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VOWEL HARMONY IN KLAO: LINEAR AND NONLINEAR ANALYSES*

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Klao, a Kru language spoken in Liberia, has a nine-vowel system. Like most other Kru languages, it displays harmony sensitive to pharyngeal constriction (tongue-root retraction). What gives the Klao vowel-harmony system special interest is the fact that a great deal of variation occurs, suggesting that vowel harmony is in some way optional. This provides a counter-example to the claim (made in Clements [1977]) that root-controlled vowel harmony is always obligatory. Given this optionality, the question arises as to which model best captures the facts of Klao vowel harmony. Two frameworks are considered: one, along the lines of Anderson [1980], treats vowel harmony as one more assimilation rule, and the other, following the model found in Clements [1981], handles vowel harmony autosegmentally.

1. Introduction

The insights that autosegmental phonology has brought to the study of tone suggest that other phonological phenomena as well are best characterized autosegmentally. Vowel harmony is one such phenomenon, and several autosegmental accounts of it have appeared in the past few years. The leading proponent of the autosegmental treatment of vowel harmony in African languages has been Clements [1977, 1980, 1981]. His 1981 article on Akan presents a highly constrained model with which he accounts for vowel harmony in the Asante dialect of that language.

The question to be taken up in the present article is how best to account for the facts of vowel harmony and other vowel-assimilation processes in Klao, a Kru language spoken in Liberia. First, a linear analysis will be presented. It will be consistent with the conclusions drawn in Anderson

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[1980]: that is, that vowel harmony is most aptly characterized as being one kind of vowel-assimilation rule and, consequently, most appropriately accounted for by one's treating it like other vowel-assimilation rules. In the course of the linear analysis, evidence will be introduced for the claim that Klao's vowel system is undergoing a restructuring. Then, once the linear analysis has been presented, a nonlinear analysis along the lines of Clements [1981] will be undertaken.

Kru languages are spoken in Liberia, the Ivory Coast, and Upper Volta. Greenberg [1963] placed them within the Kwa branch of Niger-Congo but acknowledged that the assignment was "tentative". Subsequent analyses—Vogler [1974], Bennett and Sterk [1977], and Welmers [1977]—have concluded independently that the Kru languages ought to be separated from Kwa in any classificatory scheme but do not agree as to the proper place within Niger-Congo for these languages.

Within Kru, Klao is a western Kru language (according to Marchese's [1979] division).[1] Like many other "languages" in the Kru group, Klao is more accurately considered as a dialect continuum. The present work concentrates on Talo Klao, the variety spoken in Nifu, Sasstown Territory, Liberia.

Klao has nine oral vowels and seven nasal vowels:[2]

	Front	Back	Front	Back
High	i	u	ĩ	ũ
Mid	e,ɪ	o,ʊ	ẽ	õ
Low	ɛ	a,ɔ	ɛ̃	ã,ɔ̃

The vowels /ɪ/, /ʊ/, /ɔ/, and /a/ (and their nasal counterparts) are [-EXPanded]. This feature was proposed by Lindau [1975] as a refinement

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[1]Most of the literature on Klao, e.g. Elimelech [1974] and Lightfoot [1974], refers to the language as "Kru"; more recently, "Kru" has been reserved for the language group, and "Klao" has been used to specify the language in question.

[2]The vowel symbols employed here are those used in Ivorian publications on Kru languages. /ɪ/ and /ʊ/ in Klao are, phonetically, not as high as their [-EXP] counterparts in several other Kru languages.

of [Advanced Tongue Root (ATR)] and is consistent with her findings that pharyngeal constriction is a better correlate of the difference between, for example, vowels like Klao's /e/ and /ɪ/ than is tongue-root retraction. ([+EXP] corresponds to [+ATR].)

1.1. Verb suffixes. A number of assimilation rules operate on the Klao vowels. The language has many verb suffixes of the shape (l)V, and they provide the usual site for the operation of these rules. Specifically, the suffixes are the following:[3]

/e/	Passive, Benefactive, Lexical Causative, Contrary-to-Fact, Past Incompletive, Recent
/o/	Conditional, Remote, Locative
/a/	Subordinating
/le/	Dative, Reciprocal, Locative
/la/	Locative

There are no suffixes of the form /lo/ .

Other verb suffixes include the following:

/ma/	Conditional
/ka/	Non-Present
/aka/	Yesterday
/kã/	Tomorrow
/oma/	Day Before Yesterday
/lama/	Day After Tomorrow
/wa/	Anterior, Interrogative
/ke/	Negative Perfective

Finally, object pronouns behave phonologically as part of the verb. They are the following:

	Sg	Pl
1	mú	ãmù
2	mù	ãmú
3	ɔ̃, ɛ̃	Ĩ

(Generally, ɔ̃ refers to animate beings, and ɛ̃ to inanimate objects.

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[3]The behavior of these suffixes with regard to tone requires further investigation and will not be discussed here. However, a general statement can be made with regard to these suffixes that those which are identical segmentally tend to have identical tonal behavior as well. Thus, tone does not, for the most part, serve to distinguish and disambiguate these suffixes from one another.

The functions of the suffixes and object pronouns are treated in Singler [1979a, 1979b].)

So pervasive are the assimilation rules that positing suffixal vowels to be /e/ and /o/ is a somewhat tenuous claim. (Singler [1979a] gives the arguments for this claim.) In the nonlinear analysis presented subsequently, these and all vowels are specified only for the features [BACK], [ROUND], and [LO].

2. Linear Analysis

2.1. Nasality-assimilation and [HI]-assimilation. All of the assimilation rules to be discussed are alike in that they are progressive (rather than regressive) and operate iteratively.

There is a rule of nasality-assimilation whose domain of operation is all sonorants.

(1) Nasality-Assimilation

$$\begin{bmatrix} +\text{SON} \\ <[+\text{CONS}]> \end{bmatrix} \rightarrow \begin{bmatrix} +\text{NAS} \\ <[-\text{CONS}]> \end{bmatrix} / [+\text{NAS}]\_\_\_\_$$

Examples:	/nū-a	-wa/	/ pī	-le -la/	
	do-SUBORD	-ANT[4]	cook-DAT-LOC		
	'had done'		'cook here'		
	nũ-a	-wa	pĩ	-ne -la	(1)
	nũ-ã	-wa	pĩ	-nẽ -la	(1)
	nũ-ã	-w̃a	pĩ	-nẽ -na	(1)
	nũ-ã	-w̃ã	pĩ	-nẽ -nã	(1)
	[nũ$\tilde{a}$w̃$\tilde{a}$]		[pĩnĩnã]		

(/pī-le-la/ undergoes Rule (2), discussed directly, as well.)

Also, [HI]-Assimilation operates upon $[^{-LO}_{+EXP}]$ vowels (/i, e, u, o /) in the following way:

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[4]The following abbreviations are used:

ANT	Anterior	PSV	Passive
COP	Copula	REC	Recent
DAT	Dative	RECIP	Reciprocal
LOC	Locative	REM	Remote
NOM	Nominalizer	SUBORD	Subordinating

(2) [HI]-Assimilation

$$\begin{bmatrix} +\text{SYL} \\ -\text{LO} \\ +\text{EXP} \end{bmatrix} \longrightarrow [+\text{HI}] \;/\; \begin{bmatrix} +\text{SYL} \\ +\text{HI} \end{bmatrix} ([-\text{SYL}])\_\_\_\_$$

Examples:	/dɪ̄ -o/	/dɪ̄ -le -a -la/
	eat-REM	eat-DAT-SUBORD-LOC
	'ate long ago'	'eat here'
	di -u	di -li -a -la (2)
	[dɪ̄ú]	[dɪ̄lɪ̄ālā]

2.2. Vowel harmony. Almost all Kru languages display vowel harmony. Clements [1974:281] notes

> ...the role of tongue root advancing in the so-called 'horizontal' vowel harmony systems found widely in Africa and elsewhere. In such systems, vowels are classified into two sets (with possible overlap) such that only members of a single set may cooccur within the domain of harmony; the primary phonetic characteristic distinguishing the two sets...is the position of the tongue root.

(As noted above, the findings of Lindau's research show pharyngeal constriction to be a better correlate than retraction of the tongue root.)

Thus, in Klao, vowel harmony refers to the feature [EXP]. With regard to it, Klao vowels can be divided into three categories:

A	B	C
$\begin{bmatrix} -\text{LO} \\ +\text{EXP} \end{bmatrix}$	$\begin{bmatrix} -\text{LO} \\ -\text{EXP} \end{bmatrix}$	[+ LO]
i u		
e o	ɪ ʊ	
		ɛ a, ɔ

A Category A vowel must be followed by another Category A vowel (including itself) or by a Category C vowel, e.g.

(3) $A_i + A_i$: [tētḗ] 'law'
$A_i + A_j$: [ɟēpō] 'to know'
A + C: [tlūbɔ̀] 'Monrovia'

Similarly, a Category B vowel must be followed by another Category B vowel (including itself) or by a Category C vowel, e.g.

(4) $B_i + B_i$: [tɪ̀tɪ̄] 'buying' (adj.)
$B_i + B_j$: [ɟɪpō] a proper name
B + C: [bʊ̄bɔ́] 'trousers'

The Category C vowels are "opaque", a term taken from Clements [1980, 1981]. An opaque vowel "interrupts harmony domains, and may...initiate new domains subject to its control" [1981:119]. Thus, what follows a Category C vowel ordinarily agrees with it for [EXP] (or is another Category C vowel).

(5) [+ EXP]: [cɛ̄|ō] 'red'
[- EXP]: [fāǹɔ̀] 'fear'
C + C: [ɟā̀tn̄ɛ̀] 'star'

The examples that have been given thus far are all monomorphemic forms (except for [t̀ī̀t̄ī̄]) for which the harmony is expressed through the following MSC:

(6) C_0 V C_0 V
[α EXP] ↓
{[α EXP], [+ LO]}

A kindred P-rule operates on verb suffixes:

(7) Vowel Harmony ([- EXP]-Assimilation)

$$\begin{bmatrix} +\text{SYL} \\ -\text{HI} \\ -\text{LO} \end{bmatrix} \longrightarrow [-\text{EXP}] \,/ \begin{bmatrix} +\text{SYL} \\ -\text{EXP} \end{bmatrix} C_0 \_\_\_\_\_$$

Examples:	/dIā́-Ie -Ie/	/dī -Ie -a -Ie/	
	kill-DAT-LOC	eat-DAT-SUBORD-LOC	
	'kill there'	'eat there'	
	-----	di -Ii -a -Ie	(2)
	dIa -Iι -Ie	di -Ii -a -Iι	(7)
	dIa -Iι -Iι	-----	(7)
	[dIāIíIí]	[dīIīāIῑ]	

With regard to the operation of Rule (7), it is significant that ɛ is a [+ EXP] vowel. This fact places it at variance with the other low vowels (a and ɔ), both of which are [- EXP]. The consequence of this difference is clear with regard to vowel harmony: while the other low vowels are ordinarily followed by [- EXP] vowels, ɛ is ordinarily followed by a [+ EXP] vowel:

(8)	/dā´ -e/	/fɔ̄` -e/	/dɛ̄ -e/
	call-REC	breathe-REC	come from-REC
	'called recently'	'breathed recently'	'came from recently'
	[dāí]	[fɔ̄í]	[dɛ̄é]

Probably, the fact that ɛ is [+ EXP] represents a recent innovation. In most other Kru languages having vowel harmony, when ɛ is the conditioning factor, the focus vowel is always [- EXP].[5]

2.3. Variation in verb forms. The rules posited thus far—Nasality-Assimilation, HI-Assimilation, and Vowel Harmony—generate only grammatical output. However, there are forms occurring in Klao at variance with the Vowel-Harmony Rule (7) set out above.

To begin with, when the conditioning vowel is low and the focus is /e/ or /o/ , the Vowel-Harmony Rule generates the following forms:

(9) a.

/ɟā´ -o/	/dɛ̄ -o/
climb-REM	'came from long ago'
'climbed long ago'	[dɛ̄ó]
[ɟāó]	
	/fɔ̄` -e/
/dɛ̄ -e/	'breathed recently'
come from-REC	[fɔ̄í]
'came from recently'	
[dɛ̄é]	/fɔ̄` -o/
	'breathed long ago'
	[fɔ̄ó]

However, the following forms also obtain:

(9) b. /ɟā´ -o/ [ɟāɔ́] and [ɟāó]
/dɛ̄ -e/ [dɛ̄ɛ́]
/dɛ̄ -o/ [dɛ̄ɔ́]
/fɔ̄` -e/ [fɔ̄ɛ́]
/fɔ̄` -o/ [fɔ̄ɔ́]

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[5]Marchese [1979] identifies /ɛ/ as an [-ATR], i.e. [- EXP], vowel. Using Sapir's terminology, Innes [1966] singles out /ɪ/ and /ɷ/ as "bright" (as opposed to "muffled") vowels in Grebo. However, the fact that /ɛ/ , /ɔ/ , and /a/ are always followed by "bright" vowels or themselves can be taken as evidence that they, too, are "bright", i.e. [- EXP]. Unlike most other Kru languages, Krahn (as described by Duitsman [1978]) has [+ EXP] low vowels, /ɛ/ , /ɔ/ and /a/ .

The only case where no variation occurs is when the conditioning vowel is /a/ and the suffixal vowel is /e/ .

(9) c. /ɟā´ -e/ [ɟāí] , not [*ɟāé] or [*ɟāé]
'climbed recently'

Also, for the underlying sequence /...ɔ + ɪe.../ , surface variation occurs:

(10) /bɔ̄ - ɪe/ [bɔ̄ɪī] , [bɔ̄ɪē]
'stop there' (a command)

These variants require a weakening of the vowel-harmony system. What appears to be the case is that the restriction as to what may follow a Category C vowel (only a vowel that agrees with it as to the feature [EXP]) is no longer in effect.[6]

However, there are also variants when the conditioning vowel is a Category B vowel:

(11) /wɪʊ̄´ -ɪe -ɪe/ /nī -o/
be born-DAT-LOC COP-LOC
'be born there' 'be there'
[wɪʊ̄ɪíɪí] , [wɪʊ̄ɪéɪé] [nī̃ʊ̃́] , [nī̃ʊ̃́]

(In the second example in (11), neither variant violates vowel harmony; in the first example, however, the second variant does.)

There are, then, violations of vowel harmony and variation to be accounted for. Rather than invoking stopgap and ad-hoc devices to account for these (though they may well prove unavoidable), it is appropriate to search for the cause of the violations and the variation. Certain patterns can be seen in the problematic forms; all the forms displaying variation fall into one of the following categories:

1. /ɔ/, /ʊ/, or /ɛ/ is the conditioning factor, or
2. an unrounded [-EXP] vowel (/a/, /ɪ/) is the conditioning factor and /o/ is the focus vowel.

2.4. A restructuring of the vowel system. The disruption of vowel harmony and other facts of the language provide evidence that a restructuring of

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[6]Additionally, there are a few lexical exceptions to vowel harmony, e.g. [nā̃nū̃] 'feather' and [w̃ɛ̀nɔ̃̄] 'to smell'.

the vowel system is in progress: specifically, /ɛ/ is becoming more /e/-like, and /ɔ/ and /ɷ/ are becoming more like each other. For the vowel-harmony system to be weakened is consistent with these changes.

As noted above, that /ɛ/ is [+ EXP] (and behaves accordingly in the vowel-harmony schema) almost certainly represents an innovation. Indeed, it can be argued that this feature change represents the first step in a merger between /ɛ/ and /e/ , the resultant vowel being /e/. At the same time, ɔ and ɷ have become virtually interchangeable as the [- EXP] manifestation of the suffixal vowel /o/ . These two vowels, too, seem to be in the process of merging; here, however, since ɷ sometimes behaves like ɔ and vice versa, it is not yet possible to predict which of the two vowels will survive.

2.4.1. Evidence from word-formation rules. One piece of evidence for the restructuring of the vowel system comes from two similar word-formation rules that affect monosyllabic verb-stems.

Partial Reduplication: Klao reciprocal forms have a /-le/ suffix; additionally, if the verb stem is monosyllabic ($C_1^2V_1^2$), a copy of the first consonant and first vowel of the stem is placed before the stem:

(12) /tū -le/
hug-RECIP
'hug each other'
/tu-tū-le/
[tūtū|Īˋ]

/pl̄ō -le/
'sell each other (something)'
/po-pl̄ō-le/
[pōpl̄ō|ēˋ]

/bĪsĪ -le/
'thank each other'
/bĪsĪ-le/
[bĪsĪ|Īˋ]

There are, however, adjustments in the prefixal vowel: if the first stem vowel is /a/ , the preposed copy is /ɪ/ :

(13) /ɟl̄ā -le/
'want each other'
/ɟɪ-ɟl̄ā-le/
[ɟĪɟl̄ā|Īˋ]

/dā′ -le/
'call each other'
/dɪ-da-le/
[dĪdā|Īˋ]

Also, when the first stem vowel is /ɔ/ , either /ɔ/ or /ɷ/ may occur

as a prefixal vowel; the same is true when the first stem vowel is /ɷ/ :

(14) /kɔ̄ -le/ 'possess each other' (i.e. 'marry each other')
/kɔ̄-kɔ̄-le/ , [kɔ̄kɔ̄nɨ̄`] ,
/kɷ̄-kɔ̄-le/ [kɷ̄kɔ̄nɨ̄`]

/ɲɷ̄ -le/ 'kiss each other'
/ɲɷ-ɲɷ̄-le/, [ɲɷ̄ɲɷ̄nɨ̄`] ,
/ɲɔ-ɲɷ̄-le/ [ɲɔ̄ɲɷ̄nɨ̄`]

Finally, when the first stem vowel is /ɛ/ , the prefixal vowel is /e/ :

(15) /plɛ̄ -le/ 'tell each other' /pe-plɛ̄-le/ [pēplɛ̄lē`]

According to Innes [1966], Grebo, a language closely related to Klao, has a comparable rule for reciprocal forms. (It is not, however, limited to monosyllabic stems.) The prefix vowel is a preposed copy of the first vowel of the stem except when the latter is low. Then, it is either /ɷ/ or /ɩ/ : it is /ɷ/ when the stem vowel is /ɔ/ or when the initial stem-consonant is one of a set of bilabial and labiovelar consonants; it is /ɩ/ when the stem vowel is /ɛ/ or /a/ and the stem-initial consonant does not belong to the set of special consonants. Apart from the consonant-induced exceptions in the Grebo rule, the Klao rule differs from it in these ways:

1. when the first vowel in the stem of a Klao verb is /ɛ/ , the preposed copy is [+ EXP] rather than [- EXP].
2. when the first vowel in the stem of a Klao verb is /ɔ/ , the preposed copy can be either /ɔ/ or /ɷ/ , and
3. when the first vowel in the stem of a Klao verb is /ɷ/ , the preposed copy can be either /ɔ/ or /ɷ/ .

These differences lend further support to the notion that a restructuring of the vowel system is in progress. (It will be noticed as well that the forms that occur parallel the output of the Vowel-Harmony Rule; that is, the stem vowel of the reciprocal rule corresponds to the conditioning factor for vowel harmony, and the prefixal vowel corresponds to the focus vowel.)

Full Reduplication: Klao nominalized verbs have an -ɛ suffix; if the verb stem is monosyllabic (and is followed by no verb suffixes), it undergoes reduplication:

(16) /pɔ̄ -ɛ/ /pɪ̄ -ɛ/
put-NOM 'cooking' (n.)
'putting' (n.)
/pɪ-pɪ̄-ɛ/
/po-pɔ̄-ɛ/
[pɔ̄pwɛ̄]
[pɪ̄pɪ̄ɛ̄]

Again, there is adjustment of the vowels. When the stem vowel is /ɔ/ , either /ɔ/ or /ɑ/ may appear in the first syllable. The same is true when /ɑ/ is the stem vowel.[7]

(17) /bɔ̄ -ɛ/ /bɔ-bɔ̄-ɛ/ , [bɔ̄bwɛ̄] ,
stop-NOM /bɑ-bɔ̄-ɛ/ [bɑ̄bwɛ̄]
'cessation'

/fɑ̄-ɛ/ /fɑ-fɑ̄-ɛ/ , [fɑ̄fwɛ̄] ,
'awaiting' (n.) /fɔ-fɑ̄-ɛ/ [fɔ̄fwɛ̄]

In this case, there is no adjustment when /ɛ/ is the stem vowel.[8]

(18) /plɛ̄-ɛ/ /plɛ-plɛ̄-ɛ/ [plɛ̄plɛ̄] ,
'telling' (n.) not [*plɛ̄plɛ̄]

2.4.2. Evidence from the lexicon. Klao publications offer further evidence for the restructuring hypothesis, particularly for the merger of /ɔ/ and /ɑ/ . The most dramatic evidence comes from the names of the language and dialect under study. The Kru Literacy-Literature Program of the United Methodist Church, which is responsible for the bulk of the existing literature in Klao, spells the language and dialect names "Klaɑ"

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[7]A rounded vowel becomes w in the environment ___+ ɛ , where ɛ is the nominalizer. (Thus, it is not possible to ascertain whether /bɔ-bɑ̄-ɛ/ and /bɑ-bɑ̄-ɛ/ are also acceptable output from the word-formation rule.) Tiklo, the principal consultant for this work and the author of some pamphlets in Klao, found both <bɔ̄bɑ̄ɛ̄> and <bɑ̄bɑ̄ɛ̄> (and likewise <fɔ̄fɔ̄ɛ̄> and <fɑ̄fɔ̄ɛ̄>) to be unacceptable spellings of /bɔ̄-ɛ/ (and /fɑ̄-ɛ/). The fact that variation is *not* permitted in the second syllable of these words suggests that it is that syllable that is basic. (On the other hand, not everyone shares Tiklo's fastidiousness with regard to spelling, as the discussion in 2.4.2. reveals.)

[8]An ad hoc rule deletes a or ɛ when it is followed by the nominalizing suffix.

and "Talɷ" in some publications and "Klaɔ" and "Talɔ" in others. That the distinction between these two vowels is not simply one between dialects or even between speakers can be seen, for example, in an article that appeared in the June 2, 1978, issue of Klāɔ̀-á Tì, the Methodist newspaper. Presumably, the article, "Dɛ̄kɔ̄tì ɲɔ̄ Kɔ̄-Wa ɲnɔ̄´ Dūē?" ("Why One Wife?") has a single author. However, on each page of the three-page article is a new spelling of the word for 'marriage', kɔ̄kɷ̄ɛ̄ (p.3), kɷ̄kɔ̄ɛ̄ (p.4), and kɔ̄kɔ̄ɛ̄ (p.5).[9]

2.4.3. Acoustic phonetic evidence. When changes in the phonological system are posited, it is appropriate to look for corresponding phonetic changes (though the former could take place without the latter). In fact, acoustic phonetic data do provide evidence, albeit inconclusive evidence, that supports restructuring.

Singler [1979a] provides the details of this evidence. Sound spectrograms were made of the speech of two speakers of the Talo dialect of Klao. Table 1 shows the average values of F_1 and F_2-F_1 for front vowels for the two speakers. ("n" is the number of spectrograms made of a given vowel.)

Table 1: Formant frequencies for front vowels

	Speaker One			Speaker Two		
	F_1	F_2-F_1	n	F_1	F_2-F_1	n
[i]	325	2063	2	281	1816	5
[e]	455	1710	5	414	1487	3
[ɛ]	446	1662	6	517	1318	9
[ɪ]	560	1580	5	487	1440	7

Speaker Two shows a clear distinction between /e/ and /ɛ/. On the other hand, for Speaker One, the average values of these vowels are very close to each other, so close that any difference between them is inconsequential.

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[9] 'dūē' , in the title of the newspaper article, is apparently a misspelling of /dūɛ/ . The remaining permutation of ɔ and ɷ in the word for 'marriage' would yield kɔ̄kɷ̄ɛ̄ . Because Klāɔ̀-á Tì is mimeographed and because corrections do not always "take", it is possible to see that one of the instances of kɔ̄kɷ̄ɛ̄ on p.3 was originally kɷ̄kɔ̄ɛ̄ (the final permutation) but was altered.

Only Speaker One was tested with regard to back vowels. Table 2 shows the findings.

Table 2: Formant frequencies for back vowels

	Speaker One		
	F_1	F_2-F_1	n
[u]	313	550	2
[ɔ]	392	475	3
[ɔ]	592	391	3
[ɷ]	513	275	4
[a]	713	900	2

The more limited evidence pertaining to back vowels, while not so provocative as evidence from the same speaker with reference to front vowels, does suggest that the distance between [ɔ] and [ɷ] is sufficiently small to support the possibility of a convergence of the two vowels (Mona Lindau, personal communication).

As a final comment on the restructuring, it should be noted that, along the Liberian coast, Klao is the westernmost Kru language still using [EXP] as a distinctive feature and still displaying vowel harmony. While the Kru languages east of Klao all continue to use [EXP] and display vowel harmony, the Kru languages west of Klao—Bassa, Dewoin, and Kuwaa—all have the seven-vowel systems of their Mande and West Atlantic neighbors. It could well be that ultimately the vowel mergers will provide still another example of the convergence process that Dwyer [1975] describes as characteristic of Liberia and Sierra Leone.

2.5. The assimilation rules revised. To return to the assimilation rules, the mergers being suggested are evolving in piecemeal rather than sweeping fashion. Consequently, those rules which purport to convey the state of assimilation processes in Klao must be complex rather than simple. Nasality-Assimilation and HI-Assimilation are unaffected and remain as stated in (1) and (2), respectively.[10]

[10]There is no phonemic ẽ in Klao. The increasing appearance of [ẽ] as a surface allophone of /e/ (after /ɛ̃/, e.g. /cɛ̃-le/, 'cut with', [cɛ̃nẽ]) may alter this.

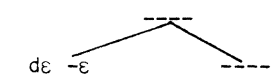
Of the needed adjustments, a rule of LO-Assimilation, operating optionally, can account for the variation when the conditioning vowel is /ɔ/ or /ɛ/ and the focus vowel, which follows immediately, is a mid vowel.

(19) LO-Assimilation (Optional)

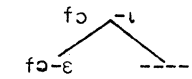
$$\begin{bmatrix} -\text{HI} \\ -\text{LO} \end{bmatrix} \longrightarrow [+\text{LO}] \; / \; \begin{bmatrix} +\text{LO} \\ \left\{ \begin{matrix} [-\text{BK}] \\ [+\text{RD}] \end{matrix} \right\} \end{bmatrix} \text{———}$$

The rule is a straightforward rule of assimilation.[11] The following provide examples of the operation (and non-operation) of it:

(20) /dɛ̄ -e/ — come from-REC — 'came from recently'



/fɔ̄ˋ -e/ — breathe-REC — 'breathed recently'



(7) (19)

An assimilation rule of this sort is by no means a necessary consequence of the proposed mergers. (Indeed, though it is much more limited in application, a similar rule, operating obligatorily, exists in Grebo even though mergers are apparently not in progress there.)

A rule that does seem to follow directly from the merger of back vowels is one which, operating optionally, permits [...ɪɔ...] and [...aɔ...] segments to be in variation with [...ɪɑ...] and [...aɑ...] segments, respectively.

(21) Back-Vowel Adjustment (Optional)

$$\begin{bmatrix} -\text{HI} \\ -\text{EXP} \\ +\text{RD} \end{bmatrix} \longrightarrow [+\text{LO}] \; / \; \begin{bmatrix} -\text{EXP} \\ -\text{RD} \end{bmatrix} + \text{———}$$

[11] Inasmuch as the language does not have front $\begin{bmatrix} -\text{EXP} \\ +\text{LO} \end{bmatrix}$ vowels or back $\begin{bmatrix} +\text{EXP} \\ +\text{LO} \end{bmatrix}$ vowels, it is assumed that a general principle of the language "corrects" the feature values for [EXP] for forms which have undergone Rule (19).

Examples:

/nɪ̄ -o/	/nā′ -o/	
COP-LOC	drink-REM	
'be there'	'drank long ago'	
nɪ̃ -õ	nã -õ	(1)
nɪ̃ -ɔ̃	nã -ɔ̃	(7)
nɪ̃-ɔ̃ ---	nã-ɔ̃ ---	(21)
[nɪ̃ɔ̃́] ~ [nɪ̃ṍ]	[nãɔ̃́] ~ [nãṍ]	

Two more cases remain to be dealt with, viz.,

1. when /a/ is the conditioning vowel in a non-nasal environment and /o/ is the focus vowel, e.g.

(22) /ɟā′-o/ [ɟāó] (as well as [ɟāṍ] and [ɟāɔ́])

2. when /o/ or /ɔ/ is the conditioning vowel in a non-nasal environment and the suffix is /ɪe/ , e.g.

(23) /bɔ̄-ɪe/ [bɔ̄ɪ̄e] (as well as [bɔ̄ɪɪ̄])

/fō-ɪe/ [fōɪ̄e] (as well as [fōɪɪ̄])

The alternatives are to add rules of disharmony to undo the work of the Vowel-Harmony Rule posited in (7) in precisely these instances or to impose conditions that make the operation of the rule optional in just these cases.

It is possible to argue that there is already a rule of disharmony, LO-Assimilation, Rule (19), and that it is appropriate to account for forms like those in (22) and (23) by adding additional rules of disharmony. The suffixal vowel (underlyingly [+ EXP]) in a form like /kɔ̃-e/ becomes [-EXP] as a consequence of the operation of vowel harmony and, subsequently, [+ EXP] by the operation of LO-Assimilation:

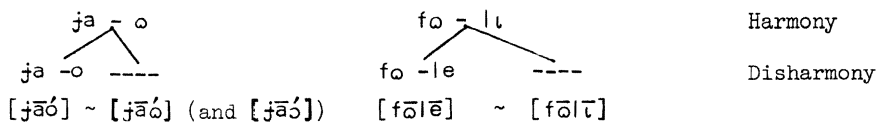
(24) /kɔ̄-e/
'possessed recently'

kɔ̃ -ẽ	(1)
kɔ̃ -ɪ̃	(7)
kɔ̃ -ɛ̃ ----	(19)
[kɔ̄ɛ́] ~ [kɔ̄ɪ́]	

In such cases, however, the variants that obtain, [kɔ̄ɛ́] and [kɔ̄ɪ́] , reflect competing assimilation processes. [- EXP]-Assimilation (vowel harmony) is "sacrificed" to LO-Assimilation in those cases where Rule (19)

applies (to /...ɛ-o.../ and /...ɔ-e.../ forms). [kɔ̃ĩ́] displays [- EXP]-Assimilation while [kɔ̃ɛ́] displays LO-Assimilation. In contrast, one cannot claim a comparable trade-off for the forms in (22) and (23). In a sequence of vowel harmony followed by vowel disharmony for these forms, there is no evidence of assimilation of the type that motivates Rule (19):

(25) /ɟā́-o/ 'climbed long ago' /fō-le/ 'be numerous there'

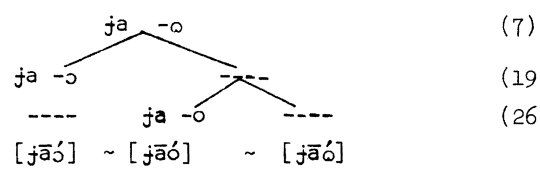


The form that rules of vowel disharmony—if posited—would take would be the following:[12]

(26) Vowel Disharmony I (Optional)

$$\begin{bmatrix} -\text{HI} \\ -\text{LO} \\ +\text{RD} \end{bmatrix} \longrightarrow [+\text{EXP}] \;/\; \begin{bmatrix} -\text{RD} \\ -\text{EXP} \\ -\text{NAS} \end{bmatrix} \_\_\_\_$$

Example: /ɟá -o/



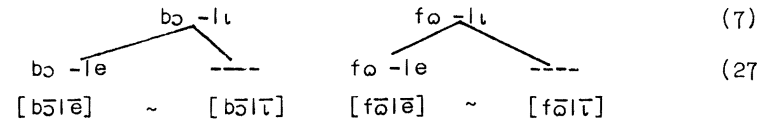
(27) Vowel Disharmony II (Optional)

$$\begin{bmatrix} -\text{HI} \\ -\text{LO} \\ -\text{RD} \end{bmatrix} \longrightarrow [+\text{EXP}] \;/\; \begin{bmatrix} +\text{RD} \\ -\text{EXP} \\ -\text{NAS} \end{bmatrix} + \begin{bmatrix} +\text{CONS} \\ +\text{SON} \end{bmatrix} \_\_\_\_$$

---

[12]A condition would have to be imposed on Rule (27) such that, in cases where iterative operation of the rule was possible, if the rule operated, it operated iteratively. Thus, the possible surface variants of /wlṓ-le-le/ 'be born there' would be [wlōlélé] (where Rule (27) had operated) and [wlōlĩ́lĩ́] (where it had not), but not [*wlōlélĩ́].

Examples: /bɔ̄ -le/ /fɷ̄ -le/



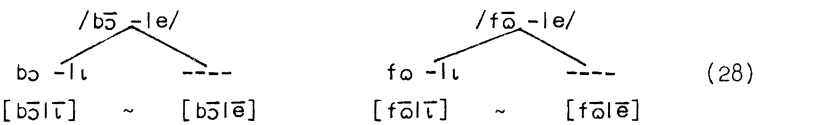
These rules would, as noted, be rules of dissimilation. The alternative to such rules is the imposition of conditions on the Vowel-Harmony Rule, (7), to make the rule optional in the cases outlined in (22) and (23). Thus, surface forms at variance with vowel harmony are accounted for by the non-operation of an existing rule (rather than by the successive operation of antithetical rules). To achieve this, the following conditions are imposed:

(28) Revised Vowel-Harmony

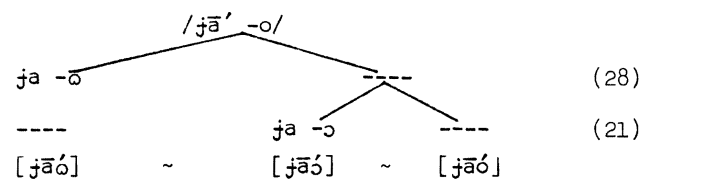
$$\begin{bmatrix} -\text{HI} \\ -\text{LO} \\ \langle[+\text{RD}]\rangle_b \end{bmatrix} \longrightarrow [-\text{EXP}] \,/\, \begin{bmatrix} -\text{EXP} \\ \langle[+\text{RD}]\rangle_a \\ \begin{pmatrix} -\text{RD} \\ -\text{NAS} \end{pmatrix}_b \end{bmatrix} \begin{pmatrix} +\text{CONS} \\ +\text{SON} \\ -\text{NAS} \end{pmatrix}_a \_\_\_$$

Condition: Optional when either set of bracketed pairs obtains.

Examples when the $\langle \ldots \rangle_a$ elements are present:



Examples when the $\langle \ldots \rangle_b$ elements are present:



Both solutions, i.e. the use of disharmony rules (26) and (27) or the revision of the Vowel-Harmony Rule (28), yield all and only actually occurring surface forms. The question that remains is which of the two solutions more perspicuously accounts for the data. The concept of vowel harmony, as it has existed not only in Kru languages but in numerous others, entails the spread of one or more features from one vowel (the conditioning vowel)

to other vowels. In the disharmony solution, the conditioning vowel triggers a change in feature values at one stage in the derivation (from [+ EXP] to [- EXP]) and then triggers the opposite change (from [- EXP] to [+ EXP]) later in the same derivation. The conditioning vowel (in a form like /ɟā'-o/) remains constant throughout the derivation; why it should trigger feature changes that are diametrically opposite to each other is not apparent. Indeed, apart from the obvious fact that it yields the actually occurring surface forms, no motivation presents itself for such a solution.

In the Revised Vowel-Harmony (RVH) solution, on the other hand, the conditioning vowel triggers, at most, a single change (in [EXP]). It does not condition a change in values at one stage in the derivation and then condition the opposite change subsequently. Rather, it either effects a feature change or it fails to. As noted earlier (section 2.4.), there is evidence of a restructuring of the Klao vowel system. The weakening of distinctions between feature values (and, therefore, between vowels) seems to be causing a concomitant weakening of the vowel-harmony system. The evidence at hand suggests that the way that this is manifesting itself is *not* by the creation of new rules in direct opposition to existing ones but rather by the erosion of the domain of the existing vowel-harmony rule. This is precisely what the RVH solution expresses. It is for that reason that the RVH solution is held to be the preferred one.

2.6. An additional vowel-harmony rule. The discussion of vowel-harmony thus far has concentrated upon changes in the suffixal vowels /e/ and /o/. There is an additional rule that acts to preserve vowel harmony, i.e. to prevent the juxtaposition of Category A and Category B vowels, but it does so with regard to -i, the third-person-plural object pronoun. The following verb-plus-pronoun combinations indicate the range of 3pl vowel-harmony:

(29)

/dɪ̄-ṯ/	[dɪ̄ṯ]	'eat them'	/kɔ̃-ṯ/	[kɔ̃ṯ]	'have them'
/ɟē'-ṯ/	[ɟēí]	'see them'	/fɷ̄-ṯ/	[fɷ̄ṯ]	'wait for them'
/ɟɪ̄-ṯ/	[ɟɪ̄ṯ]	'like them'	/dā'-ṯ/	[dṯ']	'call them'
/tṯ̀-ṯ/	[tṯ̀ṯ̄]	'buy them'			
/dū-ṯ/	[dūṯ]	'pound them'			
/pɪ̄ō-ṯ/	[pɪ̄ōṯ]	'sell them'			

(When the final vowel of the stem is /ɛ/ or /a/ and there are no verb suffixes between the stem and a vowel-initial object pronoun, the stem-final vowel is deleted. Also, when there is a sequence of the suffix /ɪe/ followed by a vowel-initial pronoun, the suffixal vowel is deleted.) As the examples in (29) indicate, the change occurs not only when the conditioning vowel is [- EXP] but also when it is /ɛ/ . This seems to be a vestige from the time when /ɛ/ was [- EXP]. It is apparently the only instance in which /ɛ/ currently triggers a feature change from [+ EXP] to [- EXP]. (At the same time, because of the deletion of stem-final /ɛ/ , the surface form does not violate vowel harmony.)

The change from /ɪ/ to [ɪ] occurs only when no verb suffix intervenes between the verb stem and the pronoun, as the following forms illustrate:

(30) /kpɔ̃ -T̄/ [kpɔ̃ɪ̃]
'borrow them'

/kpɔ̃ -ɪe -T̄/ [kpɔ̃nɪ̄] , not [*kpɔ̃nɪ̃]
borrow-LOC-them
'borrow from them'

A consequence of the non-operation of the relevant rule (proposed below) on suffixed verbs is that surface violations of vowel harmony are routine. This raises the question as to whether a verb followed by an object pronoun constitutes one word or two. If it constitutes two, then this type of vowel harmony must be posited as extending across a word-boundary, the only instance in the language where this occurs.

Evidence as to the status of object pronouns can be drawn from comparing them to possessive pronominal adjectives, specifically when both forms are vowel-initial, e.g.[13]

[13]The final ʊ of the first-person and second-person object pronouns is ordinarily realized as a voiceless vowel. Its behavior with regard to vowel harmony has not been considered.

(31)	Object Pronouns	Pronominal Adjectives
3sg (animate)	ɔ̄	ɔ̄ - á
3sg (inanimate)	ɛ̄	ɛ̄ - á
1pl	ā̀mù	à - á
2pl	ā́mú	ā - á
3pl	T̄	T̄ - á

The appropriateness of comparing the two comes from the fact that they are both vowel-initial (pronouns being the only vowel-initial forms in the language) and that they can both occur immediately after the verb, as in (32):

(32) /T̄ ɟē′ ā̀mù/ 'they saw us' /ī ɟē′ à-á ɟū′/ 'they saw our child'

Pronominal adjectives are clearly independent words; if object pronouns are, too, they should behave like pronominal adjectives.

Klao has several rules that apply to sequences of vowels. Some apply across word-boundaries, affecting, in the present context, stem-vowels, suffixes, object pronouns, and pronominal adjectives alike. On the other hand, several rules affecting vowel sequences apply to stem-vowels, suffixes, and object pronouns but not to pronominal adjectives. (Singler [1979a] lists several rules with regard to which object pronouns behave differently from pronominal adjectives; these include that paper's Rules 18, 21, 22, 24 and 25.) In every case, the object pronouns behave just like (other) verb suffixes. This division in applicability between object pronouns and verb suffixes, on the one hand, and pronominal adjectives, on the other, also extends to Nasality-Assimilation (Rule (1)) as the following forms illustrate:

(33) /kpɔ̃̄-le T̄/ 'borrow from them' [kpɔ̃̄nT̄]

/kpɔ̃̄-le ī-á dɛ̃̄′/ 'borrow from their mother' [kpɔ̃̄nī̃ yīɛ̄ dɛ̄′] , not [*kpɔ̃̄nī̃ ȳīɛ̃̄ dɛ̄′]

All of this evidence argues that object pronouns are to be separated from verbs (and other verb suffixes) by a morpheme, rather than a word, boundary, and that, consequently, the rule of 3pl vowel-harmony should have the following shape:

(34) 3pl Vowel-Harmony

$$\begin{bmatrix}+\text{SYL}\\+\text{HI}\end{bmatrix} \longrightarrow \begin{bmatrix}-\text{HI}\\-\text{EXP}\end{bmatrix} \;/\; \left[\begin{bmatrix}+\text{SYL}\\ \left\{\begin{matrix}[+\text{LO}]\\[-\text{EXP}]\end{matrix}\right\}\end{bmatrix}_{\substack{\text{VERB}\\\text{STEM}}}\right] \;\_\_\_\_$$

3. Nonlinear Analysis[14]

In discussing Schachter and Fromkin's [1968] linear analysis of Akan vowel harmony, Clements [1981:125] comments:

> ...they adopt a rule-based model of vowel harmony which accounts for vowel harmony in terms of two independent types of statements: MSC's determining cooccurrence restrictions in roots, and P-rules determining the harmonic category of affixes. Within this framework, it is entirely accidental that the same set of restrictions on vowel cooccurrence should apply internally in roots and externally across morpheme boundaries.

In contrast, Clements' account of Akan vowel harmony achieves a fundamental unity. A single mechanism, his Association Conventions (discussed below), accounts for vowel harmony in roots and affixes alike.

The linear model used above (in Section 2) for Klao has the same disadvantages that Clements points out in Schachter and Fromkin's analysis. The question that arises, then, is whether a nonlinear analysis, specifically one that makes use of Clements' autosegmental model, can more satisfactorily

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[14]Nick Clements made several helpful comments regarding an earlier version of Section 3. They have been incorporated into this version. It should be noted, though, that he has not seen this newer version and, further, that what is presented here is *my* version of how he would treat the Klao data rather than an actual analysis by him.

account for vowel harmony in Klao.[15]

3.1. Clements' model. In his nonlinear account of ATR vowel harmony in the Asante dialect of Akan, Clements [1981] shows that all one need specify is the ***P-segment(s)*** (the feature or features that have been "autosegmentalized"—in Akan, [ATR]) and the ***opaque segments,*** which he defines as "those segments which are associated with an autosegmentally-represented feature or feature matrix in underlying representation" (p. 136). (In the Akan case, the low vowel is opaque.) As cited earlier with reference to Klao, Clements' definition of an opaque vowel is that "...it interrupts harmony domains, and may...initiate new domains subject to its control" (p. 119). Clements restricts the class of possible opaque segments by saying that

> ...opaque segments are identified in terms of context-free statements which do not assign them features other than those they bear intrinsically, as a result of the usual Segment Structure Conditions. (p. 154)

A third part of the specification consists of

> ...the class of ***P-bearing units,*** that is, units which must be associated with P-segments under the provisions of the well-formedness conditions governing the class of autosegmentalized features in question...(pp. 135-36)

In the Akan case, this consists of all [+ SYL] segments; however, since only [+ SYL] segments are [+/- ATR], Clements concludes that it is unnecessary to specify the P-bearing units.

Thus, in Akan, the following statement determines vowel harmony:

(35) i. P-segments: [ATR]
ii. opaque segments: [+ SYL, + LO]

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[15]Halle and Vergnaud [1981] distinguish between directional harmony (where "the harmonic features propagate in one direction only") and dominant harmony (where "the propagation occurs in both directions"). They argue that directional harmony is best described metrically, and dominant harmony autosegmentally. Anderson [forthcoming] argues against Halle and Vergnaud's proposal and argues instead that dominant vowel harmony can be accounted for in a linear model by using mirror-image rules. Mirror-image rules would not be necessary in the Klao case, however: leftward harmony is limited to cases involving prefixes created by full or partial reduplication (as described in 2.4.1.); as such, it would be incorporated into word-formation rules.

In addition to specifying the P-segments and opaque segments in the phonological component of the grammar, one specifies roots in the lexicon as to the value each displays for the P-segments. Then, association proceeds in accordance with the following Association Conventions:

(36) i. Given a continuous string S consisting of one or more free P-segments and...[a string T consisting of one or more unassociated P-bearing units]...occurring in its domain, associate (free) P-segments in S to (free) P-bearing units in T in a one-to-one manner from left to right...;

ii. Given...[a string T consisting of one or more unassociated P-bearing units]...after the operation of (i), associate each (free) P-bearing unit in T with the P-segment in whose domain it falls (giving precedence to the P-segment associated with a P-bearing unit to the left of T) (p. 138).

3.2. The autosegmental model applied to Klao. In a nonlinear analysis of Klao vowel harmony, vowels are specified for [BACK], [ROUND], and [LO] but not for [HI] or [EXP].[16] The latter two are the P-segments. The vowels, then, are the following:

(37)

/E/ [- BK, - RD, - LO]			/O/ [+ BK, + RD, - LO]
/ɛ/ [- BK, - RD, + LO]	/a/ [+ BK, - RD, + LO]		/ɔ/ [+ BK, + RD, + LO]

The fact that a low vowel may follow any vowel (but must itself be followed by a vowel that agrees with it as to [EXP]) suggests that they are to be treated as opaque vowels. Indeed, as is required for opaque vowels, their values for [EXP] (and [HI]) are predictable from Segment Structure Conditions:[17]

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[16]It is assumed that nasality could also be handled autosegmentally. For the present, however, nasality has been specified on individual sonorants.

[17]It is assumed here that, in Clements' model, opaque vowels need not be required to display identical values for P-segments.

(38)

[+ LO]	[+ LO, - BK]	[+ LO, + BK]
↓	↓	↓
[- HI]	[+ EXP]	[- EXP]

The following specifications are to be made:

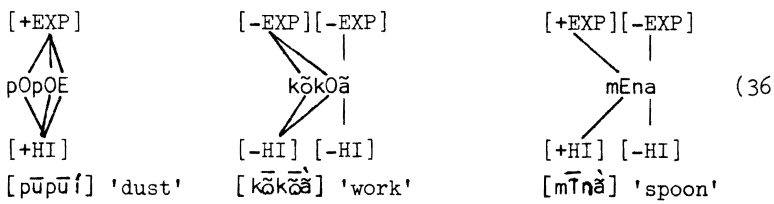
(39) P-Segments: [HI], [EXP]

Opaque Segments: [+ SYL, + LO]

Each root carries a specification on the autosegmental level for the features [HI] and [EXP]; opaque vowels are lexically specified:

(40)

[+EXP]	[-EXP][-EXP]	[+EXP][-EXP]
pOpOE	kõkÕã	mEna
[+HI]	[-HI] [-HI]	[+HI] [-HI]



(36)

[pūpūí] 'dust' [kɔ̄kɔ̄à] 'work' [mɪ̄ŋà] 'spoon'

Affixes are ordinarily unspecified for the P-segments, e.g.

(41)

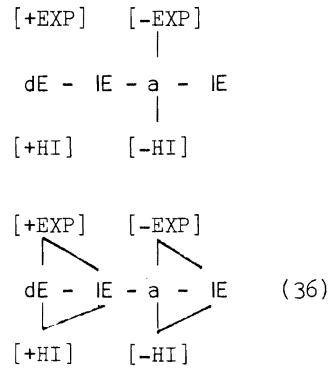
[+EXP]
dE + lE + lE
[+HI]

(36)

[dɪ̄lɪ̄lɪ̄] 'eat there'

However, opaque vowels within affixes have the same status as opaque vowels within roots; that is, they are lexically specified for the P-segments:

(42)



(36)

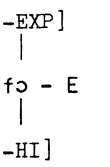
[dī līā lī] 'eat there' (the -a suffix marks subordination)

(The status of the 3pl object-pronoun vowel is taken up in 3.4.)

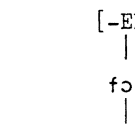
3.3. Accounting for variation. In the Revised Vowel Harmony (RVH) analysis presented above in a linear framework, vowel harmony is effected by a P-rule, the crucial cases of variation accounted for by imposing conditions on that P-rule so as to introduce optionality into its operation. In the nonlinear model, on the other hand, vowel harmony is accomplished by the operation of the Association Conventions. Because conditions parallel to those employed in the linear analysis cannot be attached to the Association Conventions, there can be no nonlinear version of the RVH solution. Rather, the variation that occurs in Klao must be accounted for by the use of optional P-rules (while the Association Conventions remain exceptionless in their application). Rules introduced within the discussion of the linear model, including, crucially, the Vowel Disharmony rules, can be adapted for use in a nonlinear analysis. They operate optionally on representations to which the Association Conventions have not yet applied. The rules in question are the rules of LO-Assimilation (19), Back-Vowel Adjustment (21), and Vowel Disharmony (26, 27). (The treatment of 3pl Vowel Harmony is taken up in 3.4.) Rules (19) and (21) alter features for

[LO], e.g.[18]

(43)



when (19) applies:



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[fɔ̃ɛ́]

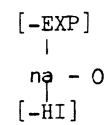
when (19) does not apply:

\----- (19)

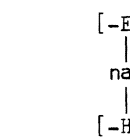
(36)

[fɔ̃í] 'breathed recently'

(44)



when (21) applies:



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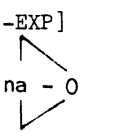
[nãɔ́]

when (21) does not apply:

\----- (21)



(36)

[nãṍ] 'drank long ago'

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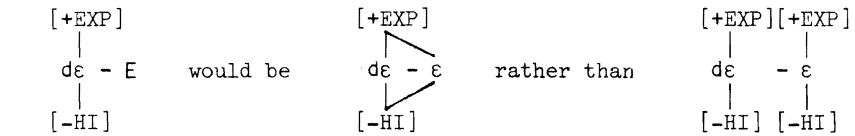
[18]It follows from the Obligatory Contour Principle (OCP) that the output of, for example, the operation of Rule (19) on

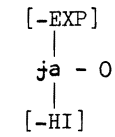
As noted in the discussion of opaque vowels, the feature values for [EXP] (and, trivially, [HI]) for low vowels is predictable; it can be assumed that a rule that creates low vowels (the opaque vowels in the Klao system) specifies the appropriate feature value for [EXP] for those vowels. Inasmuch as Rules (19) and (21) alter values for a segmental (rather than an autosegmental) feature, they are not central to the present discussion. (Moreover, all the analyses proposed here have assumed their existence.) It is the two rules of Vowel Disharmony (26 and 27) that are crucial. In a nonlinear analysis, they would operate by associating the "focus vowel" to an autosegment prior to the application of the Association Conventions, e.g.[19]



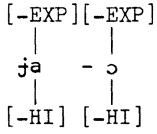
I have used the latter in (43) and subsequently for expository purposes and not as a rejection of the OCP.

[19]Rules (19) and (21) involve a change in the value of a segmental feature. P-segments provide part of the structural description of each rule even though the Association Conventions have not yet applied. This is assumed not to be a problem. Conversely, Rules (26) and (27) involve changes in P-segments (prior to the application of the Association Conventions) yet must make reference to other tiers. Again, this is assumed not to be a problem.

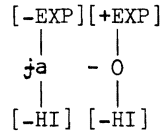
(45)



when (21) applies:



when (26) applies:



when neither (21) nor (26) applies:

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(21)

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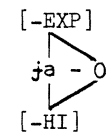
(26)



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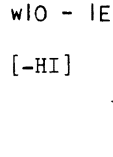
(36)

[ɟāɔ́] 'climbed long ago'

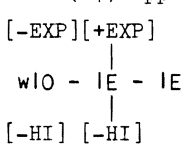
[ɟāó]

[ɟāó]

(46)



when (27) applies:



when (27) does not apply:

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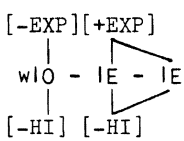
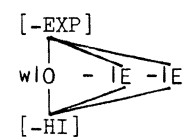
(27)





(36)

[wlɑ̄lélé] 'be born there'

[wlɑ̄lɩ́lɩ́]

The arguments as to the validity of the Vowel Disharmony solution in a non-linear model do not differ in any significant way from the arguments as to

its validity in a linear framework. They will be taken up again in Section 4.

3.4. 3pl vowel-harmony. The 3pl object-pronoun constitutes the one non-opaque vowel for which the P-segments must be lexically associated. Failure to do this yields ungrammatical forms like that in (47a):

(47) a.

[-EXP]
kpõ - lE - E
[-HI]

[-EXP]
kpõ - l - E
[-HI]

Pre-Pronominal Vowel-Deletion

[-EXP]
kpõ - l - E
[-HI]

(36)

[*kpãnĩ] 'borrow from them'

On the other hand, lexically-associating the pronominal vowel to its P-segments yields the correct forms, e.g.

(47) b.

```
[-EXP]   [+EXP]
           |
kpõ  -lE  -E
           |
[-HI]     [+HI]
```

```
[-EXP]  [+EXP]
           |
kpõ  -l   -E        Pre-Pronominal Vowel-
           |        Deletion
[-HI]   [+HI]
```

```
[-EXP]  [+EXP]
  |        |
kpõ  -l   -E        (36)
  |        |
[-HI]   [+HI]
```

[kpɔ̃nɪ̃] 'borrow from them'

At the same time, the rule of 3pl Vowel-Harmony introduced earlier (as Rule (34)) must be employed in a nonlinear analysis as well. This rule, too, precedes application of the Association Conventions. An illustration of its use is provided in (48):

(48)

```
[-EXP] [+EXP]
  |      |
 da   -  E
  |      |
[-HI]  [+HI]
```

```
[-EXP] [-EXP]
  |      |
 da   -  E       (34)
  |      |
[-HI]  [-HI]
```

```
  [-EXP]
    |
d - E            Pre-Pronominal Vowel-Deletion
    |
  [-HI]
```

[dɪ́] 'call them'

4. Conclusion

Much of the apparatus of the nonlinear model differs from that found in the linear; however, whatever advantages that apparatus may seem to possess, the basis for selecting a model must ultimately be the ability of an analysis presented within that model to account for a set of facts. Thus, in the Klao case, the choice of the linear or nonlinear model comes after choosing the Revised Vowel Harmony (RVH) or Vowel Disharmony analysis. Since the RVH analysis is not possible in the nonlinear framework, it follows that, if the RVH analysis is held to be superior in accounting for the Klao facts, the linear model is to be preferred in this case. (On the other hand, since the Vowel Disharmony analysis can be expressed in either model, showing it to be the preferred analysis makes no *a priori* statement about which model should be selected.)

In the discussion of possible competing linear analyses in 2.6., it was argued that the RVH solution does, in fact, more closely mirror the facts of Klao; that is, the consequences for Klao vowel harmony of the mergers in progress in the Klao vowel inventory (with its shrinking from nine to seven vowels) are taken to be the piecemeal erosion of the existing process (as distinctions between feature values grow more and more blurred). Moreover, the placement of conditions allowing for optionality (in precisely the environments where the erosion has taken effect) in vowel harmony is held to correlate with the facts of Klao in a way that the creation of new rules in direct opposition to the existing vowel-harmony process does not. Regardless of the model used to express the Vowel Disharmony solution, the RVH analysis prevails as the more satisfactory one.

That the RVH solution is the one argued for here (and, consequently, that the linear model is the one opted for) reflects the arguments advanced in Anderson [1980]; that is, Klao provides illustration that vowel harmony is not intrinsically different from other assimilatory processes. Rather, vowel harmony is, as Anderson argues, one more type of vowel-assimilation. Like other assimilation processes, it is best accounted for by P-rules, and, like many assimilation processes, it is subject to optional application. This latter claim—of optional application—goes against both Clements'

comment that it is a "remarkable, but generally, unnoticed fact [that]... [t]here is no known case of a (root-controlled] vowel harmony process which applied optionally [1977:112] and Anderson's [1980] suggestion that non-optionality is a necessary but not sufficient property for vowel harmony. However, the facts at hand argue that vowel harmony must—in Klao, at least—be permitted to apply optionally.

REFERENCES

Anderson, Stephen R. 1980. "Problems and perspectives in the description of vowel harmony." In Robert Vago (ed.), *Issues in Vowel Harmony*, pp. 1-48. Amsterdam: Benjamins.

Anderson, Stephen R. Forthcoming. "Differences in rule type and their structural basis." In Harry van der Hulst and Norval Smith (eds.), *The Structure of Phonological Representations (Part II)*. Dordrecht: Foris.

Bennett, Patrick R. and Jan P. Sterk. 1977. "South central Niger-Congo: a reclassification." *Studies in African Linguistics* 8:240-273.

Clements, George N. 1974. "Vowel harmony in Ewe." *Studies in African Linguistics* 5:281-301.

Clements, George N. 1977. "The autosegmental treatment of vowel harmony." In W. Dressler (ed.), *Phonologica 1976* 19:111-119.

Clements, George N. 1980. *Vowel Harmony in Nonlinear Generative Phonology*. Bloomington: Indiana University Linguistics Club.

Clements, George N. 1981. "Akan vowel harmony: A nonlinear analysis." In George N. Clements (ed.), *Harvard Studies in Phonology* 2:108-177. Bloomington: Indiana University Linguistics Club.

Duitsman, John. 1978. "The phonology of Krahn: Gbakɛsɔ̃ dialect." MS. The Institute of Liberian Languages.

Dwyer, David. 1975. "Convergence and basic vocabulary: Some interesting findings." *Working Papers in Linguistics* 2:79-108.

Elimelech, Baruch. 1974. "On the reality of underlying contour tones." *The Tone Tome: Studies on Tone from the UCLA Tone Project. UCLA Working Papers in Phonetics* 27:74-83.

Greenberg, Joseph H. 1963. *The Languages of Africa*. Indiana University Research Center in Anthropology, Folklore, and Linguistics, Publication 25. [*International Journal of American Linguistics* 29.1, Part 2.]

Halle, Morris and Jean-Roger Vergnaud. 1981. "Harmony processes." In W. Klein and W. Levelt (eds.), *Crossing the Boundaries in Linguistics*, pp. 1-23. Dordrecht: Reidel.

Innes, Gordon. 1966. ***An Introduction to Grebo.*** London: School of Oriental and African Studies.

Klaɔ̀-á Tì. 1976-1978.

Lightfoot, Nancy. 1974. "Tones on Kru monosyllables." ***Anthropological Linguistics*** 16:425-441.

Lindau, Mona. 1975. "[Features] for vowels." ***UCLA Working Papers in Phonetics*** 30.

Marchese, Lynell. 1979. ***Atlas Linguistique Kru: Essai de Typologie.*** Abidjan: Institut de Linguistique Appliquée.

Schachter, Paul and Victoria A. Fromkin. 1968. ***A Phonology of Akan: Akuapem, Asante, and Fante. UCLA Working Papers in Phonetics*** 9.

Singler, John Victor. 1979a. ***The Segmental Phonology of Verb Suffixes in Talọ Klaọ (Kru).*** Master's thesis, UCLA Department of Linguistics.

Singler, John Victor. 1979b. "Verb suffixes in Klao." ***Cahiers Ivoriens de Recherche Linguistique*** 6:9-33.

Vogler, Pierre. 1974. "Le problème linguistique kru, éléments de comparaison." ***Journal de la Société des Africanistes*** 44.2:147-176.

Welmers, William E. 1977. "The Kru languages: A progress report." In Paul F. A. Kotey and Haig der-Houssikian (ed.), ***Language and Linguistic Problems in Africa,*** pp. 353-362. Columbia, SC: Hornbeam.