

**Positional faithfulness and vowel alternation patterns:  
Monophthongization in Takibakha Bunun\***

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*Abstract.* This paper focuses on monophthongization in Takibakha Bunun. According to the fieldwork data collected from the informant, /ai/, /ia/, /au/, /ua/ in the underlying forms are monophthongized in the non-final syllable position. That is, we can observe vowel alternations, such as [aj~e], [ja~e], [aw~o], [wa~o], in the surface form of Takibakha Bunun. For example, ma-cuaz [matswáð] ‘to plant (agent voice)’; cox-an [tsóðan] ‘to plant (locative voice)’. As for the previous studies, Li (1988) and Lin (1996) mention similar alternation, vowel metathesis, in Isbukun Bunun. Li (1988) also observes the monophthongization of [aj] and [aw] across Bunun dialects. In addition, Jiang (2012), a sketch grammar of Takibakha Bunun, argues that [e] and [o] are actually phonemic, but she does not provide a complete description of the vowel alternation pattern. In this paper, I focus on the interaction between syllable structure and vowel alternation pattern, attempt to analyze this phenomenon in the positional faithfulness theory, proposed in Beckman (1997, 1998) and to explain the problem through the ranking of constraints in the OT framework.

## **1. Introduction**

The Bunun language is one of the Formosan languages. It is mainly spoken in Nantou, Hualien, Taitung, and Kaohsiung. Bunun can be divided into five main dialects, which are Takituduh, Takibakha, Takibanuaz, Takivatan, and Isbukun (Li 1999, Huang&Shi 2016). This paper focuses on the vowel alternation pattern and the monophthongization in Takibakha Bunun spoken in Xinyi Township, Nantou County. The main informants are from Dili village (地利村) and Shuanglong village (雙龍村). I attempt to explain the phenomenon based on

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the observation from my fieldwork notes and the previous studies on the Bunun language. There are some examples shown below:

(1) Vowel alternation pattern: Monophthongization in suffixed form

a.	ma-tua	[matwá]	‘to open (AV)’
	to-’un	[tóʔun]	‘to open (PV)’
b.	ma-hau’	[maháwʔ]	‘to be angry (AV)’
	ho’-an	[hóʔan]	‘to be angry (LV)’
c.	qanciap	[qantejáp]	‘to know (AV)’
	qancep-un	[qantsépun]	‘to know (LV)’
d.	lavai’	[lavájʔ]	‘to win (AV)’
	lave’-an	[lavéʔan]	‘to win (LV)’

From the given examples, we can see that diphthongs /ai/, /ia/, /au/, ua/ in the agent voice forms, even some of them are prefixed, are distinguishable, while in the suffixed forms they are monophthongized into [e] and [o] respectively. In this paper, I focus on the interaction between syllable structure and vowel alternation pattern. With the positional faithfulness theory in the OT framework, I attempt to analyze and to explain the problem through the ranking of constraints.

## 2. Literature review

There are some previous studies on the phonology of the Bunun language, including Li (1988), Lin (1996) and Huang (2005, 2006, 2008, 2015).

Li (1988) focuses on the comparison among dialects and summarizes the historical sound change in the language. Lin (1996) gives a whole picture of the phonological system of Isbukun Bunun, including segments and features, syllable structure, stress and phonological process. Huang (2005, 2006, 2008, 2015), based on the OT framework, discuss some issues such as vowel-glide alternation, syllable structure, and metrical constraints, stress shift, but the metathesis and monophthongization are not well discussed.

As for the studies on Takibakha Bunun, Chen (2008) and Manqoqo (2011) discuss the morphology and word formation in this language. Jiang (2012) gives a brief description of the grammar of the language, which also contains a brief introduction to the phonological system and some phonological phenomena. Manqoqo (2009) also makes some discussions on the relationship between the writing system and the phonological system.

Li (1977) makes a general description of the morphophonemic alternation in several Formosan languages. Besides, Li (1977) and Lin (1996) both mention the vowel metathesis in (Isbukun) Bunun, for example:

(2) Vowel metathesis in the Bunun language

a.	suaz	[swáð]	‘to plant (stem)’
	ma-suaz	[maswáð]	‘to plant (AV)’
	sauz-un	[sáwðun]	‘to plant (PV)’

Lin (1996) also records the phenomenon that diphthongs [aj] and [aw] in Isbukun Bunun sometimes can be monophthongized into [e] and [o] respectively (written as [ɛ] and [ɔ] in the original text, and [ɔ] occurs more often than [ɛ]). Li (1988) also observes the monophthongization of [aj] and [aw] across Bunun dialects. In addition, De Busser (2009) demonstrates a free variation in Takivatan Bunun: /ai/ can be realized as [aj], [æj] and [ɛj]; /au/ can be realized as [aw] and [ɔ]. Manqoqo (2011) and Jiang (2012) argue that [e] and [o] have developed into independent phonemes.

We can see that this kind of vowel alternation pattern in Takibakha Bunun is not only related to the phonological process, but also morphological issues. Further discussions and analyses are shown in section 3, 4 and 5.

### 3. Phonological sketch

#### 3.1 Phoneme Inventory in Takibakha Bunun

According to Jiang (2012), there are 16 consonants and 5 vowels in Takibakha Bunun, including 5 monophthongs and 6 diphthongs. As for the writing system, most of the letters follow IPA transcriptions of their corresponding phonemes. There are still some exceptions, such as that <c> stands for voiceless dental/alveolar fricative [ts], <z> for voiced interdental fricative /ð/, <ng> for velar nasal /ŋ/ and <’> for glottal stop [ʔ]. Also, the phonemes <c> /ts/ and <s> /s/ are usually palatalized as [tɕ] and [ɕ] when preceding or following a high front vowel /i/. Consonants and vowels in Takibakha Bunun are represented in (3) and (4):

(3) Consonant inventory in Takibakha Bunun (adapted from Jiang 2012)

	<u>Labial</u>	<u>(Inter-)dental</u>	<u>Velar</u>	<u>Uvular</u>	<u>Glottal</u>
Stop	p b	t d	k	q	’/ʔ/
Affricate		c /ts/			
Fricative	v	s z /ð/			h
Nasal	m	n	ng /ŋ/		
Lateral		l			

## (4) Vowel inventory in Takibakha Bunun (adapted from Jiang 2012)

	<u>Front</u>	<u>Central</u>	<u>Back</u>	
High	i		u	Monophthongs: a, i, u, (e, o)
Mid	(e)		(o)	Diphthongs: ai, au, ia, ua, iu, ui
Low		a		

In this paper, I mostly use the writing system to present the data and write [e] and [o] as independent phonemes/letters, based on Manqoqo (2011) and Jiang (2012)'s proposals, to demonstrate the given examples (even this way of transcription is somewhat controversial). The phonetic transcriptions are given when it is necessary.

## 3.2 Syllable structure and stress

Syllable structure in Takibakha Bunun is (C)V(C), V can also be a diphthong VV (as GV or VG in the surface form), and complex onset is not allowed. Besides, there is no glide in the underlying form. That is, the glides [j] and [w] in the surface form are actually derived from the high vowels /i/ and /u/ in the underlying form (Huang 2005).

## (5) Syllable structure in Takibakha Bunun (adapted from Manqoqo 2010)

<i>Structure</i>	<i>Example</i>	<i>Gloss</i>
V	<i>u</i>	'yes'
CV	<i>ni</i>	'no'
VC	<i>al</i>	'if'
CVC	<i>lac</i>	'fruit'
VV	<i>ui</i>	'to make (sb. to do sth.)'
CVV	<i>vau</i>	'eight'
VVC	<i>aun</i>	'do not (do sth.) (Imp.)'
CVVC	<i>puaq</i>	'flower'

In two of the papers by Huang (Huang 2005, 2008), she proposes that each underlying vowel in Isbukun Bunun bears a mora, which determines the syllable weight. She also points out that Isbukun Bunun displays a quantity-sensitive trochaic stress system. That is, the unmarked position for stress is the penult, but stress falls on the final syllable when the syllable is heavy. The stress in Takibakha Bunun, as in Kaohsiung Isbukun, generally falls on the penultimate syllable or the final syllable with diphthong (i.e. the heavy syllable) except for some particular words. We can thus see that Takibakha Bunun and Kaohsiung Isbukun Bunun share a similar stress pattern. Here are some examples:

## (6) Example of stress assignment in Takibakha Bunun

- a. *macial* [matejál] ‘good’
- b. *qanup* [qánup] ‘to hunt (AV)’  
*qanup-an* [qanúpan] ‘to hunt (LV)’

In example (6a), we can see that the word *macial* [matejál] ‘good’ ends with a heavy syllable where the stress falls on. Also, stress is regularly assigned on the penultimate syllable in the suffixed form, e.g. in example (6b), *qanup-an* [qanúpan] ‘to hunt (LV)’ still get a penultimate stress.

## 4. Vowel alternation pattern in Takibakha Bunun

As what has been mentioned, monophthongized vowels, [e] and [o], can be observed in the suffixed forms. In this section, I make a brief introduction to the collected data. First, I narrow down our vision to the core of the morphological domain by distinguishing suffixes and clitics. Then, I also demonstrate the distribution and the restriction on syllable type. The variation on vowel quality among speakers is also discussed.

## 4.1 Suffixed form and encliticized form

In Takibakha Bunun, we can find this kind of vowel alternation pattern: the diphthongs /ai, ia, au, ua/ in the stem become monophthongs [e] or [o] in their surface forms when the words are suffixed. In other words, the suffixes, such as *-un* ‘(patient voice; PV)’, *-an* ‘(location voice; LV)’, *-a* ‘(imperative agent voice; AV.imp)’, *-i* ‘(imperative patient voice; PV.imp)’, trigger monophthongization. E.g. *macuaz* [matswáð] ‘to plant (AV)’, *cozun* [tsóðun] ‘to plant (PV)’.

## (7) Morpho-phonological change in suffixed form

	Agent voice		Suffixed form		Gloss
a.	/ua/	<i>macuaz</i> [matswáð]	<i>cozan</i> [tsóðun]		‘to plant’
		<i>matua</i> [matwá]	<i>to’un</i> [tóʔun]		‘to open’
b.	/au/	<i>mahau’</i> [maháwʔ]	<i>ho’an</i> [hóʔan]		‘to be angry’
		<i>tusauc</i> [tusáwts]	<i>tusocun</i> [tusótsun]		‘to sing’
c.	/ia/	<i>qanciap</i> [qantejáp]	<i>qancepun</i> [qanteépun]		‘to know’
		<i>mindia</i> [mindjá]	<i>Indie’un</i> [indéʔun]		‘to choose’

d.	/ai/	<i>lavai'</i>	[lavájʔ]	<i>lave'an</i>	[lavéʔan]	'to win'
		<i>kusbai</i>	[kusbáj]	<i>kusbe'an</i>	[kusbéʔan]	'to escape'

In contrast, perfective clitic *=(k)in* never trigger the monophthongization. E.g. *macuaz=in* [matswáðin] 'to plant (AV.perf)'. Some examples are shown in (8):

(8) Morpho-phonological change in encliticized form

		<i>Agent voice</i>		<i>Encliticized form</i>	<i>Gloss</i>
a.	/ua/	<i>macuaz</i>	[matswáð]	<i>macuazin</i>	[matswáðin] 'to plant'
		<i>matua</i>	[matwá]	<i>matuakin</i>	[matwákin] 'to open'
b.	/au/	<i>mahau'</i>	[maháwʔ]	<i>mahau' in</i>	[maháwʔin] 'to be angry'
		<i>tusauc</i>	[tusáwts]	<i>tusaucin</i>	[tusáwtein] 'to sing'
c.	/ia/	<i>qanciap</i>	[qantejáp]	<i>qanciapin</i>	[qantejápin] 'to know'
		<i>mindia</i>	[mindjá]	<i>mindiaquin</i>	[mindjákin] 'to choose'
d.	/ai/	<i>lavai'</i>	[lavájʔ]	<i>lavai' in</i>	[lavájʔin] 'to win'
		<i>kusbai</i>	[kusbáj]	<i>kusbaikin</i>	[kusbájkin] 'to escape'

Li (1977) and Lin (1996) both mention metathesis in Isbukun Bunun. Lin (2009) explain it is triggered by morphological rules rather than phonological processes. However, from the examples given in (7) and (8), we can see that suffixes trigger monophthongization (metathesis in Isbukun Bunun) whereas clitics do not. Unlike suffixes, clitics in these Bunun dialects do not cause the stress shift. We can see the difference between suffixes and clitics through the comparison given in (9).

(9) Comparison of suffixed and encliticised forms in Isbukun and Takibakha Bunun

	<i>Isbukun</i> <sup>1</sup>	<i>Takibakha</i>	<i>Gloss</i>	<i>Description</i>
a.	<i>matua</i>	<i>matua</i>	'to open (AV)'	/ua/ remains as [wa] in both dialects
b.	<i>tau'un</i>	<i>to'un</i>	'to open (PV)'	/ua/ becomes [aw] in Isbukun Bunun and [o] in Takibakha Bunun

<sup>1</sup> Isbukun data are cited from Lin (2009).

- c. *matua-in matua-kin* ‘to open (AV.perf)’ /ua/ remains as [wa] in both dialects

Hence, we can say that clitics might not be in the same morphological domain as suffixes, while suffixes play a more important role in a word.

## 4.2 Syllable type distribution and restriction

In the previous section, we discuss that either metathesis or monophthongization can be taken as positional neutralization. Huang (2015) discusses and compares the syllable types of Bunun and Atayal. The study shows that both CGVC/CVGC syllables are allowed in Isbukun Bunun, but word-medial CGVC syllables have not been found.<sup>2</sup> According to my field notes, both word-medial CGVC and CVGC syllables are not found in Takibakha Bunun (except loan words, some onomatopoeic words, and reduplication forms). In (10), it gives few examples of syllable type differences between these two dialects.

### (10) Comparison of syllable type distribution

	<i>Isbukun</i> <sup>3</sup>	<i>Takibakha</i>	<i>Gloss</i>	<i>Position</i>
a.	<i>tai</i>	<i>tai</i>	‘taro’	monosyllabic word
	<i>vau</i>	<i>vau</i>	‘eight’	
b.	<i>kusbai</i>	<i>kusbai</i>	‘to escape’	final syllable
	<i>tusaus</i>	<i>tusauc</i>	‘to sing’	
c.	<i>mai’asang</i>	<i>me’acang</i>	‘old tribe’	non-final syllable
	<i>binanau’az</i>	<i>binano’az</i>	‘woman’	

I postulate that CGVC/CVGC structure is not allowed in the non-final syllable in the grammar of younger speakers of Takibakha Bunun. Because of the restriction, diphthongs in the final syllable are forced to become monophthongs in suffixed form, in which the diphthongs are located in a non-final position. Based on these distributional evidences, we can summarize the syllable type restriction among these varieties as below:

<sup>2</sup> There is only one exception: the word *miahan* [mjáɣan] (data cited from Huang 2005), in which the sequence [jaɣ] can be regarded as the realization of /iɣ/ in the underlying form.

<sup>3</sup> Isbukun data are cited from Lin (1996) and Huang & Shih (2016).

## (11) Comparison of restriction of different types of syllable

	Non-final syllable	Final syllable
Isbukun, Takibakha (elder)	*CGVC / CVGC	CGVC / CVGC
Takibakha (younger)	*CGVC / *CVGC	CGVC / CVGC

Lipski (1990) proposes that metathesis might be a result of the syllable “**template matching**” and illustrates the process of metathesis with CV theoretic model. If we consider that, in Bunun, non-final syllable need to have a falling sonority slope in rime, then CGV sequence in the surface form, must undergo metathesis after gliding of underlying high vowels. Maybe it can explain why CGV structure is not allowed the in these Bunun dialects. That is, CGV initial syllable is somehow regarded as a marked form when a verb with CGV structure is suffixed, the CGV sequence appearing in the non-final syllable has to be rearrange because of the structural restriction. So the syllable undergoes vowel metathesis or furthermore, monophthongization, in the Bunun language.

(12) A over-simplified process of “template matching” analysis <sup>4</sup>

	Non-final syllable	Final syllable
UR	/CVV(C)-/	/CVV(C)#/
high vowel gliding	CGV(C)-	CGV(C)-
“template matching”	CVG(C)-	-
(no CGV in non-final syllable position)		
SR	[CVG(C)-]	[CGV(C)#]

The “template matching” analysis points out that a language might have different preference on the syllable shape in a certain position. Although it might be a good description of the distribution of different types of the syllable in the language, the existence of the “template” and the asymmetry of final and non-final position is still not explained.

### 4.3 Variation on vowel quality

From the distribution of different syllable types, we can see that CGV sequences are not allowed to appear in the non-final position in both Isbukun and Takibakha. During the fieldwork, I also noticed that the original diphthong in the non-final position varies among the speakers: the elders retain the [aj], [aw] or sometimes [ej], [ow] sequences in the non-final position. In contrast, the sound change of monophthongization is almost completed

<sup>4</sup> I postulate that “high vowel gliding rule” must precede “template matching rule” since the CGV template requires a glide to be filled in the template.



in the utterance of the younger speakers.

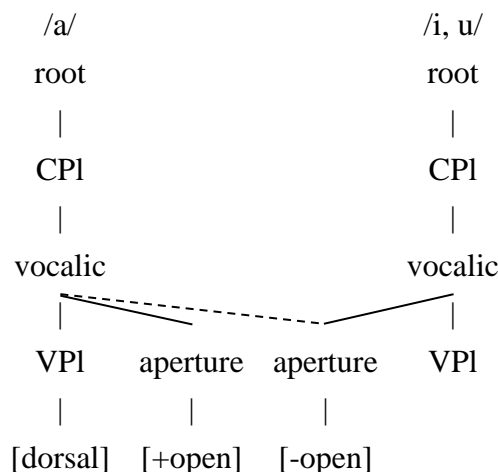
To account for this variation, we have to list down the phonetic difference among the speech forms Isbukun, elder Takibakha, and younger Takibakha. In the table in (13), I make a comparison of the vowel alternation pattern among three varieties with a more specific phonetic notation:

(13) Comparison of vowel alternation pattern

	Underlying representation	Surface: Non-final syllable	Surface: Final syllable
Isbukun, Takibakha (elder)	/ai/, /au/	[aj], [aw]	[aj], [aw]
Takibakha (elder)	/ai/, /au/	[ej], [ow]	[aj], [aw]
Takibakha (younger)	/ai/, /au/	[e], [o]	[aj], [aw]

Here I take /ai/ as an example, /a/ and /i/ are two separate vowels, but the high vowel /i/ somehow becomes a glide in the surface form (as in Isbukaun and elder Takibakha). In addition, these underlyingly distinct vowels become one in the speech of younger Takibakha. In De Busser (2009), it shows similar free variations in Takivatan Bunun: /ai/ can be realized as [aj], [æj] and [ɛj]; /au/ can be realized as [aw] and [ɔ]. Lin (1996) uses aperture in the feature geometry and describes monophthongization in Bunun as an interaction of aperture node and [open] feature.

(14) Spreading of aperture feature (Lin 1996)



Lunden (2006) studies the relationship between syllable position and syllable weight in the Norwegian language. At the beginning of this study, it presents some cross-linguistic comparisons: final syllables are lengthened in many languages. In my opinion, the non-final

syllable might not be compatible with too many segments, so that the compression of the syllable occurs more easily. This may explain why diphthongs can be preserved in the final syllable more easily but not in the non-final syllable, where they tend to become monophthongs.


## 5. An OT-based analysis

### 5.1 Final and non-final asymmetry

In the previous discussion, we can see that there seems to be a “template” for syllable structure in the Bunun language, which restricts the occurrence of different types of syllables within a word. It also shows that the asymmetry of final and non-final position: CGV structure is only allowed to appear in final-position of a word in the Bunun language. Moreover, CVG is also banned in the younger variety of Takibakha Bunun.


To resolve this problem with an OT-based analysis, we can start with the different ranking of constraints in final and non-final position. I set up two (temporary) constraints, **FAITH** (faithfulness of the vowel quality) and **\*DIPH** (markedness of diphthongs), to formulate the phenomenon. These two constraints are set up simply for the sake of simplicity of demonstration. I will dig into the content of these general constraints in the following sections.

(15) Different ranking of constraints in final and non-final position

Input: /ma-,tsuaǾ/	FAITH	*DIPH
a.  ma.tswaǾ		*
b. ma.tsoǾ	*!	

**Faithfulness » Markedness**

(Diphthong remained in final position)

Input: /tsuaǾ,-un/	*DIPH	FAITH
a.  tso.Ǿan		*
b. tswa.Ǿan	*!	

**Markedness » Faithfulness**

(Coalescence in non-final position)

In (15), we can see the asymmetry between final and non-final syllable. To deal with this asymmetry, context-free constraints are obviously not sufficient. We must have set up context-sensitive constraints to filter out the disfavored forms in the specific position. In the following section, I use the theory of **positional faithfulness** as my analytic framework.

## 5.2 Positional faithfulness

As what we have discussed, vowel alternations in the Bunun language, either metathesis or monophthongization, can be taken as a kind of positional neutralization. Based on the syllable restrictions, we can further discuss the constraint ranking. Beckman (1997, 1998) proposes an alter view of positional neutralization: **positional faithfulness**. Instead of regarding that neutralization is shaped by the contextual markedness constraints interacting with context-free faithfulness constraints, the positional faithfulness point of view reverses the roles of markedness and faithfulness constraints: i.e. the neutralization can be described as positional faithfulness which maintains the contrast in a certain position while the contrast is eliminated in the other position because of the context-free markedness. E.g. ‘coda neutralization’ can be described as ‘faithfulness in onsets’. Kager (1999) has illustrated these two aspects of positional neutralization as below:

(16) Two possible views of positional neutralization (Kager 1999:407)

- a. Context-free faithfulness ↔ Positional markedness
- b. Positional faithfulness ↔ Context-free markedness


Accounting for the monophthongization in Takibakha Bunun, we can use positional faithfulness theory to set up the constraints that we need. Here is the ranking schema for positional neutralization with the perspective of positional faithfulness:

(17) Ranking schema for positional neutralization (Kager 1999:408)

IO-Faithfulness (*prominent positions*) » Markedness » IO-Faithfulness (*general*)


According to positional faithfulness, segments that are contained in a ‘strong’ position (prominent positions) are resistant to the neutralization processes; in contrast, those which are contained in corresponding ‘weak’ position (general) are not (Beckman 1998, Smith 2002).

(18) “Positional faithfulness” analysis

Input: /ma-,tsuað/	FAITH/fin	*DIPH	FAITH
a.  ma.tswað		*	
b. ma.tsoð	*!		*

*Faithfulness/final* »

*Markedness* » *Faithfulness*

Input: /tsuað,-un/	FAITH/fin	*DIPH	FAITH
a.  tso.ðan			*
b. tswa.ðan		*!	

The positional faithfulness analysis intensifies the role of ‘strong’ and ‘weak’ position, and it explains phonological behaviors based on the retention of the feature in the prominent position, rather than searching specific constraints on the ‘weak position’. By adopting this analysis, we can break down the original “template structure” into several constraints, and the restriction of the syllable in a different position can be reinterpreted the result of the interaction of these constraints. In the following parts, I would like to clarify the substance of **FAITH** and **\*DIPH** with different sets of constraints.

### 5.2.1 Metathesis and linearity

First of all, I would like to discuss the case of metathesis. The classic example of the metathesis in the Bunun language is found in Isbukun dialect: the original diphthongs GV/VG (underlying as two vowels) are neutralized as VG, i.e. the vowel metathesis occurs in the variety. This phenomenon is also found in the speech of elder speakers of Takibakha Bunun. We can use the strategy of positional faithfulness to tackle this problem: Positional anti-metathesis constraint **LINEARITY/fin** is undominated, while the markedness constraint **\*GV** is dominated by the positional faithfulness constraint. Then, the markedness constraint **\*GV** dominates the context-free faithfulness constraint **LINEARITY**. Besides, we need the constraint **ONSET** to avoid two adjacent vowels in the surface form (adapted from Huang 2005, 2008). Constraints and tableaux are shown in (19)-(21)<sup>5</sup>.


(19)

- a. **LINEARITY/fin** » **\*GV**  
No metathesis in word-final syllable (which is more important than avoiding glide-vowel sequence).  
E.g. **ma.tswaǾ**, but **\*ma.tsoǾ**
- b. **\*GV** » **LINEARITY**  
No glide-vowel sequence (which is more important than more important than avoiding metathesis).  
E.g. **tsaw.Ǿan**, but **\*tswa.Ǿan**
- c. **ONSET**  
Onset are required.  
E.g. **ma.tswaǾ**, but **\*ma.tsu.aǾ**


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<sup>5</sup> There is no phonemic /ts/ in Isbukun Bunun, all the \*ts in the proto-Bunun has changed into /s/ (see Li 1988). In the consideration of the convenience to compare these different Bunun dialects, I keep writing the word *masuaz* ‘to plant (AV)’ in Isbukun Bunun as /ma-tsuaǾ/.

(20) Tableau: Retaining of diphthong in final syllable position

Input: /ma-tsu <sub>1</sub> a <sub>2</sub> ð/	ONSET	LIN/fin	*GV	LIN
a.  ma.tsw <sub>1</sub> a <sub>2</sub> ð			*	
b. ma.tsa <sub>2</sub> w <sub>1</sub> ð		*!		*
c. ma.tsu <sub>1</sub> .a <sub>2</sub> ð	*!			

(21) Tableau: Vowel metathesis in non-final syllable position

Input: /tsu <sub>1</sub> a <sub>2</sub> ð-an/	ONSET	LIN-σ]	*GV	LIN
a.  tsa <sub>2</sub> w <sub>1</sub> .ðan				*
b. tsw <sub>1</sub> a <sub>2</sub> .ðan			*!	
c. tsu <sub>1</sub> .a <sub>2</sub> .ðan	*!			

### 5.2.2 Lowness feature spreading

I also mention that there are free variations in the speech of elder speakers of Takibakha Bunun, which are [aj~ej] and [aw~ow]. These free variations [ej] and [ow] can be taken as the original [aj] and [aw] with the backward assimilation of the lowness feature. We just need to follow the same track: Positional constraint **IDENT-IO(low)/fin** is undominated, while the markedness constraint **AGREE(low)** is dominated by the positional faithfulness constraint, and the general faithfulness constraint **IDENT-IO(low)** is dominated by **AGREE(low)**.<sup>6</sup> Constraints and tableaux are shown in (22)-(24).

(22)

a. **IDENT-IO(low)/fin** » **AGREE(low)**

Lowness feature must be kept in the word-final syllable.

E.g. **ma.tswað**, but \***ma.tswoð**


b. **AGREE(low)** » **IDENT-IO(low)**

Lowness feature of two segments should be agree (which is more important than keeping the lowness feature).


E.g. **tsow.ðan**, but \***tsaw.ðan**

<sup>6</sup> The constraint, **AGREE(low)**, might not be an appropriate constraint since its implication of “vowel harmony” in a language. Spreading of [low] feature here is more like a kind of vowel reduction. I just keep using this constraint for the sake of simplicity.

## (23) Tableau: Retaining of lowness in final syllable position

Input: /ma-tswaǎ/	ID(low)/fin	AGREE(low)	ID(low)
a.  ma.tswaǎ		*	
b. ma.tswǎǎ	*!		*

## (24) Tableau: Monophthongization in non-final syllable position

Input: /tsuaǎ-an/	ID(low)/fin	AGREE(low)	ID(low)
a.  tsow.ǎan			*
b. tsaw.ǎan		*!	

The monophthongized vowels, [e] and [o], shows that [ej] and [ow] are not very stable. This issue might also require a more detailed experiment to make sure the phonetic value of these sounds.

## 5.2.3 Coalescence and Uniformity

Last but not least, I want to deal with the monophthongization in the non-final syllable. Monophthongization may be regarded as vowel coalescence. According to positional faithfulness, we may account for this distribution as ‘Anti-coalescence in word-final syllable position’. That is, the positional faithfulness constraint may be **UNIFORMITY/fin** while diphthongs are ruled out by markedness constraints **\*GV** and **\*VG**, which are dominated by **UNI/fin** but not by the general faithfulness constraint **UNIFORMITY**. Hence, the diphthongs could be retained in the word-final syllable but not elsewhere.

## (25)

a. **UNIFORMITY/fin** » **\*GV**

No coalescence in word-final syllable (which is more important than avoiding glide-vowel sequence).


E.g. **ma.tswaǎ**, but **\*ma.tsoǎ**

b. **\*GV,\*VG** » **UNIFORMITY**


No glide-vowel or vowel-glide sequence (which is more important than avoiding coalescence).

E.g. **tso.ǎan**, but **\*tsua.ǎan**, **\*tsaw.ǎan**

(26) Tableau: Retaining of diphthong in final syllable position

Input: /ma-tsuað/	UNI/fin	*GV	*VG	UNI
a.  ma.tswað		*		
b. ma.tsoð	*!			*

(27) Tableau: Monophthongization in non-final syllable position

Input: /tsuað-an/	UNI/fin	*GV	*VG	UNI
a.  tso.ðan				*
b. tsaw.ðan			*!	
c. tswa.ðan		*!		


The emergence of **\*VG** shows the direction of sound change on the diphthongs in Takibakha Bunun. By considering these different cases of positional faithfulness, we can actually replace **FAITH** with **LINEARITY**, **UNIFORMITY** and **IDENT(low)** and **\*DIPH** with different sets of constraints.

### 5.3 Variation and constraint competition


As for the variation between elder and younger variety in Takibakha Bunun, I regarded this phenomenon as the competition of constraints: **AGREE(low)**, **IDENT(low)**, **\*VG** and **UNIFORMITY**. In other words, VG sequences, [ej] and [ow], are acceptable in elder variety (compared to [aj], [aw] in Isbukun); in contrast, the younger speakers tend to apply vowel coalescence but the elders do not. Here, I propose a co-phonology model. The main idea of the co-phonology is that some of the constraints have a fixed ranking in the language, while the others might be rearranged according to the preference of different varieties in the language (Inkelas & Zoll 2007). We can represent these different rankings of constraints as follows:

(28)


a. Tableau: [aw] &gt; [ow], [o] (Isbukun, elder Takibakha)

Input: /tsuað-an/	UNI	IDENT(low)	AGREE(low)	*VG
a.  tsaw.ðan			*	*
b. tsow.ðan		*!		*
c. tso.ðan	*!	*!		

b. Tableau: [ow] &gt; [aw], [o] (elder Takibakha)

Input: /tsuað-an/	UNI	AGREE(low)	IDENT(low)	*VG
a. tsaw. ðan		*!		*
b.  tsow. ðan			*	*
c. tso.ðan	*!		*	

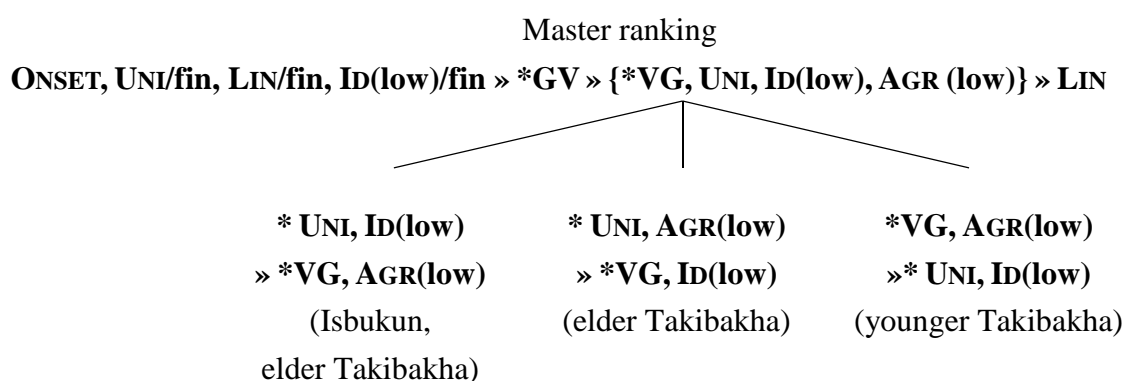
c. Tableau: [o] &gt; [aw], [ow] (younger Takibakha)

Input: /tsuað-an/	*VG	AGREE(low)	IDENT(low)	UNI
a. tsaw. ðan	*!	*!		
b. tsow. ðan	*!		*	
c.  tso.ðan			*	*

Li (1977) makes a comparative study of Atayalic languages. The study shows that, in many modern decedents, the diphthongs \*ay and \*aw in the non-final syllable tends to evolve into [e] and [o]. This sound change is very similar to the monophthongization in Takibakha Bunun: the elder speakers retain the diphthong while the younger speakers have already made the change and so pronounce the proto diphthongs as monophthongs.

The co-phonology can be organized in a grammar lattice, from which we can derive same or different rankings of constraints. Besides, a “master ranking” showing a partial ranking to all the individual varieties is placed in the grammar lattice (Inkelas & Zoll 2007). According to these different rankings of constraints, we can, therefore, organize these co-phonologies in a grammar lattice as shown in (29).

(29) Grammar lattice for suffixation in the Bunun language

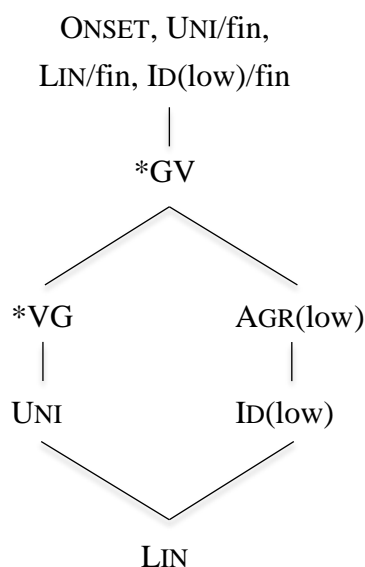


The co-phonologies share the same master ranking while differ in the hierarchy of two constraints: \*VG and Uniformity, which interact with each other and cause the difference between the varieties of the elder and the younger speakers of Takibaakha Bunun.



In the diagram in (30), I portrait the relationship of these constraints in the younger variety of Takibakha Bunun. If we suggest that the Isbukun and Takibakha dialects share the same original form in the beginning, we can say that the monophthongization in Takibakha Bunun is the result of demotion of two faithfulness constraints: **UNIFORMITY** and **IDENT(low)**, while the positional faithfulness constraints stay as higher ranked constraints so that diphthongs in word-final syllable remain the same in the output form.

(30) Hasse diagram of constraint ranking (younger variety of Takibkha)



## 6. Concluding Remarks

In this paper, I attempt to explain the phenomenon of monophthongization in Takibakha Bunun and make a brief description of this vowel alternation through the positional faithfulness analysis in the OT framework. According to the previous studies, we can know that the Bunun language has a special morpho-phonemic alternation: vowel metathesis. We also see that another kind of vowel alternation pattern: monophthongization is shown in Takibakha Bunun. In section 4, we observe the difference between suffixes *-un*, *-an*, *-i*, *-a* and clitic *-in*: suffixes trigger metathesis or monophthongization whereas clitics do not. Therefore, we can distinguish the later from the former, and then focus on the core morphological domain of the words. I conclude that either metathesis in Isbukun Bunun or monophthongization in Takibkha Bunun should be a kind of positional neutralization, i.e. /ia, ai/ or /ua, au/ in the word-final syllable are distinct, while in the non-final syllable, they become [aj], [aw] or even monophthongs [e] and [o].

By observing the distribution of syllable type in Bunun, I demonstrate some examples and make a summary on the restriction of syllable types and the variation on vowel quality among varieties. We find that whether a diphthong changes into a monophthong depends on

the restriction of the different position, so metathesis and monophthongization can be regarded as “template matching”. In section 5, I introduce the concept of positional faithfulness, proposed in Beckman (1997, 1998), and then I reinterpret the “template matching” phenomenon as the interaction among faithfulness, markedness, and positional faithfulness constraints. These constraints shape the typological differences in these dialects of Bunun. Comparing the monophthongization in Bunun with the historical development of Atayalic languages, we can also see that diphthongs /ai/ and /au/ share a similar development across different languages.

During the fieldwork, there are still some unexplained cases: (1) /iu/ in the stem: the verbs with /iu/ sequence in its stem apply /i/ deletion when it is suffixed. For example: *ma-ciul* [matejúl] ‘to water (the plant) (AV)’; *cul-a* [tsúla] ‘to water (the plant) (AV.imp)’. (2) /aʔu/ in the stem: the verb *ma’un* [máʔun] ‘to eat (AV)’ apply /ʔ/ deletion and monophthongization in suffixed form: *kon-un* [kónun] ‘to eat (PV)’. While the verb *muna’u* [munaʔú] ‘to invite (AV)’ does not undergo monophthongization but only make the vowel fusion of the suffix and its stem: *una’un* [unaʔún] ‘to invite (PV)’. These results can be taken as the anomaly of lexical items, since these cases have special morpho-phonemic alternations so that we can only, for this time, treat them as exceptions.

As for the analysis, there is also some remaining issues: (1) Markedness of GV and VG sequences: we can see that the distribution and restriction of GV and VG sequences are quite different; that is, GV is totally banned in the non-final position whereas VG may still be one of the free variations of the neutralized diphthongs. Even though the sonority slope matching can reach the right results, but what makes the difference between these two types of diphthongs is still under-discussed. (2) The problem of prominent position: By adopting the approach of ‘positional faithfulness’, it implies that the result of such asymmetry between final and non-final syllable is caused by the prominence of the position. In the analysis, as given in section 5, the constraints refer that the final position is the prominent one. Why is the final position prominent? Can the constraints refer to other equally prominent positions as well? As for these questions, it involves the phonological status of glides in diphthongs and the determination of the prominent positions in the Bunun language. To look forward to further discussions, we have to consider more factors that fall behind the way how the phonological system works in this language.

In spite of some remaining questions, this paper still makes a preliminary analysis on the issue of vowel alternation in Takibakha Bunun in the OT framework. Overall, I hope this study can provide some help in the formal linguistic studies on Formosan languages. I also hope that we can collect more data to analyze and understand the linguistic system of Formosan languages in the upcoming future.

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### Appendix : Core data - I

	AV	Gloss	PV -un	LV -an	AV.imp -a	PV.imp -i
<b>ia(C)#</b>	ikma'ia	'to use'	ikma'e'un	-	? ikma'e'a <sup>7</sup>	ikma'e'i
	kat'ia	'to touch'	kat'e'un	-	-	-
	laqsial	'to fall'	-	laqselan	-	-
	maqanciap	'to know'	qancepun	-	-	-
	mindia	'to choose'	inde'un	-	-	-
	patu'ia	'to play (instrument)'	patu'e'un	-	patu'e'a	patu'e'i
	pit'ia	'to cook'	-	pit'e'an	-	-
	tu'ia	'to yell'	-	tu'e'an	-	-
<b>ai(C)#</b>	kusbai	'to escape'	-	kusbe'an	-	-
	lavai'	'to win'	lave'un	lave'an	lave'a	lave'i
	laqai'	'to pass by'	laqebun	laqeban	-	laqebi
	ma'aiv	'to give'	'evun	'evan	-	'evi
	macaiv	'to send'	-	cevan	-	cevi
	makai	'to dig'	ke'un	ke'an	ke'a	ke'i
	malain	'to peel (corn)'	-	-	-	leni
	mapait	'to peel'	petun	-	peta	peti
	masicai	'to be tilt'	-	-	-	pasice'i
	mavail	'to throw away'	-	-	-	veli
	muqaiv	'to sunset'	-	?uqevan	-	-
	pacais	'to exchange'	-	-	cesa	cesi

<sup>7</sup> The mark “?” denotes that the form is unsure or only accepted by few speakers.

## Appendix : Core data - II

	AV	gloss	PV -un	LV -an	AV.imp -a	PV.imp -i
<b>ua(C)#</b>	kanuas	‘to be envy’	kanosun	-	-	-
	lacmuav	‘to exceed’	-	-	-	lacmovi
	lintuaz	‘to pull down’	-	lintozan	-	-
	macuaz	‘to plant’	cozun	cozan	coza	cozi
	mahua	‘to draw’	-	-	?ho’a	?ho’i
	mahuaq	‘to pull’	mahoqun	-	patu’e’a	mahoqi
	matua	‘to open’	to’un	to’an	-	to’i
	misluac	‘to burn’	-	m<in>islocan <sup>8</sup>	-	-
	palasmuav	‘to lie’	palasmovun	palasmovan	-	-
	silaluan	‘to cheat’	-	silalonan	-	-
	susua’	‘to yawn’	-	suso’an	-	-
<b>au(C)#</b>	ma’un	‘to eat’	konun	-	kona	koni
	mahau’	‘to be angry’	-	ho’an	-	-
	minka’un	‘to climb’	-	inkonan	-	-
	pakahau’	‘to quarrel’	-	pakaho’an	-	-
	pintau	‘to divide sth. into three’	pinto’un	-	pinto’a	pinto’i
	tangqaun	‘to dig’	tangqonun	-	?tangqona	tangqoni
	tusauc	‘to sing’	tusocun	-	tusoca	tusoci

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<sup>8</sup> As for the word *misluac* ‘to burn’, we can only find the suffixed form with perfective infix *-in-*.