ-a/	→	kùùɣá	‘to say something’
	b.	e+u → iu	/n-ge-um-a/	→	gíúmà	‘I came out’
		(within word)	/n-ge-uɣ-a/	→	gíúɣà	‘I said something’

Armstrong cites the example *njok**e** **u**ma* → *njok**iu**ma* 'Njũkĩ, come out!' (p. 24) with *e*+*u* surfacing as *iu* across a word boundary, but our speaker produces this form with *eu* (*jòk**é*** ˡ***ú**mà* → *jòk**é**ˡ**ú**mà*).

3. Generalizations and rules accounting for core vowel hiatus resolution patterns

This section gives generalizations and rules to account for all observed patterns in the context we are focusing on (combinations of short vowels across word boundaries).

We assume autosegmental theory but present SPE-style rules as a shorthand except where autosegmental representations are crucial to understanding a pattern.

When a [-ATR] mid V_1 precedes its [+ATR] counterpart as V_2, V_2 assimilates to [-ATR] (*ɛe*, *ɔo* → *ɛɛ*, *ɔɔ*):

(12) V → [-ATR] / V ___
[-high, -low, +ATR, αback] [-high, -low, -ATR, αback]

It is crucial that the rule applies only when the vowels agree in backness, since [-ATR][+ATR] input sequences with vowels disagreeing in backness (*ɔe*, *ɛo*) do not behave this way. Input *ɛ*+*o* changes to *eo*, as follows:

(13) V → [+ATR] / ___ V
[-high, -low, -ATR, -back] [-high, -low, +ATR, +back]

On the other hand, *ɔ*+*e* surfaces as *oɛ*. We account for *ɔe* → *oɛ* in two steps. First, *ɔe* → *ɔɛ*, as follows:

(14) V → [-ATR] / V ___
[-high, -low, +ATR, -back] [-high, -low, -ATR, +back]

Then, *ɔɛ* → *oɛ* via a general rule that changes a [-ATR] mid vowel to [+ATR] when followed by a [-ATR] mid vowel (*ɛɔ* → *eɔ*, and *ɔɛ* → *oɛ*):

(15) V → [+ATR] / ___ V
[-high, -low, -ATR] [-high, -low, -ATR]

Note that these two steps cannot be reversed to yield *ɔe* → *oɛ*, since if *ɔe* first changed to *oe*, we would have no motivation for *e* lowering to *ɛ* (the input sequence *o*+*e* surfaces as *oe*, not *oɛ*).

Note also that on this analysis with an intermediate stage *ɔɛ*, the [+ATR] feature that surfaces on the [o] in *ɔe* → [oɛ] is not the same instance of the [+ATR] feature that was present on the input /e/.

A final point to note about (15) is that although it only affects sequences where the two vowels disagree in backness/ roundness, this does not have to be stated in the rule because we assume that /ɛ+ɛ/ and /ɔ+ɔ/ fuse into a single long V (via a fusion rule, V_i+V_i → V_iː) prior to the application of (15) (thereby preventing *ɛ*+*ɛ*, *ɔ*+*ɔ* from changing to *eɛ*, *oɔ*).

In *ɛ*+*a* sequences, *ɛ* raises to *e*, yielding *ea*:

(16) V → [+ATR] / ___ V
[-high, -low, -ATR, -back] [+low]

The rule needs to be specific to [-back] vowels since *ɔ*+*a* does not change to *oa*.

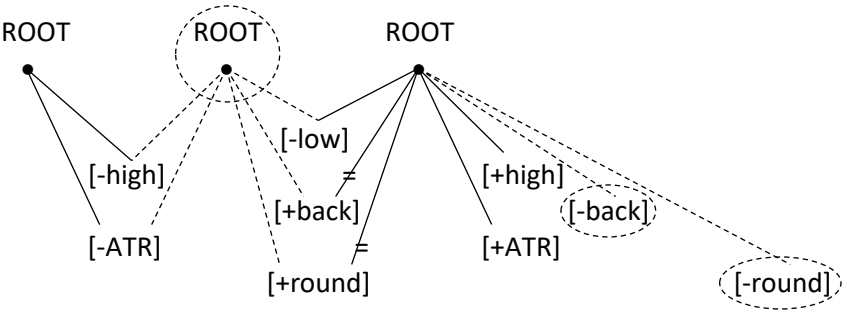
When *a* precedes any mid vowel, it assimilates to [-low] and to the backness/roundness of the triggering vowel while retaining its [-ATR] feature (so *a+o* and *a+ɔ* surface as *ɔɔ*, while *a+e* and *a+ɛ* surface as *ɛɛ*):

(17) V → [-low, αback, αround] / ___ V
[+low] [-high, -low, αback, αround]

This rule feeds the rule in (12) (which changes *ɛe*, *ɔo* to *ɛɛ*, *ɔɔ*), so we account for *a+e* → *ɛɛ* in two steps (a+e → ɛe → ɛɛ).

Some unusual changes apply to V_1+u sequences where V_1 is [-high, -ATR]: *ɛu* → *eɔi*, *au* → *ɔi*, and *ɔu* → *ɔi*. In all cases, *u* undergoes dipthongization, changing to *ɔi*, via the rule in (18). Dashed circles indicate inserted items, though [-back] and [-round] may be inserted by default rather than by this rule.

(18)



Following the change of *u* to *ɔi*, further rules apply to the triggering V. *ɛ* raises to *e* via the independently needed rule in (15). *ɔ* and *a* are deleted, and since both also delete before *ɔɔ* as shown below, we hypothesize that a single rule causes deletion before both *ɔɔ* and *ɔi* (i.e., deletion occurs before any VV (including a single long V) where the first is *ɔ*).

(19)	a + ɔɔ → ɔɔ	ná ɔ́ɔ́tì	→	nɔ́ɔ́tì	'... and baskers'
	ɔ + ɔɔ → ɔɔ	gèkɔ̀nyɔ́ ɔ́ɔ́nìrɛ̀	→	gèkɔ̀nyɔ́ɔ́nìrɛ̀	'Gĩkonyo saw (something)'

We can formulate this deletion rule as applying only to *ɔ*, since *a* → *ɔ* / __ *ɔ* via the rule in (17), which feeds (20):

(20) ɔ → Ø / __ ɔ V

4. Other factors/contexts affecting vowel hiatus resolution
In this section we discuss some complications to the core pattern, based on the factors/contexts identified in (2).

4.1 Segment preceding V_1
A **vowel** preceding the V_1+V_2 sequence can affect the outcome of hiatus resolution. For example, Armstrong reports (p. 22) that input *iɛ+a* surfaces as *ia* with the *ɛ* elided. Normally *ɛ+a* surfaces as *ea* (see above), so deletion of *ɛ* from *iɛ+a* is conditioned by *i*. We have not investigated 3-vowel sequences systematically, so it is unclear how general the deletion rule is (in terms of which specific vowels undergo or trigger it). This is a matter for future research.[2]

A **consonant** preceding the V_1+V_2 sequence affects hiatus resolution in terms of whether glide formation (GF) applies to V_1 (see Kuzmik 2020 for further analysis of glide formation).

Generally, GF can apply to *o*, changing it to *w* when it precedes any vowel except *o* or *u.* It is sometimes optional but is obligatory for some forms (we have not yet determined when it is obligatory vs. optional):

[2] Note however that the number of combinations makes it impractical to study all 3-V sequences systematically. If any of the 14 long/short vowels can hypothetically precede all 49 combinations of short vowels across a word boundary, this yields 686 V_1+V_2V_3 combinations; multiply by 2 to include utterances where the boundary occurs instead after V_2 (V_1V_2+V_3), yielding 1372 combinations. Multiply by 2 to compare with the morpheme boundary context (within-word), yielding a total of 2744 unique combinations.

(21)	a.	o+i → wii ~oi	wàjìkó íkòmí	→	wàjìkwííkòmí ~ wàjìkòíkòmí	‘ten Wanjikũs’
		o+e → wee ~oe	wàjìkó étékà	→	wàjìkwéétékà ~ wàjìkóétékà	‘Wanjikũ, answer!’
		o+ɛ → wɛɛ ~oɛ	wàjìkó ɛ́hɛ́rà	→	wàjìkwɛ́ɛ́hɛ́rà ~ wàjìkóɛ́hɛ́rà	‘Wanjikũ, stand aside!’
		o+a → waa ~oa	wàjìkó áyá	→	wàjìkwááyá ~ wàjìkóáyá	‘these Wanjikũs’
		o+ɔ → wɔɔ ~oɔ	wàjíkó ɔ́hà	→	wàjíkwɔ́ɔ́hà ~ wàjíkóɔ́hà	‘Wanjikũ, tie!’
	b.	o+o → oo *woo	wàjìkó òyò	→	wàjìkóóyó *wajikwooyo	‘this Wanjikũ’
		o+u → ou *wuu	wàjìkó úɣà	→	wàjíkóúɣà *wajikwuuɣa	‘Wanjikũ, say something!’

GF can also apply to *o* derived via raising of *ɔ* before *ɛ* (so GF is ordered after V raising):

(22)	ɔ+ɛ → oɛ (→ wɛɛ)	húkɔ́ ɛ́hɛ́rà	→	húkwɛ́ɛ́hɛ́rà ~ húkóɛ́hɛ́rà	‘mole, stand aside!’
		mèhèèdɔ́ èná	→	mèhèèdwɛ̀ɛ̀nà ~ mèhèèdòɛ̀nà	‘four ropes’
		jɔ̀mɔ̀ ɛ́hɛ́rà	→	jɔ̀mwɛ́ɛ́ˡhɛ́rà ~ jɔ̀mɔ́ɛ́ˡhɛ́rà	‘Njomo, stand aside!’

Some vowels other than *o* also undergo GF, but less robustly. In contrast to Mugane’s report (1997: 9) that *i* and *u* do not undergo GF, *i* does undergo GF in some cases, but apparently only before *u*:

(23)	a.	mwààgì úmà	→	mwààgyúúmà *mwaagiuma	‘Mwangi, come out!’
		mwààgì úɣà	→	mwààgyúúɣà *mwaagiuɣa	‘Mwangi, say something!’
		wààbìtí úɣà	→	wààbìtyúúɣà ~ wààbìtíúɣà	‘Wambiti, say something!’
		gèðèèjí úɣà	→	gèðèèjyúúɣà ~ gèðèèjíúɣà	‘Gĩthĩnji, say something!’
		kàríòkí úɣà	→	kàríòkyúúɣà ~ kàríòkìúɣà	‘Kariũki, say something!’
		kèmání úmà	→	kèmányúúmà ~ kèmáníˡúmà	‘Kĩmani, come out!’
		kàɣɔ̀ʃí úɣà	→	kàɣɔ̀ʃˡyúúɣà ~ kàɣɔ̀ʃíˡúɣà	‘Kagoci, say something!’
		kàrémí úɣà	→	kàrémˡyúúɣà ~ kàrémìúɣà	‘Karĩmi, say something!’
	b.	mwààgì íkòmí	→	mwààgííkòmí *mwaagyiikomi	‘ten Mwangis’
		mwààgì étékà	→	mwààgìètékà *mwààgyèètékà	‘Mwangi, answer!’

	mwààgì ɛ́hɛ́rà	→	mwààgíɛ́hɛ́rà *mwaagyɛɛhɛra	‘Mwangi, stand aside!’
	mwààgì áyá	→	mwààgìàyá *mwaagyaaya	‘these Mwangis’
	mwààgì ɔ́hà	→	mwààgíɔ́hà *mwaagyɔɔha	‘Mwangi, tie!’
	mwààgì òyò	→	mwààgìòyó *mwaagyooyo	‘this Mwangi’

Similarly, *u* seems to undergo glide formation most readily before *i* (24a), though it also applies before non-round vowels (24b). We do not have examples of it applying before *ɔ*, *o*, or *u* (24c):

(24)	a.	kàrúúgú íkòmí	→	kàrùùgwìikòmí *karuuguikomi	‘ten Karungus’
		màfùkù ìkòmí	→	màfùkwìikòmí *mafukuikomi	‘ten books’
		kààbútú íkòmí	→	kààbútwííkòmí *kààbútúíkòmí	‘ten Kambutus’
	b.	kàrúúgú étékà	→	kàrúúgwèètékà ~ kàrúúgùètékà	‘Karungu, answer!’
		kàrúúgú ɛ́hɛ́rà	→	kàrúúgwɛ́ɛ́hɛ̀rà ~ kàrúúgúɛ́ꜜhɛ́rà	‘Karungu, stand aside!’
		kàrúúgú àtáánó	→	kàrùùgwààtáánó ~ kàrùùgùàtáánó	‘five Karungus’
	c.	kàrúúgú ɔ́hà	→	kàrúúgùɔ́hà *karuugwɔɔha	‘Karungu, tie!’
		kàrúúgú óyó	→	kàrùùgùòyó *karuugwooyo	‘this Karungu’
		kàrúúgú úɣà	→	kàrúúgùúɣà *karuugwuuɣa	‘Karungu, say something!’

We have observed a small number of instances of *e* undergoing GF:

(25)	a.	kèvàkè ɛ̀hɛ́rà	→	kèvàkyɛ́ɛ́ꜜhɛ́rà ~ kèvàkèɛ́ꜜhɛ̀rà	‘Kĩbakĩ, stand aside!’
		kèvàkè áyá	→	kèvàkyààyá ~ kèvàkèàyá	‘these Kĩbakĩs’
		gèʃòké áyá	→	gèʃòkyááyá ~ gèʃòkéáyá	‘these Gĩcũkĩs’
		kèvàkè ɔ́hà	→	kèvàkyɔ́ɔ́hà ~ kèvàkèɔ́hà	‘Kĩbakĩ, tie!’
		kèvàkè óyó	→	kèvàkyòòyó ~ kèvàkèòyó	‘this Kĩbakĩ’
		gèʃòké òyò	→	gèʃòkyóóyó ~ gèʃòkéóyó	‘this Gĩcũkĩ’
		kèvàkè úɣà	→	kèvàkyúúɣà ~ kèvàkèúɣà	‘Kĩbakĩ, say something!’

b.	kèvàkè étékà	→	kèvàkèètékà *kevakyeeteka	‘Kĩbakĩ, answer!’
	kèvàkè íkòmí	→	kèvàkéíkòmí *kevakyiikomi	‘ten Kĩbakĩs’

Other forms with *e* as V_1 fail to undergo GF:

(26)	gèʃóhè úɣà	→	gèʃóhèúɣà *geʃohyuuɣa	‘Gĩcũhĩ, say something!’
	gàré úɣà	→	gàréˡúɣà *garyuuɣa	‘Ngarĩ, say something!’
	mòtè óʃíɔ	→	mòtèòʃíɔ *motyooʃiɔ	‘that tree’
	gèʃòké ɛˡhɛ́rà	→	gèʃòkéɛˡhɛ́rà *geʃokyɛɛhɛra	‘Gĩcũkĩ, stand aside!’
	gèʃòké ɔ́hà	→	gèʃòkéˡɔ́hà *geʃokyɔɔha	‘Gĩcũkĩ, tie!’
	gèʃòké úɣà	→	gèʃòkéˡúɣà *geʃokyuuɣa	‘Gĩcũkĩ, say something!’

Mugane (1997: 10) reports *mũtyũcio* for ‘[that] tree’, implying [motyoʃiɔ] although presumably the *o* after the glide is lengthened; our speaker rejects the form with GF for that phrase, as seen in (26).

Note also in comparing (25) with (26) that the final V of the name Gĩcũkĩ variably undergoes GF, seemingly depending on the following V but with no clear phonological generalization.

The preceding C (if any) affects the likelihood of GF application. A preceding *k* seems to make GF most likely, but it can apply after other consonants:

(27)	/k/	màfùkù ìkòmí	→	màfùkwììkòmí (*mafukuikomi)	‘ten books’
	/g/	kàrúúgú íkòmí	→	kàrùùgwììkòmí (*karuuguikomi)	‘ten Karungus’
	/t/	wààbìtí úɣà	→	wààbìtyúúɣà ~ wààbìtíúɣà	‘Wambiti, say something!’
	/d/	mòhéédɔ̀ étékà	→	mòhéédòètékà ~ mòhéédwɛ̀ètékà	‘rope, answer!
	/dʒ/	gèðèèjí úɣà	→	gèðèèjyúúɣà ~ gèðèèjíúɣà	‘Gĩthĩnji, say something!’
	/ʃ/	kàɣɔ̀ʃí úɣà	→	kàɣɔ̀ʃˡyúúɣà ~ kàɣɔ̀ʃíˡúɣà	‘Kagoci, say something!’
	/r/	gèʃòrò ɔ́nà	→	gèʃòròɔ́nà ~ gèʃòrwɔ́ɔ́nà	‘Gĩcũrũ, see!’
	/m/	wàìrìmó áyá	→	wàìrìmwááyá ~ wàìrìmóáyá	‘these Wairimũs’
	/n/	kèmání úmà	→	kèmányúúmà ~ kèmáníˡúmà	‘Kĩmani, come out!’
	/ŋ/	dòòŋó íkòmí	→	dòòŋwííkòmí ~ dòòŋòíkòmí	‘ten Ndũng’ũs’

The following consonants preceding the target V appear to inhibit or block GF:

(28)	/ɣ/	bɔ̀ɣɔ̀ ɛ́hɛ́rà	→	bɔ̀ɣòɛ́hɛ́rà (*bɔɣwɛɛhɛra)	‘Mbogo, stand aside!’
	/ʃ/	gɛ̀ʃó étèkà	→	gɛ̀ʃóétékà (*gɛʃweeteka)	‘Ngecũ, answer!’
	/ð/	kèmɔ̀ðɔ̀ ɛ́hɛ́rà	→	kèmɔ̀ðòɛ́hɛ́rà (*kemɔðwɛɛhɛra)	‘Kĩmotho, stand aside!’
	/h/	mòhóhò ɛˡhɛ́rà	→	mòhóhòèhɛ́rà (*mohohwɛɛhɛra)	‘Mũhoho, stand aside!’ (name is pronounced like *Mũhũhũ*)
	/r/	mòðúúrí úɣà	→	mòðúúrìúɣà (*moðuuryuuɣa)	‘elder, say something!’
	/ny/	gèkɔ̀nyɔ́ ɛ́hɛ́rà	→	gèkɔ̀nyóɛ́hɛ́rà (*gekɔnywɛɛhɛra)	‘Gĩkonyo, stand aside!’
	/ɣ/	wàmóyò étèkà	→	wàmóyòétèkà (*wamoyweeteka)	‘Wamũyũ, answer!’

Notice that some consonants (*r*, *ʃ*) appear on both lists. While a preceding *r* does not inhibit GF applying to *o*, it does seem to inhibit GF applying to *i* (our consultant attributed this to the fact that the sequence *rw* sounds natural to him but *ry* does not). Conversely, while GF does apply to *i* after *ʃ*, it seems to be inhibited from applying to *o* in this context.

4.2 Segment following V_2

Another V following V_2 can affect hiatus resolution in ways we have not systematically studied. One instance where we saw this was in the examples above involving changes to a V followed by *ɔ* vs. by *ɔV*. Recall that the changes in (29) apply when *a* or *ɔ* precedes a short *ɔ*:

(29)	a → ɔ / __ ɔ	tààtà ɔ́yà	→	tààtɔ́ɔ́yà	'Aunt, lift!'
		nyààbùrá ɔ́hà	→	nyààbùrɔ́ɔ́hà	'Nyambura, tie!'
	ɔ + ɔ → ɔɔ	gèkɔ̀nyɔ́ ɔ́hà	→	gèkɔ̀nyɔ́ɔ́hà	'Gĩkonyo, tie!'
		mòɣɔ̀ ɔ́yà	→	mó$^{!}$ɣɔ́ɔ́yà	'Mũgo, lift!'

On the other hand, these vowels are deleted when followed by *ɔi* or *ɔɔ*:

(30)	a → Ø / __ ɔi	tààtà úɣà	→	tààtɔ́ìɣà	'Aunt, say something!'
	(from /u/)	bùrá úrà	→	bùrɔ́ìrà	'rain, come down!'
	ɔ → Ø / __ ɔi	gèkɔ̀nyɔ́ úɣà	→	gèkɔ̀nyɔ́$^{!}$íɣà	'Gĩkonyo, say something!'
	(from /u/)	bɔ̀ɣɔ̀ úɣà	→	bɔ̀ɣɔ́íɣà	'Mbogo, say something!'
	a → Ø / __ ɔɔ	ná ɔ́ɔ́tì	→	nɔ́ɔ́tì	'... and baskers'
	ɔ → Ø / __ ɔɔ	gèkɔ̀nyɔ́ ɔ́ɔ́nìrɛ̀	→	gèkɔ̀nyɔ́ɔ́nìrɛ̀	'Gĩkonyo saw (something)'

We leave further study of effects of a vowel following the V_1+V_2 sequence to future research.

A nasal C following V_2 can obscure the effects of hiatus resolution. A [+ATR] mid vowel followed by a nasal is, to us, auditorily very similar to its [-ATR] counterpart (i.e., *o* and *e* sound like *ɔ*, *ɛ* before a nasal). The ATR contrast is not neutralized before nasals, but due to the confusability of vowels in this context, we have avoided forms with nasals following the V+V sequence where possible in this study.

4.3 Boundary type between V_1 and V_2 (morpheme vs. word)

Earlier we saw examples where the type of boundary (morpheme vs. word) between the two vowels results in different hiatus resolution effects. In the case of word boundaries, the type of syntactic boundary has not proved significant; the effects seem to apply across word boundaries anywhere within the clause (though not across clauses in an utterance).

In discussion of differences between our description and Armstrong's, we saw that while *o+ɔ* surfaces as *oɔ* across a word boundary, it changes to *uɔ* within words across a morpheme boundary. Similarly, while *o+u* surfaces as *ou* across a word boundary, it changes to *uu* across a morpheme boundary, and *e+u* surfaces as *eu* across a word boundary but as *iu* across a morpheme boundary.

In addition, *e+o* surfaces as *eo* across a word boundary but as *io* across a morpheme boundary:

(31)	a.	e+o → eo	mòtè óyó	→	mòtèòyó	'this tree'
		(across words)	mòtè òʃíɔ́	→	mòtèòʃíɔ́	'that tree'
			né ótà	→	néótà	'it's a bow'
			né ótùkò	→	néótùkò	'it's night'
	b.	e+o → io	/n-ke-ok-a/	→	gíókà	'I came'
		(within words)	/n-ke-or-a/	→	gíórà	'I got lost'

Interestingly, Armstrong (p. 24) reports no change to *e+o* even within words (cf. *ŋgeoka* 'I came').

The differences between the across-word vs. within-word contexts shows that there are some hiatus resolution rules that apply at the lexical level but not post-lexically:

(32) **Additional VHR rules that apply only lexically**

a. o → u / __ ɔ
b. o → u / __ u
c. e → i / __ u
d. e → i / __ o

Rules (32b-c) can be collapsed into a single rule:

(33) [-high, -low, +ATR] → [+high] / __ [+high, +back]

Note that this rule has to be limited to applying before a [+back] vowel since *i* does not trigger raising (*oi*, *ei* do not change to *ui*, *ii* within words; cf. /ko-ìkár-à/ → *ɣòíkàrà* 'to stay', /n-ke-ikar-a/ → *gèìkárá* 'I stayed').

It is also not possible to write rules raising *o*, *e* before all [+back, +round] vowels because *o* does not raise before *o* (though this could be explained via the fusion of *o+o* → *o:* applying before raising) and *e* does not raise before ɔ (*eɔ* → *eɔ* both within and across word boundaries; cf. /n-ke-ɔh-a/ → *géɔ́hà* 'I tied').

4.4 Vowel length

Armstrong provides few examples of combinations involving long vowels, tending to lump them in with combinations of short vowels despite the fact that they behave somewhat differently, as we show below.

The table below shows combinations of a short V_1 with a long V_2 across a word boundary (gray shading indicates differences from Armstrong; question marks indicate combinations we have been unable to elicit):

(34) **Short V_1 + Long V_2**

V_1↓ V_2→	ii	ee	ɛɛ	aa	ɔɔ	oo	uu
i	ii	ie	iɛ	ia	iɔ	io	iuu
e	eii	ee	eɛ	ea	eɔ	eo	euu
ɛ	ɛii	ɛɛ	ɛɛ	ea	eɔ	eo	ɛuu
a	aii	ɛɛ	ɛɛ	aa	ɔɔ	ɔɔ	auu
ɔ	?	oɛ	oɛ	ɔa	ɔɔ	ɔɔ	?
o	?	oe	oɛ	oa	oɔ	oo	?
u	?	?	uɛ	ua	uɔ	uo	?

One sytematic difference between our description and Armstrong's concerns the behavior of V+V: sequences where the vowels have identical quality. Armstrong reports (p. 12) that these surface as 'very long' (e.g., *meteeerea* 'those trees') but we consistently find long vowels in this context that sound the same as other long vowels, not 'very long' (e.g., *mèt**èé**réá* → *mèt**èè**réá* 'those trees').

Another difference concerns long vowels following *o*. Armstrong suggests (pp. 23-24) that all vowels except short ɔ and *u* surface unchanged after *o*, implying that long vowels are not shortened in this context, and specifically states (fn. 1, p. 24) that '*oɔɔ* (*wɔɔ*) and *ouu* (*wuu*) occur', though no examples are cited. We hypothesize that the forms in question are [wɔɔ] and [wuu] (we cannot confirm this since Armstrong cites no examples) and that these may result from a two-step

process of shortening and GF (which re-lengthens the V), e.g., *o+ɔɔ → oɔ → wɔɔ*. Otherwise, we have no explanation for why vowels would systematically fail to shorten after *o*, which happens to be the only V that consistently undergoes GF.

A final discrepancy involves whether long *ee* and *oo* undergo shortening. In our data, *ee* and *oo* shorten after another V. According to Armstrong, however, *ɔ+ee* fails to undergo shortening, surfacing as *ɔee* or *oɛɛ* (p. 21) (e.g., *meheend**ɔ ee**rea → meheend**oɛɛ**rea* 'those ropes'), *e+oo* surfaces as *eoo* (p. 20) (e.g., *maɣua m**e oo**ke → maɣua m**eoo**ke* 'honeycombs contain honey'), and *ɛ+oo* surfaces as *ɛoo* or *eɔɔ* (p. 20) (e.g., *mocɛɛr**ɛ oo**rea → mocɛɛr**eɔɔ**ea* 'that rice'). As seen in (35), our speaker produces these sequences as *oɛ*, *eo*, and *eo*, respectively.

Most long vowels as V_2 undergo shortening, and most V+V: combinations have surface forms identical to the corresponding V+V combinations:

(35) **Sequences with long V_2 where the surface form is identical to sequence with short V_2**

i + ii → ii	tí ííjí émòè	→	tííjí émòè	'this is not one inch'
i + ee → ie	mèìrí èèréá	→	mèìríéréá	'those *P. africana* trees'
	gààrí èèréá	→	gààríéréá	'that car'
i + ɛɛ → iɛ	kèmàní éétìrɛ́	→	kèmàníétìrɛ́	'Kimani called'
	tí éɛ́ɣà	→	tíɛ̀ɣà	'they (people) are not good'
i + aa → ia	kèmàní áányɔ́nírɛ́	→	kèmàníányɔ́nírɛ́	'Kĩmani saw me'
i + ɔɔ → iɔ	kèmàní ɔ́ɔ́nìrɛ́	→	kèmàníɔ́nìrɛ́	'Kĩmani saw (something)'
i + oo → io	mòðùùrì òòréá	→	mòðùùrìòréá	'that elder'
e + ee → ee	mètè ééréá	→	mètèèréá	'those trees'
	gàré èèréá	→	gàrééréá	'that leopard'
e + ɛɛ → eɛ	gèʃóhè éétìrɛ́	→	gèʃóhèétìrɛ́	'Gĩcũhĩ called'
	né èèɣà	→	néèɣà	'they (people) are good'
e + aa → ea	gèʃóhè áányɔ́nírɛ̀	→	gèʃóhèányɔ́nírɛ̀	'Gĩcũhĩ saw me'
	gèʃóhè áárèɔ́nírɛ̀	→	gèʃóhèárèɔ́nírɛ̀	'Gĩcũhĩ saw it (cl. 5)'
e + ɔɔ → eɔ	gèʃóhè ɔ́ɔ́nìrɛ́	→	gèʃóhèɔ́nìrɛ́	'Gĩcũhĩ saw (something)'
e + oo → eo	gèʃóhè òòréá	→	gèʃóhèòréá	'that Gĩcũhĩ'
	mòtè óóréá	→	mòtèòréá	'that tree'
ɛ + ee → ɛɛ	ŋɔ̀ɔ̀bè èèréá	→	ŋɔ̀ɔ̀bèèréá	'that cow'
ɛ + ɛɛ → ɛɛ	ɔ́ɔ́nèètɛ́ èèkí	→	ɔ́ɔ́nèètɛ́ékì	's/he saw doers'
ɛ + aa → ea	mònènɛ́ áányɔ́nírɛ̀	→	mònènéányɔ́nírɛ̀	'the boss saw me'
	jɔ̀rɔ̀gé áányɔ́nírɛ̀	→	jɔ̀rɔ̀géányɔ́nírɛ̀	'Njoroge saw me'
ɛ + ɔɔ → eɔ	mwèèrɛ́ ɔ́ɔ́kè	→	mwèèréɔ́kè	'tell him to come'
	ɔ́ɔ́nèètɛ́ ɔ̀ɔ̀tí	→	ɔ́ɔ́nèètéɔ́tì	's/he saw baskers'
ɛ + oo → eo	mòʃéérè òòréá	→	mòʃéérèòréá	'that rice'
	né déétè óòké	→	né déétèòkè	'I have eaten honey'
a + ee → ɛɛ	mèkààdá èèréá	→	mèkààdééréá	'those ropes'
a + ɛɛ → ɛɛ	ná éékì	→	néékì	'... and doers'
	nà èèjánì	→	nèèjánì	'... and hairdressers'
a + aa → aa	nyààbùrá áányɔ́nírɛ̀	→	nyààbùráányɔ́nírɛ̀	'Nyambura saw me'
a + ɔɔ → ɔɔ	ná ɔ́ɔ́tì	→	nɔ́ɔ́tì	'... and baskers'
	nà ɔ̀ɔ̀bí	→	nɔ̀ɔ̀bí	'... and potters'
a + oo → ɔɔ	mòrààtá òòréá	→	mòrààtɔ́ɔ́réá	'that friend'
	márééáɣà òòké	→	márééáɣɔ̀ɔ̀ké	'they eat honey'
ɔ + ee → oɛ	mèhèèdɔ̀ èèréá	→	mèhèèdòèréá	'those ropes'
ɔ + ɛɛ → oɛ	gèkɔ̀nyɔ́ éétìrɛ́	→	gèkɔ̀nyóétìrɛ́	'Gĩkonyo called'

ɔ + aa → ɔa	gèkɔ̀nyɔ́ áányɔ̀nírɛ̀	→	gèkɔ̀nyɔ́ányɔ̀nírɛ̀	‘Gĩkonyo saw me’
ɔ + ɔɔ → ɔɔ	gèkɔ̀nyɔ́ ɔ́ɔ́nìrɛ̀	→	gèkɔ̀nyɔ́ɔ́nìrɛ̀	‘Gĩkonyo saw (something)’
ɔ + oo → ɔɔ	gèkɔ̀nyɔ́ òòréá	→	gèkɔ̀nyɔ́ɔ́réá	‘that Gĩkonyo’
o + ee → oe	mèðààdókò èèréá	→	mèðààdókòèréá	‘those wattle trees’
	mètìtó èèréá	→	mètìtóéréá	‘those forests’
o + ɛɛ → oɛ	gèʃòrò ɛ́ɛ́tìrɛ́	→	gèʃòròɛ́tìrɛ́	‘Gĩcũrũ called’
	gèʃó ɛ́ɛ́tìrɛ́	→	gèʃóɛ́tìrɛ́	‘Ngecũ called’
o + aa → oa	gèʃòrò áányɔ̀nírɛ̀	→	gèʃòròányɔ̀nírɛ̀	‘Gĩcũrũ saw me’
o + ɔɔ → oɔ	gèʃòrò ɔ́ɔ́nìrɛ́	→	gèʃòròɔ́nìrɛ́	‘Gĩcũrũ saw (something)’
o + oo → oo	gèʃòrò óóréá	→	gèʃòròòréá	‘that Gĩcũrũ’
u + ɛɛ → uɛ	mátú ɛ́ɛ́tìrɛ́	→	mátúɛ́tìrɛ́	‘Matu called’
u + aa → ua	mátú áányɔ̀nírɛ̀	→	mátúányɔ̀nírɛ̀	‘Matu saw me’
u + ɔɔ → uɔ	mátú ɔ́ɔ́nìrɛ̀	→	mátúɔ́nìrɛ̀	‘Matu saw (something)’
u + oo → uo	màtù óóréá	→	màtùòréá	‘that Matu’

In the following cases, a V+V: sequence yields a different surface form from its V+V counterpart:

(36)

V_1+ V_2 quality	**Output w/ long V_2**	**Output w/ short V_2**	**Type of difference**
ɛ+i	ɛii	ɛi	mora count
a+i	aii	ai	mora count
i+u	iuu	iu	mora count
e+u	euu	eu	mora count
a+u	auu	ɔi	mora count; application of quality change
ɛ+u	ɛuu	eɔi	application of quality change

Representative examples are given below:

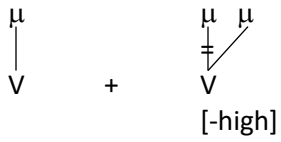
(37) **Combinations where long V_2 yields a different surface form from short V_2**

i + uu → iuu	tí úúbúðé	→	tíúúbúðé	‘those are not dregs’
	tí úúmèrò	→	tíúú¦mérò	‘this is not an exit’
e + ii → eii	né ííjì	→	néííjì	‘this is an inch’
	né ííjìní	→	néííjìní	‘this is an engine’
e + uu → euu	né úúbùðè	→	néúúbùðè	‘those are dregs’
ɛ + ii → ɛii	ɔ́ɔ́nìrɛ́ ííjìní	→	ɔ̀ɔ̀nìrɛ́ííjìní	‘s/he saw an engine’
ɛ + uu → ɛuu	ɔ́ɔ́nɛ̀ɛ̀tɛ́ úúgùmáníá	→	ɔ́ɔ́nɛ̀tɛ́úúgùmáníá	‘he saw corruption’
a + ii → aii	dɔ̀ɔ̀ná ííjìnì	→	dɔ̀ɔ̀náííjìnì	‘I saw an engine’
	ná ¦ííjìnì	→	ná¦ííjìnì	‘... and an engine’
a + uu → auu	ná úúbùðè	→	náùùbùðè	‘... and dregs’
	nà ùùðí	→	nàùùðí	‘... and thread’

All *ii*-initial words we have found are borrowed, and the long *ii* may derive from pre-nasal lengthening. This probably does not account for the failure of shortening, however, since, as we will show below, high vowels also do not undergo shortening in V_1 position, as non-high vowels do. Also, the long *uu* in words like *ùùðí* results from combining the cl. 14 prefix *u-* with an *u*-initial stem and still does not shorten (cf. forms in (35) with initial non-high long vowels containing the cl. 14 prefix that do shorten, such as *ooke* ‘honey’).

The failure of *ii* and *uu* to shorten shows that the shortening rule applies only to [-high] vowels:

(38)



A separate rule accounts for *i* + *ii* → *ii*. In general, all sequences of V+V: where the quality of the vowels is identical surface as V:, but in the case of non-high vowels, it is not clear whether that rule or the one in (38) is responsible for shortening.

An important fact to note is that while V length can be difficult to distinguish auditorially, it is clearly the V+V: context and not simply the fast-speech context that induces shortening in word-initial long vowels, since the vowels still surface as long in isolation when elicited in fast speech:

(39) **Words with initial long vowels pronounced in isolation in fast speech**

ííjí	'inch'	*iji
ééréá	'those (cl. 4)'	*erea
éétìrέ	'he called'	*ɛtirɛ
áányɔ̀nírɛ̀	'he saw me'	*anyɔnirɛ
ɔ̀ɔ̀tí	'baskers'	*ɔti
òòké	'honey'	*oke
úúbúðé	'dregs'	*ubuðe

The forms in (40) with *ɛuu*, *auu* combinations show that diphthongization to *ɔi* applies only to short *u*, not to long *uu* (these forms cannot surface with **eɔi*, **ɔi*):

(40)	ɔ́ɔ́nɛ̀ɛ̀tɛ́ úúgùmáníá	→	ɔ́ɔ́nɛ̀tɛ́úúgùmáníá *ɔɔnɛteɔigumania	'he saw corruption'
	ná úúbùðɛ̀	→	náùùbùðɛ̀ *nɔibuðe	'... and dregs'

V:+V combinations show significantly different behavior from V+V and V+V: combinations. Below are combinations with a long V_1 (Armstrong does not comment on these combinations, so no comparison is possible):

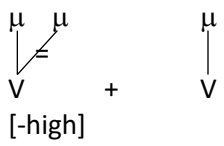
(41) **Long V_1 + Short V_2**

V_1↓ V_2→	i	e	ɛ	a	ɔ	o	u
ii	ii	iie	iiɛ	iia	iiɔ	iio	iiu
ee	ei	ee	eɛ	ea	eɔ	eo	eu
ɛɛ	ɛi	ɛɛ	ɛɛ	ɛa	eɔ	eo	ɛu
aa	ai	aɛɛ	aɛɛ	aa	aɔɔ	aɔɔ	?[3]
ɔɔ	ɔi	oɛ	oɛ	ɔa	ɔɔ	ɔɔ	ɔu
oo[4]	?	?	?	?	?	?	?
uu	uui	uue	uuɛ	uua	uuɔ	uuo	uu

Since shortening applies to non-high vowels before any vowel, we propose the rule below (the mirror image of (38)):

[3] The *aa*-final nouns we have identified (*báá* 'dew' and *dàà* 'louse') exceptionally resist shortening before *u*, for reasons we have not established. Due to the otherwise general shortening pattern and the small number of lexical items involved, we suspect this cell should be filled with *au* but do not have examples to confirm this.

[4] Our one *oo*-final noun, *móó* '*M. hildebrandtii* tree', does not undergo shortening in any context. We hypothesize that there is something exceptional about this noun, and that if we are able to identify other nouns with final *oo*, they will undergo shortening.

(42) 

Below is a summary of differences in VHR outcomes when V_1 is long vs. short:

(43)

V_1+ V_2 quality	**Output w/ long V_1**	**Output w/ short V_1**	**Type of difference**
i+V	iiV (except ii)	iV	mora count
u+V	uuV (except uu)	uV	mora count
ɛ+a	ɛa	ea	application of quality change
ɛ+u	ɛu	eɔi	mora count; application of quality change
a+e, a+ɛ	aɛɛ	ɛɛ	mora count; application of quality change
a+o, a+ɔ	aɔɔ	ɔɔ	mora count; application of quality change
a+u	a(a?)u (see above)	ɔi	mora count (?); application of quality change
ɔ+u	ɔu	ɔi	mora count; application of quality change

Some of these differences can be attributed to the shortening rule in (42) applying late in the derivation, counterfeeding some of the quality changes described and analyzed in §§2-3 if we analyze those rules as applying only to short vowels. For example, ordering the *ɛa* → *ea* raising rule before (42) explains the failure of raising in (44):

(44) ɛɛ + a → ɛa

mòðéè áyá	→	mòðéàyá	‘these Mũthees’
mòðéè áɣérà	→	mòðéˡáɣérà	‘Mũthee, be nice!’

The mirror image shortening rule in (38), in contrast, feeds most of the quality changes, as in the following examples where the shortened V is the trigger (45a) or the target (45b):

(45)

a.	ɛ + aa → ea	jɔ̀rɔ̀gɛ́ áányɔ̀nírɛ̀	→	jɔ̀rɔ̀gɛ́ányɔ̀nírɛ̀	‘Njoroge saw me’
	ɔ + ɛɛ → oɛ	gèkɔ̀nyɔ́ ɛ́ɛ́tìrɛ́	→	gèkɔ̀nyóétìrɛ́	‘Gĩkonyo called’
b.	ɛ + ee → ɛɛ	ŋɔ̀ɔ̀bɛ̀ èèréá	→	ŋɔ̀ɔ̀bɛ̀èréá	‘that cow’
	ɔ + oo → ɔɔ	gèkɔ̀nyɔ́ òòréá	→	gèkɔ̀nyɔ́ɔ́réá	‘that Gĩkonyo’
	ɔ + ee → oɛ	mèhèèdɔ̀ èèréá	→	mèhèèdòèréá	‘those ropes’

The relative ordering of the two shortening rules also allows us to make sense of some unexpected surface forms when *aa* is followed by a mid V, shown below:

(46)

aa + e → aɛɛ	dàà étékà	→	dàɛ́ɛ́tèkà *daeteka, *dɛɛteka, *daɛteka	‘louse, answer!’
	báà étékà	→	báˡɛ́ɛ́tèkà *baeteka, *bɛɛteka, *baɛteka	‘dew, answer!’
aa + ɛ → aɛɛ	báà ɛ́hɛ́rà	→	báɛ̀ɛ̀hɛ́rà *baɛhɛra, *bɛɛhɛra	‘dew, stand aside!’
aa + ɔ → aɔɔ	báà ɔ́hà	→	báˡɔ́ɔ́hà *baɔha, *bɔɔha	‘dew, tie!’
aa + o → aɔɔ	báà ókà	→	báˡɔ́ɔ́kà *baoka, *bɔɔka, *baɔka	‘dew, come!’

Recall that the corresponding sequences behave as follows when both vowels are short (47a) and when V_2 is long (47b):

(47) a. a+e → ɛɛ
a+ɛ → ɛɛ
a+ɔ → ɔɔ
a+o → ɔɔ

b. a+ee → ɛɛ
a+ɛɛ → ɛɛ
a+ɔɔ → ɔɔ
a+oo → ɔɔ

Our explanation for this difference is that in aa+V, the second half of the long *aa* interacts with the following mid V, fusing into *ɛɛ* or *ɔɔ* while the initial mora of the *aa* remains associated to the features of *a*. The resulting a+V: sequence does not undergo the rule that normally shortens non-high long vowels after another V because that rule already applied earlier in the derivation, as shown below:

(48) **Derivation of /baa oka/→ baɔɔka**

Underlying form	baa oka
Shortening of V+VV	N/A
a+o → ɔɔ	baɔɔka
Shortening of VV+V	N/A
Surface form	baɔɔka

We can identify which of the VHR rules apply before vs. after V:+V→VV based on the quality changes that do vs. do not apply in V:+V sequences. The following rules affecting V_1 do apply to V:+V sequences, suggesting that they should be ordered after the rule that shortens V: before a short vowel:[5]

(49) a. ɛ+ɔ → eɔ mòðéè ɔ́hà → mòðéˡɔ́hà ‘Mũthee, tie!’
b. ɛ+o → eo mòðéè óyó → mòðéòyó ‘this Mũthee’
mòðéè ókà → mòðéˡókà ‘Mũthee, come!’
c. ɔ+e → oɛ kàŋɔ́ɔ̀ étékà → kàŋóˡétékà ‘Kang’oo, answer!’
d. ɔ+ɛ → oɛ kàŋɔ́ɔ̀ étɛ̀réràà → kàŋóˡétéréràà ‘Kang’oo, wait!’

A final discrepancy between V:+V and V+V that needs to be accounted for is that we do not find examples of *u*-diphthongization following a long *ɛɛ*, *aa*, or *ɔɔ* (even if the long vowel is later shortened):

(50) ɛɛ + u → ɛu mòðéè úɣà → mòðéˡúɣà ‘Mũthee, say (something)!’
*moðɛɔiɣa, *moðɛɔiɣa
aa + u → aau báà úɣà → bááˡúɣà ‘dew, say something!’[6]
*baɔiɣa, *baaɔiɣa
ɔɔ + u → ɔu kàŋɔ́ɔ̀ úɣà → kàŋɔ́ˡúɣà ‘Kang’oo, say something!’
*kaŋɔiɣa, *kaŋɔɔiɣa

This suggests that the diphthongization rule is triggered specifically by a preceding *short* V, and that diphthongization must apply prior to the rule that shortens a long V before another V.

One last type of combinations to consider is V:+V:. These are difficult to elicit due to the scarcity of long vowels both initially and finally. The combinations we have found are consistent with our observations about other combinations involving long vowels, including that non-high vowels undergo shortening when they precede or follow a V, but high vowels do not:

(51) ii + ɛɛ → iiɛ kèfîì ɛ́ɛ́tìré → kèfííˡétìré ‘fog called’
ii + aa → iia kèfîì áányɔ̀níré → kèfííˡányɔ̀níré ‘fog saw me’

[5] Other rules also apply as seen in the table, but in cases where the rule only affects V_2, we do not have to assume any particular ordering with the rule that shortens V_1, unless the rule is specified as only being *triggered* by a short V.
[6] See fn. 3 regarding the failure of *aa* to undergo shortening.

ii + ɔɔ → iiɔ	kèfîì ɔ́ɔ́nìrɛ́	→	kèfíí^{l}ɔ́nìrɛ́	'fog saw (something)'
uu + ɛɛ → uuɛ	wààbúù ɛ́ɛ́tìrɛ́	→	wààbúú^{l}ɛ́tìrɛ́	'Wambuu called'
uu + aa → uua	wààbúù áányɔ̀nírɛ̀	→	wààbúú^{l}ányɔ̀nírɛ̀	'Wambuu saw me'
uu + ɔɔ → uuɔ	wààbúù ɔ́ɔ́nìrɛ̀	→	wààbúú^{l}ɔ́nìrɛ̀	'Wambuu saw (something)'
uu + oo → uuo	wààbúù óóréá	→	wààbúúòréá	'that Wambuu'

The one combination we have found involving long *aa* with another V: is consistent with our analysis of the aa+V examples above:

(52)	aa + ee → aɛɛ	báà ééréá	→	báɛ̀réá	'that dew'
		dàà ééréá	→	dáɛ̀réá	'that louse'

The derivation of aa + ee → aɛɛ is explained as follows:

(53) **Derivation of /baa eerea/→ baɛɛrea**

Underlying form	baa eerea
Shortening of V+VV	baaerea
a+e → ɛɛ	baɛɛrea
Shortening of VV+V	N/A
Surface form	baɛɛrea

We have elicited two combinations of identical V:+V:, and in both cases the surface form is V: (a single long V that does not sound 'over-long'):

(54)	ɛɛ + ɛɛ → ɛɛ	mòðɛ́ɛ̀ ɛ́ɛ́tìrɛ́	→	mòðɛ́^{l}ɛ́tìrɛ́	'Mũthee called'
	oo + oo → oo	mòò óóréá	→	móòréá	'that *M. hildebrandtii* tree'

This is as expected since we have rules that shorten a long V both before and after another V, so V:+V: first changes to V:+V and then to V+V (and then fuses into a single long vowel).

The only other V:+V: combinations we have found involve *ɛɛ* followed by another long V:

(55)	a.	ɛɛ + aa → ɛa	mòðɛ́ɛ̀ áányɔ̀nírɛ̀	→	mòðɛ́^{l}ányɔ̀nírɛ̀	'Mũthee saw me'
	b.	ɛɛ + ɔɔ → eɔ	mòðɛ́ɛ̀ ɔ́ɔ́nìrɛ̀	→	mòðɛ́^{l}ɔ́nìrɛ̀	'Mũthee saw (something)'
	c.	ɛɛ + oo → eo	mòðɛ́ɛ̀ óóréá	→	mòðéòréá	'that Mũthee'

(55b) and (55c) are consistent with the surface forms of all other types of combinations (V+V, V+V:, V:+V). (55a) behaves like *ɛɛ+a* in failing to undergo the raising (*ɛ+a* → *ea*) that applies when *ɛ* is underlyingly short (*ɛ+a*, *ɛ+aa*). This follows from our earlier claim that the raising rule targets only short *ɛ* and applies before the rule that shortens a long V_1.

5. Conclusion

In this paper we have attempted a comprehensive analysis of VHR effects in Kikuyu. A number of outstanding issues remain for future research.

First, we have not distinguished diphthongs from V sequences that cross a syllable boundary. We perceive that some VV sequences sound shorter than others (e.g., *ei* sounds short), suggesting they may be tautosyllabic while others are in separate syllables, but this is hard to distinguish and we have not identified a diagnostic for syllable membership.

Relatedly, we have not addressed the relationship of tone to VHR. Our transcriptions reflect some tone differences between slow and fast speech, but we have not made any claims about underlying tones. Clements & Ford (1978: 317-

318) show how a rule of tonal absorption can distinguish between lexical items ending in a diphthong vs. heterosyllabic V.V sequences when they have a final LH tone pattern, but we have not yet been able to adapt this or any other tonal diagnostic for use in derived VV sequences originating across a word or morpheme boundary.

One interesting aspect of our findings is that the failure of long high vowels to undergo shortening suggests that VHR in general is not motivated by a pressure to produce optimal diphthongs. In theory, a high V (like any peripheral vowel) is an ideal start or end point for a diphthong since the accurate perception of a diphthong relies on there being sufficient distance between the two portions of the V, so it is perhaps unexpected that high vowels fail to shorten in order to form diphthongs when combined with other vowels.

Another matter of theoretical interest concerns the difference in outputs comparing V:+V sequences with V+V. In an OT account, the change of *ɛa* to *ea* cannot be straightforwardly driven by a markedness constraint **ɛa* since [ɛa] is the correct output for *ɛɛ+a*. There would need to be a faithfulness constraint that preferentially protects the quality features of *ɛɛ* over those of *ɛ*. The analytical challenge is that this preferential faithfulness is not manifested across the board but only relative to certain VHR rules (e.g., *ɛɛ* does raise to *e* when it precedes *o* or *ɔ*). It is partly for this reason that we have opted for an analysis in terms of ordered rules.

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