

A bottom-up approach to vowel systems: the case of Yadu Qiang*

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Examining vowel harmony processes at work in Yadu Qiang reveals the smallest set of features needed to account for vowel oppositions, hence vowel structure. Arguments are evaluated for binarity/unarity of features, and the roles of marginal and disappearing contrasts. A minimal set of features that accounts for vowel processes predicts the existence of abstract vowels, which are shown to be active in the vowel system. The required binary features are Front, ATR, and Low, while Round and Rhotic are unary features. The study draws parallels with Hyman's (2003) analysis of Kalong, in which all vowel features are shown to be unary.

Key words: phonology, vowel harmony, phonological features, ATR, Qiang (Yadu).

Nous dressons la liste minimale des traits distinctifs nécessaires pour rendre compte des oppositions vocaliques en qiang yadu, à partir d'une analyse des mécanismes régissant l'harmonie vocalique. Nous discutons des arguments plaçant pour ou contre la binarité de ces traits, ainsi que de certains contrastes marginaux et en voie de disparition. Cet inventaire minimal prédit l'existence de voyelles abstraites, et nous montrons le rôle joué par celles-ci dans le système vocalique. Les traits binaires nécessaires sont [antérieur], [ATR], et [bas], tandis que les traits [arrondi] et [rhotique] sont des traits unaires. Il est aussi fait référence à l'analyse de Hyman (2003) sur le kalong, où tous les traits vocaliques sont unaires.

Mots-clés : phonologie, harmonie vocalique, traits distinctifs, ATR, qiang (yadu).

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1. INTRODUCTION

This paper attempts to answer the question – what does the vowel structure of a language look like (e.g., Yadu Qiang), if the analysis is determined solely by the active vowel processes of that language, rather than by starting with a pre-established set of features and feature geometry?

Based on such a bottom-up, or system-driven analysis of Kalong (Cameroon: Bantu A.62d (Guthrie 1967-71)), Hyman (2003) draws several implications for phonological analyses in general, and for vowel research in particular. Of particular interest to the present study are the issues of binarity/unarity of features, abstractness/underspecification, and interactions between height and ATR properties. In this paper we apply Hyman's methodology to the Yadu dialect of Northern Qiang, a language of the Qiangic branch of Tibeto-Burman, spoken in Northern Sichuan Province, China. The analysis leads to findings in four areas, namely binarity vs. unarity of vowel features, abstractness vs. underspecification of features, vowel height/ATR issues, and the role played by marginal distinctions in the system of vowel features. We briefly introduce these topics below, and then return to them after the data have been presented.

1.1. Binarity vs. Unarity of features

All of Kalong's vowel features (ATR, Front, Open, Round) are unary (or 'privative'); cf. Trubetzkoy 1969 [1939] rather than binary (equipollent), as in the *SPE* treatment of English (Chomsky & Halle 1968). Hyman's extension of the analysis to the B.40 Bantu language Punu shows that Punu's vowel features are also unary. He asks, "Might we ultimately discover another type of language which provides 'bottom-up' evidence that all of its vowel features are binary?" The present analysis shows that the Yadu Qiang vowel features are weighted toward binarity, and that the

unary feature ‘Rhotic’ is fading in importance within the system. We also provide a partial answer to Hyman’s question.

1.2. Abstractness of feature specification

The vowel processes that are observable in Kalong do not require that for each vowel, each feature is specified. In fact, because all of the vowel features in Kalong are unary, if every feature were specified, then there would be only one vowel in the system, which would be specified [ATR, Front, Open, Round], or /*ə*/, a vowel not found in the inventory of Kalong. As might be expected for a system in which vowels may be sparsely specified, Kalong has two “abstract” vowels, each of which is only specified for one feature. The present study demonstrates that, like Kalong, Yadu Qiang also has several sparsely specified vowels. An important distinction is to be drawn between abstract vowels and underspecified vowels: namely, how their empty feature specifications are supplied. This distinction is discussed in section 3.2.

Using a bottom-up, system-driven approach leads to a “natural” analysis of abstract vowels, which differ from other vowels in degree, not in type. The same processes that are observed to operate among more highly specified vowels are also at work among the sparsely specified vowels of Yadu Qiang, as in Kalong.

1.3. Vowel height implications

Kalong has one unary height feature, Open, which separates the vowels /*e*, *o*, *ɛ*, *ɔ*, *a*, *ə*/ from /*i*, *u*/. The remaining necessary height values are supplied implicationally by universal properties of the feature Advanced Tongue Root [ATR], namely *[+High, -ATR] and *[+Low, +ATR]. These height constraints of ATR have been extensively developed in research on other languages. For example, a review of more than one hundred Niger-Congo and Nilo-Saharan languages does not find systems where ATR is contrastive for low

vowels and non-contrastive for high vowels (Casali 2003); for similar findings in Italian dialects, *cf.* Calabrese (1998, 1999).

In a similar fashion to what has been observed for Kalong, the Yadu Qiang binary feature Low separates /a, ʌ/ from /i, y, e, ə, u, o/. The non-low vowels are further separated into the [+ATR] vowels /i, y, ə, u/ and the [-ATR] vowels /e, o/. Typical ATR properties predict that Low vowels will be specified [-ATR], a prediction that is confirmed by vowel harmony properties. In short, in both Kalong and Yadu, vowel height is marked directly by a non-high feature (Low/Open), and indirectly by the height constraints on ATR vowels.

1.4. Role of marginal phonemes, features

In addition to the issues raised by the properties of the vowel system of Kalong, another concern that is relevant to the present study is the effect that marginal phonemes and features can have on the entire vowel feature system. In Yadu, /y, o/ are highly constrained in their occurrences. Both are rare in the lexicon, and both are subject to strong phonotactic restrictions. Nevertheless, their phonemic status may be established unequivocally, and the system of vowel features and oppositions is made more complex by their existence. Similarly, the Rhotic feature is not common, and is becoming less common in the speech of middle aged and younger speakers, especially in some lexical items and in morphologically complex environments. As with /y, o/, the vowel feature system must accommodate a distinction whose significance is increasingly marginal.

The approach to vowel feature structure exemplified by Hyman (2003) allows for meaningful typological comparisons without having to fit the data into a preexisting theoretical framework. This paper is an attempt to discover the degree to which these methods can be applied to a language that is neither related to Kalong, nor geographically proximal to it.

2. GENERAL OUTLINE OF THE YADU VOWEL SYSTEM

Qiang is spoken by about 110,000 people in Sichuan Province, China. Yadu is a dialect of Northern Qiang which is spoken by about 23,000 people (Liu 1998:17), and is the native language of author Huang, whose speech forms the basis for this paper; his variety is spoken by the roughly 100 inhabitants of Ronghong village in Mao county in the Aba Qiang and Tibetan Autonomous Prefecture, and is mutually intelligible with the other varieties of Yadu Qiang. Phonologization and transcription follow LaPolla with Huang (2003), except for the marking of stress (*cf.* J. Sun 2003) and the transcription of medials; where the source transcribes /-u-, -i-/ , we write /-w-, -j-/ , due to vowel harmony properties that are elucidated below.

As shown in (1a), Yadu has eight plain and three retroflex vowels that occur in the surface forms of monomorphemes. With the exception of /ə/, vowels may be phonemically lengthened. Representative forms in (1b) exemplify these vowels:

(1) Yadu surface vowels in monomorphemes

a. i	y	u	b. /ɕpi/	'thirst'	/tɕy/	'take'	/pu/	'pint'
e	ə	o	/pe/	'snow'	/pə/	'buy'	/po/	'thick'
a	ɑ		/ba/	'big'			/ba/	'old'
ɿ, ɛ, ɶ			/q ^h ɿ.q ^h ɿ/	'split (v.)'	/q ^h ɛ/	'rice'	/ɤə/	'Han Chinese'

Examples of vowel harmony in Qiang varieties have been given elsewhere (H. Sun (1981:49-53), Liu (1998:67-71, 74-76), LaPolla with Huang (2003:35-36), B. Huang and Zhou (2006:48-55), Evans (2006)). However, it has not been demonstrated how vowel harmony can be used to elucidate the structure of Qiang vowel features.

It is shown below that vowel harmony in Yadu provides missing vowel feature specifications; that is, harmony allows sparsely specified vowels to be pronounced as the surface vowels in (1). Vowels whose binary features are less than fully specified occur only in bound morphemes.

The Yadu vowels /y, o/ are highly restricted in their environments, and are relatively uncommon in the lexicon. The phoneme /y/ only follows palatals, where it contrasts with /i, u/: /tɕi/ ‘house’, /tɕy/ ‘take’, /tɕu/ ‘see’. The phoneme /y/ is rare, occurring in fewer than ten words in a corpus of three thousand forms (LaPolla with Huang 2003). In Mawo (Northern Qiang) and Taoping (Southern Qiang), /y/ has a much broader distribution, as shown in Table 1:¹

Table 1. Yadu cognates of Mawo, Taoping² /y/ forms

Mawo	Taoping	Yadu	Gloss
ly	ly ³³	lu	‘come’
ts ^h y	tɕyi ⁵⁵	ts ^h u	‘drop, fall’
sy	sy ⁵⁵	su	‘learn, teach’
dy	--	ɰdzy	‘strike (iron)’
--	ɣty ³³	ɕtɕy	‘graze (v.t.)’
syt	sy ⁵⁵ .dy ³¹	su-dzu ~ su-dzy	‘day after tomorrow’
ɰy ɰy	--	ju.ju ~ jy.jy	‘divide’
--	tɕy ³³	tɕu	‘see’

After non-palatals, Mawo and Taoping /y/ corresponds to Yadu /u/ (‘come’, ‘drop’, ‘learn’). After palatals, Yadu may have /y/ (‘strike’, ‘graze’), /y ~ u/ (‘day after tomorrow’, ‘divide’), or /u/ (‘see’). Hongyan, a Northern Qiang variety included within the Mawo dialect by Sun (1981) and Liu (1998) lacks /y/ entirely

¹ J. Sun (2003) also expresses some concerns about the status of /y/ in Mawo.

² Mawo and Taoping data from *Zhongguo Shehui Kexueyuan* (1991). Mawo and Yadu are not tonal; tones in Taoping range from 1 (lowest) to 5 (highest).

(Evans 2006), as do some Southern Qiang varieties; *e.g.*, Lobuzhai (Wen & Fu 1943; Evans, Chu, & Aston n.d.).

The vowel /o/ barely contrasts with /u/ in native words: only one minimal pair has been found: /po/ 'thick', /pu/ 'pint'. When stressed, /o/ becomes /u/: /tu-'pu/ 'become thick'. In disyllables /o/ only occurs before a stressed non-front vowel: /ko. 'pu/ 'mountain', /dzɔ-'dzə/ 'armpit', /ʃo.χtʂa/ 'wipe'. Some Qiang varieties, such as Mawo, lack /o/ entirely (Liu 1998:38); *e.g.*, Mawo /pu/ 'thick', 'pint'.

2.1. Overview of Yadu vowel harmony

In this paper, we describe the structure of the vowel system of Yadu through an analysis of its vowel harmony. We set out to do this without any theoretical assumptions or commitments. The one assumption made in this paper which colors its analysis is that vowel harmony involves the spreading of at least one feature value from one vowel to another. The absence of a feature is not a "thing" that can spread. If a feature is unary, its presence can spread to a vowel that is not specified for it; for a binary feature, both positive and negative values can spread to vowels not specified for that feature. We assume the simplest structure: features are unary, unless demonstrated to be binary.

As shown below and demonstrated subsequently, Yadu has five vowel harmony processes: Front harmony, Low harmony, ATR harmony (all binary), and Round and Rhotic harmony (both unary). The last of these is marginal in the phonology of middle-aged and younger speakers.

(2) Five vowel harmony processes in Yadu

	Feature	Sample affected forms	Environment	
a.	± Front	1sg	[a ~ ɑ]	before/after ± Front vowel
b.	± Low	'one', DIR ₂	[e ~ a ~ o ~ ɑ]	before ± Low vowel
c.	± ATR	KIN	[i ~ a ~ u]	before ± ATR vowel
d.	Round	'do'	[ə ~ u]	before/after [-Front, Round]
e.	Rhotic	non-rhotic vowels		before rhotic vowel

These five processes provide the necessary and sufficient feature categories to define the surface vowels of Yadu. The feature specifications are given in Table 2, and demonstrated in the following discussion.³

Table 2. Feature-based description of the Yadu monomorphemic surface vowels

	i	y	e	a	ə	u	o	ɑ
Front	+	+	+	+	-	-	-	-
Low	-	-	-	+	-	-	-	+
ATR	+	+	-	-	+	+	-	-
Round		•				•	•	

	ĩ	ẽ	ə̃
Front	+	+	-
Low	-	-	-
ATR	+	-	+
Round			
Rhotic	•	•	•

Note that Round has the following feature co-occurrence restrictions: *[Round, +Low], *[Round, +Front, -ATR], cf. section 2.4. With regard to rounding, there is no vowel more exotic than /y/ in the system.

2.2. Front and Low harmonies

The first of these processes, Front harmony, is demonstrated by the examples in (3), in which the 1sg suffix [a ~ ɑ] agrees in frontness with the stem vowel:

³ The binary values for 'Front', 'Low' and 'ATR' are indicated by the traditional +/- in Tables 1, 6, 7 and 9 below while the unary values for 'Round' and 'Rhotic' are indicated by the symbol •. Abbreviations used in this article are as follows: ATR = advanced tongue root; DIR = directional prefix; CON = continuative aspect marker; GEN = genitive marker and PERF = perfective.

(3) Rightward Front harmony onto 1sg suffix [a ~ ɔ]

a. Verb root vowels that are underlyingly Front

p ^h i	'sow'	>	p ^h i- <u>a</u> [p ^h ja]	'I am sowing'
tɕy	'take'	>	tɕy- <u>a</u> [tɕɣa]	'I am taking'
tse	'look at'	>	tse- <u>a</u> [tsa]	'I am looking at'
ba	'big'	>	ba- <u>a</u> [ba]	'I am big'

b. Verb root vowels that are not underlyingly Front

p ^h u	'run, flee'	>	p ^h u- <u>ɔ</u> [p ^h wa]	'I am running'
tɕ ^h ə	'drink'	>	tɕ ^h ə- <u>ɔ</u> [tɕ ^h ɔ]	'I am drinking'
tɕa	'ride'	>	tɕa- <u>ɔ</u> [tsa]	'I am riding'

The forms to the right of the arrow in (3) show that the 1sg suffix, a low vowel, assimilates to the frontness of the preceding root vowel. The harmony pattern in (3) shows that /i, y, e, a/ are Front vowels in Yadu, while /u, ə, ɔ/ are not. There are no polysyllabic verbs with root vowel /o/ (see previous discussion); as mentioned above, /o/ patterns with the non-front vowels. The fact that Front harmony spreads leftward is demonstrated in (4).

The vowel in the 1sg morpheme (3) does not fully assimilate to the root vowels [i, y, e, ə, u]. We interpret this fact to mean that these vowels and [a ~ ɔ] have opposing height values, namely [±Low], a binary feature. Binariness of [Low] is seen in the fact that the low feature of [a ~ ɔ] does not spread either to or from the root vowels; that is, the lack of change in height of the affix and of the root vowels is an indication that the vowels /i, y, e, ə, u/ have one specified value for this feature, and /a, ɔ/ have a different value.

Some morphemes demonstrate both Low and Front harmonies, such as the vowel in the morpheme 'one' [e ~ a ~ o ~ ɔ]. Numbers in Qiang are bound morphemes which are only pronounced in combination with subsequent classifiers:

(4) Leftward Front and Low harmonies for ‘one’

a. Number vowel completely assimilates to classifier vowel

e-'pe	‘one bowl of’
a-'kwa	‘one place’
ɑ-'la	‘one stick-like thing’

b. Number vowel incompletely assimilates to classifier vowel

e-'pi	‘one dollar’
e-'tɕy	‘one sentence’
ɑ-'zə	‘one little bit of’
o-'tsu	‘one group of’

The vowel in the numeral ‘one’ (also found in other prefixes, such as the demonstrative marker [ts- e ~ a ~ o ~ ɑ]) is able to take on Front /e, a/ and not Front /ɑ, o/ values, as well as Low /a, ɑ/ and not Low /e, o/ values, indicating that it is not specified for these features. The exact identity of this and other “abstract” vowels is discussed in section 3.2.

2.3. ATR properties

As seen in (4), the vowels /i, y, ə, u/ have a feature value that the vowel in ‘one’ does not accept. We have not performed articulatory measurements to determine the exact nature of this feature to see if tongue root advancement is a shared physical phenomenon among these vowels. Nevertheless, from a vowel system perspective, it is evident that this set of vowels is distinguished by a shared feature value, which we provisionally term ATR. Although the vowels /i, y, ə, u/ are the highest vowels in their respective columns, impressionistic phonetic evidence does not support labeling this feature High, because /ə/ is never pronounced anything like [i], [u], etc.; in fact, listeners categorically reject a high pronunciation of this vowel. Nevertheless, the fact that the ATR vowels are the highest vowels in

their place of articulation columns is not mere coincidence; Calabrese (1998) notes that Italian dialects have “an active constraint against” the feature combination [+High, -ATR]. The appropriateness of the ATR label is further explored in section 3.3. after all of the relevant vowel harmony data have been presented.

The importance of ATR in the vowel system may be demonstrated by the set of directional prefixes. Dialects of the Qiang language have fixed classes of about six to eight directional verbal prefixes (‘DIR’, H. Sun 1981, Liu 1998, LaPolla with Huang 2003, Evans 2004), as has been described for other Qiangic languages, such as rGyalrong (Nagano 1984:28-42, Jacques 2004:358-369, J. Sun 2007). In Qiang they indicate the orientation of an action, as well as convey perfectivity or imperativity. Yadu DIR morphemes have one of two vowels: the set DIR₁ [i ~ u ~ ə] is specified [+ATR], and the set DIR₂ [e ~ a ~ o ~ ɑ] is specified [-ATR] (the same vowel that is in ‘one’ (4)). The following sets of data show that the Yadu DIR prefixes may be divided into [±ATR] sets, harmonizing both frontness and lowness (as mentioned above, /o/ does not occur on affixed verb roots):

Table 3. Leftward Low and Front harmonies of DIR morphemes

a. DIR₁ [+ATR] morphemes with vowel [i ~ u ~ ə].

‘push’	‘enclose’	‘push’	‘drive’	‘run, flee’	‘face’	‘chase’	
ti-‘tɕtɕi	ti-‘tɕʰy	ti-‘le	ti-‘wax	tu-‘pʰu	tə-lə	tə-‘dza	‘...up ward’
ni- ‘tɕtɕi	ni-‘tɕʰy	ni-‘le	ni-‘wax	nu- ‘pʰu	nə-lə	nə- ‘dza	‘...up- stream’
si-‘tɕtɕi	si-‘tɕʰy	si-‘le	si-‘wax	su- ‘pʰu	sə-lə	sə- ‘dza	‘...down- stream’
i-‘tɕtɕi	i-‘tɕʰy	i-‘le	i-‘wax	u-‘pʰu	ə-lə	ə-‘dza	‘... in’
zi-‘tɕtɕi	zi-‘tɕʰy	zi-‘le	zi-‘wax	zu- ‘pʰu	zə-lə	zə- ‘dza	‘...toward ego’

b. DIR₂ [-ATR] morphemes with vowel [e ~ a ~ o ~ ɔ]

'push'	'enclose'	'push'	'drive'	'run, flee'	'face'	'chase'	
fi- 'tɕi	fi-'tɕ ^h y	fi-'le	fi- 'waɣ	fi- 'p ^h u	'fi-a-lə	fi- 'dza	'...down -ward'
he- 'tɕi	he-'tɕ ^h y	he-'le	ha- 'waɣ	ho- 'p ^h u	'ha-lə	ha- 'dza	'...out ward'
de- 'tɕi	de-'tɕ ^h y	de-'le	da- 'waɣ	do- 'p ^h u	'da-lə	da- 'dza	'... from ego'

The two classes of prefix are semantically opposed: all of the [-ATR] prefixes have antonyms which are [+ATR] morphemes, although the reverse is not true: both 'upstream' and 'downstream' prefixes have [+ATR] vowels. The ATR distinction among DIR prefixes is not phonologically conditioned, as seen in the fact that /t, d/ both occur before both [+ATR] vowels (/stu/ 'cool', /zdu/ 'deer'; /stə/ 'soak', /zdə/ 'read') and [-ATR] vowels (/to'pu/ 'love', /do'qu/ 'trousers', /ta/, 'wear cap' /da/ 'meet').

There is one vowel that can take both [±ATR] values. It occurs in the kinship (KIN) prefix [i ~ u ~ ɔ]. Recall that /i, u/ have the feature value [+ATR], while /a/ is specified [-ATR]:

(5) Leftward ATR harmony.

- a. Kinship prefix [i ~ u ~ ɔ] with [+ATR] noun root
- | | |
|--------|--|
| i-'pi | 'uncle (father's elder brother)' |
| i-'mi | 'aunt (mother's elder sister)' |
| i-'tɕi | 'aunt (father's younger brother's wife)' |
| u-'pu | 'uncle (father's younger brother)' |
| u-'du | 'grandmother' |
- b. Kinship prefix [i ~ u ~ ɔ] with [-ATR] noun root
- | | |
|--------|----------------------------|
| a-'pa | 'grandfather' |
| a-'kwa | 'uncle (mother's brother)' |

The kinship prefix can receive the feature values [\pm Front], [\pm Low], [\pm ATR], and Round, which indicates that it carries no feature specifications of its own. The vowels /i, u, α / are the only vowels that occur on roots that take this prefix. We have observed that all of the terms which take this prefix are potential care-givers of young children, other than the parents themselves. The restriction to corner vowels and simple syllable structure may facilitate acquisition by young children.

This degree of feature abstractness is not found in KIN prefixes in other Qiang dialects. Following are kinship forms of address from Puxi and Mianchi, varieties of Southern Qiang (SQ). Both varieties have low vowels; Puxi KIN is unspecified for frontness, Mianchi (which does not distinguish /a, α /) has an invariant KIN prefix.

Table 4. Mianchi and Puxi forms of address

Mianchi (Evans 2001)	Puxi (C. Huang 2004)	Gloss
á-ià	a-'ka	'father, step-father'
á-mà	a-'ma	'mother'
à-kù	α -'ku	'mother's brother'
á-pà	α -'bu	'grandfather'

The KIN prefix is the only morpheme/vowel in Yadu that can harmonize ATR. Thus, there are no instances of ATR harmony spreading rightward.

The last form in (5) / α -'kw α / 'uncle' demonstrates the advantage of transcribing the medial labiovelar sound as /w/, rather than as /u/. Here the kinship prefix, which accepts all of the feature values of the root vowel, becomes / α /, rather than /u/, showing that the medial does not exert a harmonizing influence. This transcriptional advantage can be further seen in harmonized forms of 'one':

(6) Advantages of medial /w/ consonant analysis

a-'kwa	'one place'	*o-kua
e-'dzwe	'one section'	*o-dzue

Due to a paucity of medial /j/ forms in Ronghong Yadu, the same argumentation is not available to show that transcribed medial /-i-/ is best considered consonant /j/. However, data from the mutually intelligible variety Ekou Yadu show harmony patterns that mirror what has been observed above for /u/. Ekou /lju/ 'come' (Ronghong /lu/) shows that the [-Front, Round] properties of /u/ pass through medial /j/. Ekou DIR prefixes show the same [ATR] vowel properties as are found in Ronghong:

(7) Ekou Yadu DIR-'come' (B. Huang 1991)

- a. [+ATR] directional prefixes
- | | |
|---------|-------------------|
| tu-'lju | 'come up' |
| nu-'lju | 'come upstream' |
| su-'lju | 'come downstream' |
| ku-'lju | 'come in' |
| zu-'lju | 'come here' |
- b. [-ATR] directional prefixes
- | | |
|-----------|-------------|
| fi'o-'lju | 'come down' |
| ho-'lju | 'come out' |

The claim that ATR is a binary feature in Yadu is supported by the morpheme 'five', whose vowel is specified [-Front, -ATR], as seen in the following number-classifier combinations:

(8) [-Front, -ATR] properties of 'five'

- a. Before [-Front, +Round]
- | | |
|----------|---------------|
| ɛwo-'tsu | 'five groups' |
|----------|---------------|

b. Elsewhere

ɤwa-'pi	'five dollars'
ɤwa-'tɕy	'five sentences'
ɤwa-'pe	'five bowls of'
ɤwa-'kwa	'five places'
'ɤwa-lə	'five pots of'
ɤwa-'la	'five (stick-like things)'

The accessibility of the ATR feature is demonstrated in reduplication. In addition to identical reduplication, which is found on both verbs (/p^{hi}-p^{hi}/ 'dig', /stə-'stə/ 'soak') and nouns (/χtu-'χtu/ 'turban', /gi-'gi/ 'claw'), Yadu also has ATR reversal reduplication, in which nouns and verbs show opposite patterns:

(9) ATR shift in reduplication

a. [+ATR] – [-ATR] reduplication in verbs

/ə-ɑ/	stwə-'stwa	'shaking'
	mə-'ma	'plastering'
/i-e/	stwi-'stwe	'pulling (weeds)'
/ə-e/	dʒwə-'dʒwe	'robbing'
	lə-'le	'enclosing'

b. [-ATR] – [+ATR] reduplication in nouns

/ɑ-ə/	tɑ-'tə	'father'
/o-u/	ɤo-'ɤu (-la)	(village name)
/o-ə/	dʒo-'dʒə	'armpit'

2.4. Round harmony

Round harmony can be observed in the following compounds, in which [ə] assimilates to a previous /u/. The following set shows the harmony possibilities for the suffix /-pə/ 'to do', which is appended to polysyllabic verbs borrowed from

Chinese. Except for ‘respect’, all forms are from LaPolla with Huang (2003:36, 47). The fact that /ə/ does not become Front after /i, e, a/ shows that it has a negative specification [-Front], demonstrating the binarity of [Front].

(10) Rightward Round harmony in /-pə/ suffix

root V	compound		surface form	gloss
/u/	/kwa. 'k ^h u-pə/	>	kwa. 'k ^h u-p <u>u</u>	‘be sarcastic’
/i/	/tsun. 'tɕin-pə/	>	tsun. 'tɕin-p <u>ə</u>	‘respect’
/e/	/tə'tɕ ^h e-pə/	>	tə'tɕ ^h e-p <u>ə</u>	‘back up a car’
/a/	/ɕyn. 'njan-pə/	>	ɕyn. 'njan-p <u>ə</u>	‘train’
/ə/	/tsun. 'pəj-pə/	>	tsun. 'pəj-p <u>ə</u>	‘prepare’
/a/	/pe. 't ^h jaw-pə/	>	pe. 't ^h jaw-p <u>ə</u>	‘chat’

Round harmony also operates leftward. The following examples show leftward Round harmony in compounds (the last three examples from LaPolla with Huang 2003:35):

(11) Leftward Round harmony

p ^h ə-'lu	‘price’-‘come’	>	p ^h <u>u</u> -'lu	‘expensive’
wə-'ɕpu	‘bird’-‘flock’	>	w <u>u</u> -'ɕpu	‘(wild) pigeon’
'mə-xu	‘fire’-‘smoke’	>	'm <u>u</u> -xu	‘smoke’ ⁴
p ^h ə-'xɕu	‘forest’-‘roe deer’	>	p ^h <u>u</u> -'xɕu	‘wild animal’

Rounding harmony, like the occurrence of Round generally in Yadu, is restricted by universal tendencies. We have noted the feature value co-occurrence restrictions: *[Round, +Low], *[Round, +Front, -ATR], which is a feature notational way to say that nothing more ‘exotic’ than /y/ is found among the round vowels. This

⁴ In the source, this form is transcribed with a voiceless vowel in the second syllable. We consider vowel devoicing/loss to be a predictable effect on /u, ə/ following a stressed syllable, cf. J. Sun (2003).

conforms to observations of vowel markedness hierarchies, such as that found in Crothers (1978, especially Appendix I).

The effect of these restrictions may be seen in the harmony patterns of the 1sg suffix [a ~ ɔ], which does not become rounded in the environment of round vowels; *cf.* (3):

(12) Resistance to rounding of 1sg [a ~ ɔ]:

tɕy	'take'	>	tɕy- <u>a</u> [tɕɣa]	'I am taking'
p ^h u	'run, flee'	>	p ^h u- <u>ɔ</u> [p ^h wa]	'I am running'

There is one abstract Round vowel that surfaces as [u ~ y] in [ho'tɕu ~ ho'dɕu ~ ho'tɕy ~ ho'dɕy] 'ten'. This vowel is specified both [Round] and [+ATR], because it does not surface as [o], a [-ATR] vowel. The feature Round only spreads when the root vowel is [-Front]; /y/ does not cause rounding harmony, as evident in the following set involving the abstract vowel in 'seven' which is only specified [+ATR]:

(13) Round harmony of 'seven' only conditioned by a [-Front] vowel

a. Before [-Front] vowels

ɕtɕu-'tsu	'seven groups'
'ɕtɕə-lə	'seven pots of'
ɕtɕə-'la	'seven (stick-like things)'

b. Before [+Front] vowels

ɕtɕi-'pi	'seven dollars'
ɕtɕi-'pe	'seven bowls of'
ɕtɕi-'kwa	'seven places'
ɕtɕi-'tɕy	'seven sentences' [+Front, +ATR] *-> y

In the Mawo variety, where /y/ has a much greater distribution than it does in Yadu, /y/ causes rounding harmony, as

in /ø-dy/ ‘one mouthful’ (H. Sun 1981:51). The vowel [ø] only occurs in Mawo in the context of vowel harmony. The fact that Yadu /y/ cannot cause Round harmony further demonstrates its marginality in the vowel system. That is, not only is /y/ highly restricted syntagmatically, it also does not cause rounding of an affixed vowel.

Yadu data give no reason to propose [-Round]; there are no processes that require a negative specification for this feature. Steriade (1995) presents arguments that Round is universally privative, that languages do not specify [-Round]. Van der Hulst & van de Weijer (1995) also mention that their survey of vowel harmony has not found any [-Round] harmony systems. Some possible counterexamples are presented by Goldsmith (1985), Hyman (2002), and McCarthy (2003). As mentioned above, Hyman (2003) asks if there might be any all-binary vowel systems. If Steriade (1995) and van der Hulst & van de Weijer (1995) are right about universal unarity of Round, then any vowel system that specifies Round has at least one unary feature.

2.5. The Rhotic feature

Rhotic vowels are found across Northern Qiang varieties. In monomorphemes and reduplicates, Yadu has /ɪ̯, e, ə/: /phɪphɪ/ ‘rip (v.)’, /q^he/ ‘rice’, /gə/ ‘guard’. Other vowels may become rhotacized by the 1pl suffix /-ɔ̯/:

(14) 1pl suffix /-ɔ̯/

/i/	ɕtɕi	>	ɕtɕɪ̯	‘we push’	
/y/	tɕ ^h y	>	tɕ ^h ɪ̯	‘we enclose’	
/e/	le	>	le̯	‘we live’	
/a/	χqa	>	χqe̯	‘we carry’	a → e
/u/	p ^h u	>	p ^h ɪ̯	‘we run/flee’	
/ə/	lə	>	lə̯	‘we plough’	
/a/	dza	>	dza̯	‘we chase’	

The vowel /a/ only surfaces as [aː] after lengthening, as when prospective aspect is added to the ‘carry’ form above: /χqa-a:-/ [χqaː] ‘we will carry’. Because any vowel except the highly constrained /o/ can accept the feature Rhotic, there is no need to specify a negative value for this feature; Rhotic is unary in Yadu. Rhotacization of first person plural is a direct application of a vowel feature, rather than a process of harmony between two vowels. Rhotic harmony can nonetheless be observed in some polysyllables. However, the spread of the Rhotic feature is not even; some compounds and affixed words show rhotic harmony (15a), but many do not (15b). Rhotic harmony is only leftward:

(15) Rhotic compounds

a. With leftward harmony (LaPolla with Huang 2003:35)

kuɑ- ^h e ‘five’-‘hundred’	→	kuɑ- ^h e ‘five hundred’
me- ^h we ‘not’-‘reduce’	→	me- ^h we ‘unceasingly’

b. Without leftward harmony

zə-te-m ‘earth’-DIR-‘move’	→	zə-teːm ‘earthquake’
zuːm.meː ‘snail’	→	zuːm.meː ‘snail’

Verb prefixes show variation in the extent to which they rhotacize:

(16) DIR + Rhotic verb with optional spreading of Rhotic feature

k ^h e	‘lay (egg)’	>	fiɑ-χe	‘lay (egg)’
q ^h e	‘split’	>	fiɑ(ː)- ^h q ^h e	‘split downward’
q ^h e	‘split’	>	sə(ː)- ^h q ^h e	‘split downstream’

In most cases, the other features of the rhotacized vowel harmonize, but the r-coloring itself does not spread; the set /khe/ is representative:

(17) No spreading of Rhotic feature

k ^h e	‘to saw’	>	i-k ^h e	‘saw inwards’
k ^h e	‘to saw’	>	fi-e-k ^h e	‘saw downward’

Older speakers preserve (and spread) rhotacization more than middle-aged and younger speakers do. LaPolla with Huang (2003:28) note, “[R]-coloring is often lost in rapid speech, and it seems that it is being lost completely among the younger people, as there is variation and uncertainty about its use.” In the case of compounds where the rhotic feature spreads (15a), it is often difficult to detect Rhotic harmony in the speech of middle aged and younger speakers. Both older and middle aged speakers preserve rhotacization through vowel coalescence, whereas younger speakers do not. Both middle aged and younger speakers do not pronounce rhotacization on some lexical items where older speakers have rhotic vowels. A small survey of three generations of speakers from one family showed that a forty-two year old male patterned with the seventy year old female in preserving the rhotic feature through vowel coalescence (18a), but in lexemes he had reduced rhotacization, like the eighteen year old female (18b). The youngest speaker consistently derhotacized a suffixed rhotic vowel. All three speakers shared the reduplicated, non-suffixed forms /q^hi-‘q^hi/ ‘snip’, /qe-‘qe/ ‘peel (fruit)’:

(18) Differences in rhotacization by age.

- a. Middle-aged speaker rhotacizing like older speaker
 tə-‘q^hr-a → tə-‘q^hɑ (70 y.o., 42 y.o. speakers)
 DIR:PERF-snip-1sg
 “I snipped (clothes)” → tə-‘q^ha (18 y.o. speaker)
- b. Middle-aged speaker omitting some rhotacization
 zɛ.‘pi fia-‘qe-a → zɛ.‘pi fia-‘qɑ (70 y.o.)
 skin DIR:PERF-peel-1sg
 “I peeled (fruit)” → zɛ.‘pi fia-‘qɑ (42 y.o.)
 → zɛ.‘pi fia-‘qe-ja (18 y.o.)

The fact that the Rhotic feature does not spread rightward may be observed in the following numeral complexes involving /k^he/ 'eight':

(19) Lack of rightward spread of Rhotic feature

k ^h e-'pi	'eight dollars'
k ^h e-'tɕy	'eight sentences'
k ^h e-'pe	'eight bowls of'
k ^h e-'kwa	'eight places'
k ^h e-'tsu	'eight groups'
'k ^h e-lə	'eight pots of'
k ^h e-'la	'eight (stick-like things)'

Rhotic is a unary feature, as no processes have been observed which refer to a negative value for this feature. The examples of Rhotic processes show that it is a distinction which is fading.

2.6. Summary of observations

Given the phenomena observed above, we review the features necessary to account for them, noting that leftward (anticipatory) harmony is much more widespread than rightward (perseveratory) harmony, as has been observed by Hyman (2002):

Table 5. Summary of features required by the Yadu vowel system

Feature	Leftward harmony examples	Rightward harmony examples	Evidence of binarity
[±Front]	(4), Table 3	(3)	(10)
[±Low]	(4), Table 3	--	(3)
[±ATR]	(5)	--	Table 3, (8)
[Round]	(11), (13)	(10)	--
[Rhotic]	(14)	--	--

The evidence that has been given indicates that the features Front, Low, and ATR require binary values, but that the behavior of Round and Rhotic can be modeled with just a unary value. We may represent the surface vowels of Yadu as in Table 6 (*cf.* Table 2).

Table 6. Feature-based description of the Yadu surface vowels

	i	y	e	a	ə	u	o	ɑ
Front	+	+	+	+	-	-	-	-
Low	-	-	-	+	-	-	-	+
ATR	+	+	-	-	+	+	-	-
Round		•				•	•	
Rhotic	(•)	(•)	(•)	(•)	(•)	(•)		(•)

The following section discusses the phonological implications of the Yadu vowel system, and a comparison with what has been observed for Kalong.

3. DISCUSSION

As mentioned in §1, an analysis of vowel features in Yadu Qiang leads us to four interesting points of discussion. As in Kalong (Hyman 2003), the vowel system of Yadu raises questions related to binarity/unarity of features, abstractness of vowel specification, and vowel height/ATR concerns. In addition, marginal phonemes and features in Yadu play a role in the vowel feature system that is disproportionate to their frequency of occurrence. Each of these issues is discussed separately below.

3.1. Binarity vs. Unarity of features

Following Trubetzkoy (1969 [1939]), a distinction has been drawn between binary (or “equipollent”) and unary (“privative”) features. Unary features can be present (represented in charts by a

dot) or absent. For binary features, it must be discerned whether the possible values are +/- or +/-Ø, where Ø represents a lack of specification for a feature. Vowel harmony processes in Yadu call on two values for the features Front, Low, and ATR, confirming that they are all binary features. It has been demonstrated that vowels which undergo harmony lack at least one specification for one of these binary features (alternatively stated, they have a specification of Ø). This lack of specification for a binary feature is what sets apart abstract vowels from surface vowels in Yadu:

Table 7. Abstract vowels of Yadu

	A	I	E	O	U	R	Ø
Front				-			
Low	+						
ATR		+	-	-	+		
Round					•		
Rhotic						•	
surface forms	a ~ ɑ	i ~ u ~ ə	e ~ a ~ o ~ ɑ	o ~ ɑ	u ~ y	ɤ	i ~ ɑ ~ u
<i>e.g.:</i>	1sg	DIR ₁	DIR ₂ , 'one'	'five'	'ten'	1pl	KIN

Round and Rhotic are both demonstrated to be unary features, because vowel harmony processes only refer to one value for each of these features. Unlike what has been shown for binary features, unary features in Yadu are somewhat peripheral; *e.g.*, Round can only spread to schwa, and /y/ does not induce Round harmony. Similarly, Rhotic has been shown to be peripheral, both in terms of the small inventory of non-derived contexts in which it occurs (/r, e, ə/), and in terms of its shrinking occurrence in the speech of middle-aged and younger speakers.

It should be clear by this point that the system of vowel features in Yadu is weighted toward binarity. By way of comparison, we present the vowel features of Kalong (Hyman

2003), in which all features are unary. Abstract vowels are written with capital letters:

Table 8. Kalong vowel features (Hyman 2003)

	i	u	I	U	e	o	ɛ	ɔ	a	ə [e]
ATR	•	•			•	•				
Front	•		•		•		•			
Round		•		•		•		•		
Open					•	•	•	•	•	•

3.2. Abstract vowels

We now turn our attention to the vowels which have undergone harmony in the above examples. Following Hyman (2003), we term these “abstract” vowels, because they require the addition of feature values before they can be pronounced. Note that this use of ‘abstract’ differs from that found in discussions such as Hyman (1970, 1973), Harms (1973), and Vago (1973): these papers discuss the role of invisible phonemes – fully specified vowels that never directly surface. An example of this type of abstractness is the vowel /y/ in the Vidin dialect of Turkish; this vowel always surfaces as [u], resulting in two ‘classes’ of [u], one (< *u) which takes back vowel suffixes, and another (< *y) which takes front vowel suffixes, and which palatalizes /k, g, l/ (Vago 1973).

The sense of ‘abstract’ used in this paper and in Hyman (2003) is that certain vowels are insufficiently specified to be pronounced, and hence receive additional feature specifications syntagmatically, from adequately specified neighboring vowels. Contrary to the usage of ‘abstract’ in the previous paragraph, the abstract vowels of Yadu (Table 7) are pronounced once their missing binary feature values are provided.

An important distinction is to be drawn between abstract and underspecified vowels. By way of comparison, we consider the

underspecified vowels of Tigrinya, described according to Combinatorial Specification (Buckley 1994):

Table 9. Tigrinya vowel feature specifications

	i	e	ɨ	ʌ	a	o	u
high		–		–		–	
low					+		
back	–	–					
round						+	+

Predictable feature values are inserted by the following rules:

(20) Tigrinya vowel feature redundancy rules

- Ø → [+high]
- Ø → [-low]
- Ø → [+back]
- Ø → [-round]

Thus, a completely underspecified Tigrinya vowel paradigmatically receives all of its feature values, according to the above specifications and rules, resulting in /i/. On the other hand, an abstract vowel in Yadu (26) or Kalong (27) receives its feature values syntagmatically; a featureless vowel like the Yadu kinship prefix is identical in surface form to the vowel of its root morpheme (see example (5)).

It has been observed by one of the anonymous reviewers that ‘schwa’, from Hebrew ‘naught’ or ‘emptiness,’ is generally used to designate a featureless vowel, or, in the words of Harris & Lindsey (2000), “Schwa is informationally empty.” What, then, of a vowel (our schwa) that is without positive specification for some features – viz., [-Front], [-Low], not [Round] and not [Rhotic] – but that is also positively specified [+ATR], thus actively contributing to

vowel harmony? There are arguments that can be made (as this reviewer has) that this vowel is more properly /ə/ or /ɤ/. These arguments include the following points:

(21) Arguments against the label {ə}.

- This vowel patterns with the back vowels /u, ɑ/, suggesting a designation like /ɤ/, an unrounded back vowel that is the counterpart of /o/.
- The vowel designations /ə/, /ɤ/ have the benefit over schwa of having rounded counterparts at the same place of articulation.
- Specifying [+ATR] means that this vowel is not neutral with regard to phonological processes, which is what linguists expect of schwa.

Taking these considerations in turn, we observe first that /ə, u, o, ɑ/ share the designation of being [-Front] vowels, a category that includes both central and back vowels. Unless there is a demonstrated need for a Back category, there is no need to subdivide the [-Front] vowels. Thus far, no phonological process has been found in Yadu that requires a [+Back] specification.

Second, we consider the possible advantages of specifying this vowel as /ə/ or /ɤ/, which have the added benefit over schwa of being members of roundedness pairs. The problem with these designations is that the rounded counterpart of this Yadu vowel is not /ə/ or /o/, but rather /u/, which carries the specifications [-Front, -Low, +ATR, Round]. As mentioned above, the pronunciations [i] and [u] for this vowel have been ruled out by speaker judgments.

Third, does a [+ATR] specification mean that this vowel, which might otherwise be neutral, is too phonologically active to be considered /ə/? We do concede that this vowel is highly phonologically active; we recall that for binary features, both

positive and negative specifications carry weight. This is demonstrated throughout Yadu; *e.g.*, the vowel in 'one' is specified [-ATR], and can only surface as [e ~ a ~ o ~ ʊ]; it cannot accept positive ATR values (4). In fact, the activity of both positive and negative specifications is a clear way to identify binarity in a phonological system. That is, neither positive nor negative specifications are neutral, and the fact that the vowel in question has the specifications [-Front, -Low] means that it is already phonologically active. Is phonological activity sufficient grounds for rejecting a schwa designation for this vowel? We may answer this question in two parts, first by observing cross-linguistically that not all featureless vowels are schwa, but that phonological grammars have different ways of making featureless vowels pronounceable; schwa is one such strategy. Yadu does, in fact, have a vowel that is completely featureless, namely the vowel in the kinship prefix (5), which takes all of the features of the subsequent vowel; it does not surface as schwa. On the one hand, in Yadu, a featureless vowel accepts specifications syntagmatically before being pronounced; on the other hand, languages such as Tigrinya fill empty feature designations paradigmatically (Table 9), and featureless vowels in these languages also do not necessarily surface as [ə].

Second, we note a distinction between the use of schwa in many phonological descriptions (as represented by our reviewer's comments), and a description based on the IPA chart, in which schwa is a vowel designator that has certain coordinates on the front-back and high-low axes. Taking the IPA chart as a point of departure for labeling, there is nothing inherently wrong with treating a vowel that is [-Front, -Low] and not [Round] as schwa. To further specify its ATR status, it could be transcribed /ə/.

In addition to these justifications, there are some behaviors of this vowel that are exactly what one expects of schwa, namely its relationship to stress. The following traits are all observed:

(22) Prototypical schwa-like behaviors

- a. Under most conditions, this vowel cannot be stressed. Only if the other vowel(s) in the word is /o/, or this vowel, can it be stressed.
- b. This vowel deletes under conditions where other vowels are devoiced (nonstressed final open syllable). It also deletes under reduplication conditions where it follows a stressed syllable.
- c. Other vowels become this vowel when they are destressed.

The first behavior, that this vowel is resistant to stress, can be observed in the stress patterns of verbs with directional prefixes, as in Table 3, a portion of which is repeated below as Table 10 where we note that prefixed /ə/ 'face' has a different stress pattern than other verbs:

Table 10. Stress patterns of prefixed verbs (*cf.* Table 3)

'push'	'enclose'	'push'	'drive'	'run, flee'	'face'	'chase'	
ti-'tɕtɕi	ti-'tɕʰy	ti-'le	ti-'wax	tu-'pʰu	'tə-lə	tə-'dza	'... up- ward'
ni-'tɕtɕi	ni-'tɕʰy	ni-'le	ni-'wax	nu-'pʰu	'nə-lə	nə-'dza	'... up- stream'
si-'tɕtɕi	si-'tɕʰy	si-'le	si-'wax	su-'pʰu	'sə-lə	sə-'dza	'... down- stream'

Etc.

For these sets, stress is on the verb root, unless the root vowel is schwa, in which case stress retracts to the initial syllable. While this does result in stress on first syllable /ə/, it only receives

stress if the other vowel(s) are schwa, as in DIR-‘face’ words, or /o/, as in /dzo-dzə/ ‘armpit’. We recall that /o/ is never stressed in Yadu.

The second schwa-like behavior is that this vowel typically is not pronounced in non-stressed final position, so that the ‘face’ forms in Table 3 and Table 10 surface as [təl], [nəl], [səl], etc. Under reduplication conditions, this vowel deletes, if it follows a stressed syllable (deleted vowels underlined):

(23) Schwa deletion in reduplicated words (LaPolla with Huang 2003:35)

/nə-/	DIR	+	/lə-lə/	‘exchange’	>	[nəllə]	‘exchanged’
/tə-/	DIR	+	/tʃhə-tʃhə/	‘weigh’	>	[tətʃtʃhə]	‘weighed’

Third, this vowel is the variant that occurs as the unstressed allophone of other vowels:

(24) Schwa as unstressed variant of /a/ (LaPolla with Huang 2003:33)

a.	ʼfi-a-mə-tʃi-xtʃəpə-tə	b.	ʼfi-a-xtʃəp-nike
	DIR-NEG-CON-dark-GEN		DIR-dark-after
	‘before it got dark’		‘after it got dark’

The data in (24) suggest that Yadu has three levels of stress, as evidenced by the vowel /a/ in the first syllable of ‘dark’ in (a), the schwa in the second syllable of ‘dark’ in (a) and the first syllable of ‘dark’ in (b), and the elision of second syllable schwa in (b). A similar case of three vowel grades that vary by stress may be seen in the first vowel of ‘short’, which is underlined below:

(25) Stress and vowel grades (LaPolla with Huang 2003:33)

/tə-/	DIR	+	/wətsi/	‘short’	>	/təʼwətsi/	‘become short’
/tə-a-/	CON	+	/wətsi/	‘short’	>	/təʼawətsi/	‘still short’

The phonetic and phonological details of stress and vowel grades in Yadu are objects for further study.

Given the fact that, with regard to stress, this vowel behaves exactly like prototypical /ə/, and given that the IPA character [ə] is consistent with this vowel's height, frontness, and rounding characteristics, we consider that the most straightforward designation of this vowel is schwa. We note that schwa in Yadu may be a bleached vowel as viewed from the effects of stress, but with regard to vowel harmony it is highly active. If one does not regard this argument as sufficient to warrant keeping the designation /ə/, the slightly higher vowel /ə/ could be used to designate a 'neutral' vowel that is nevertheless specified [+ATR].

3.3. ATR and vowel height

In the above description, the binary feature ATR separates /i, y, ə, u/ from /e, a, o, ɔ/. It was also observed that each [+ATR] vowel is at the highest level for its column. As a result, we note the feature co-occurrence constraint *[+Low, +ATR]. It is thus redundant to mark [-ATR] in the feature listing for /a, ɔ/. It has also been observed that constraints like *[+Low, +ATR] or *[-High, +ATR] are common in ATR systems (Calabrese 1998, 1999; Hyman 2003; Guion, Post, & Payne 2004).

An alternative to the feature ATR, proposed by one reviewer, is to treat the series /i, y, ə, u/ as High, resulting in the following set of vowels, in which /ə/ is replaced by /i/ (note that in this system, High would be a binary feature, for the same reasons given above that showed ATR to be binary, *cf.* Table 3, (8)):

(26) Alternative vowel height analysis.

i, y	i	u	+ High, -Low
e		o	- High, -Low
a		ɔ	- High, +Low

This proposed solution has its elegance; the greatest concern is how to motivate an invariant schwa rule:

(27) Schwa rule in alternative analysis.

/i/ → [ə]

The schwa rule is necessary because speakers neither produce nor accept [i], [u], etc., as pronunciations of the mid central vowel. Another alternative analysis would be to propose two height specifications as in Clements (1991): [±Open₁], [±Open₂]. In this analysis, the rows in (26) would be labeled from top to bottom [-Open₁, -Open₂], [-Open₁, +Open₂], [+Open₁, +Open₂]. This analysis encounters the same problem as the previous alternative – an invariant schwa rule is required. While we do not propose these alternative analyses, we do acknowledge that ATR serves to indicate *relative* height in Yadu, something like [±Highest].

Another alternative to [±ATR] would be the use of a tense/lax distinction to separate /i, y, ə, u/ from /e, a, o, ɑ/. However, an analysis that labels /ə/ as tense and /e/ as lax is not in accord with typical usage. Tense/lax and ATR are articulatorily distinct, as shown by Tiede (1996).

All vowels in Yadu, including abstract vowels, have some type of height specification, either [±Low] or [±ATR]; the only counterexamples are the completely unspecified vowel in the KIN prefix, and the Rhotic feature, which does not in itself identify a full vowel. This observation aligns with the observation that a vowel must have an indication of “aperture” (van der Hulst & van de Weijer 1995, Hyman 2002). In Yadu, ATR and Low function as indications of aperture, while Rhotic, Round, and Front constitute the “color” features of the vowel system.

We now consider the fitness of the category ATR as a label for the phonological facts that have been observed. In particular,

we note that this feature is positive for the highest vowels, negative for the lowest vowels, and distinctive for the vowels in between. Thus, it is a mixed height distinction. We may compare these properties of this feature with the properties of ATR in languages where advancing of the tongue root has been established.

In the Kalenjin language (Kenya: Southern Nilotic) as described by Local & Lodge (2004) there are five pairs of vowels that are distinguished by ATR:

(28) Vowels paired by [ATR] value in Kalenjin

[+ATR]	[i, e, a, o, u]
[-ATR]	[ɪ, ɛ, ʌ, ɔ, ʊ]

Measurements show that [-ATR] vowels are acoustically lower (have higher F1) than their [+ATR] counterparts, although phonological heights of the two systems are interleaved; [-ATR] [ɪ] has lower F1 than [+ATR] [a], etc.

Degema (Nigeria: Niger-Congo) also has a ten vowel system, in which pairs of vowels are distinguished by ATR harmony (Fulop, Kari & Ladefoged 1998):

(29) Vowels paired by [ATR] value in Degema

[+ATR]	[i, e, ə, o, u]
[-ATR]	[ɪ, ɛ, ʌ, ɔ, ʊ]

In this study, perception tests showed that acoustic height (F1) was distinctive for distinguishing the mid-height ATR pairs [e, ɛ] and [o, ɔ], although F1 was not distinctive for higher and lower vowel pairs.

The Maa language (Kenya, Tanzania: Eastern Nilotic), has an ATR system which is less balanced than has been observed for Degema and Kalenjin (Guion *et al.* 2004):

(30) Vowels paired by [ATR] value in Maa

[+ATR]	[i, e, o, u]
[-ATR]	[ɪ, ɛ, ɔ, ʊ, ɑ]

As in the abovementioned studies, Degema [-ATR] vowels are acoustically lower than their [+ATR] counterparts.

The ATR distinctions that may be observed in these three languages are consistent with observations of the distinction in Yadu that has been labeled ATR thus far:

(31) Properties of “ATR” in Yadu

- The lowest vowels are [-ATR]
- The highest vowels are [+ATR]
- ATR is distinctive for vowels that are neither highest nor lowest.

Because the properties and behavior of this feature in Yadu are consistent with the behaviors of ATR in languages where it has been demonstrated to be active, and because the Yadu “ATR” behaviors cannot be adequately characterized by appealing purely to height factors, we retain ATR as the descriptor for this feature.

As a side note, we observe that the role of ATR in the vowel system of Yadu is very similar to what has been reconstructed for Proto-Nilo-Saharan, where a seven vowel system is proposed, in which ATR is only distinctive for mid vowels: *i, *e, *ɛ, *u, *o, *ɔ, *ɑ. (Guion, et al. 2004, citing Bender 1997 and Ehret 2001).

3.4. The effects of marginal distinctions

Yadu shows two kinds of marginal distinctions. The Round vowels /y, o/ are relatively uncommon, and are highly restricted in their phonotactics. Likewise, the Rhotic feature is becoming rarer with each successive generation of speakers, as observed by

LaPolla with Huang (2003:28) and as verified in our small sample. Nevertheless, the system of vowel contrasts must account for these aspects of native phonology, and the presence of each of these distinctions adds complexity to the total system.

The present system requires the constraints *[Round, +Low], *[Round, +Front, -ATR]. If /y/ were to disappear from the vowel system, as has happened historically in the Hongyan and Lobuzhai varieties, then the constraints on Round could be succinctly stated as *[Round, +Front], *[Round, +Low], and it would no longer be necessary to specify *[Round, +Front, -ATR]. In addition, the overall vowel system would become less typologically marked (no front round vowels), and it would not be necessary to specify that only [-Front] vowels can spread Round.

If /o/ were missing from the vowel inventory, as it is in the Mawo and Lobuzhai varieties, then the more general restriction *[Round, -ATR] would replace *[Round, +Low], and any vowel in the remaining inventory could accept the Rhotic feature. The existence of /y, o/ in the vowel system affects the co-occurrence constraints that must be written, even though these two vowels are not common within the lexicon.

As shown in 2.5., Rhotic is becoming increasingly rare in the vowel system of Yadu. It is very likely that within one to two generations, it will cease to exist in Yadu, as it has in Southern Qiang dialects. Nevertheless, even as it dwindles in importance, it must be specified, maintaining complexity in the system of vowel features.

4. CONCLUSIONS

The approach to vowel feature analysis offered here offers advantages over analyzing a system based on an assumed feature set, or based on assumptions about binarity/unarity of features. If an analysis is based on preconceived features and/or feature structures,

then it may be “obvious” how a given vowel system fits into a pre-ordained universal phonology. However, such an analysis may constitute a procrustean approach to the data, forcing it to support a theory that unadulterated data might not support.

On the other hand, if only those features are posited which the data of a given language demonstrate to have active phonological properties, and if the phonological processes of that language dictate whether those features are binary, unary, or perhaps have some other internal structure, then the linguist avoids doing violence to the data. Instead, an analysis is produced that can then inform phonological theory.

At the same time, use of the present method enriches our understanding of vowel system typology. For example, a comparison of Yadu and Kalong reveals differences in the weightings of binarity and unarity. Data from the two languages show that binary and unary ATR behave differently: Yadu has one abstract vowel whose only feature specification is [-ATR]. Such a vowel, along with its harmony patterns, is an impossibility in a vowel system with only unary features, as in Kalong.

In Yadu, the unary feature Rhotic is becoming less active in the system. If universal unarity of Round is assumed, then if/when Rhotic disappears from the system, the Yadu vowel system will be as binary as it could be.

A potential disadvantage of this method over a top-down, theory-driven approach is that some aspects of the vowel system become more difficult to compare cross-linguistically. For example, Kalong and Yadu have no Back vowels. However, perhaps this ‘problem’ helps to prevent drawing undeserved comparisons, for it is well established that the ‘same’ phone may not have the same phonology.

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