An Historical Analysis of Pahoturi River Labialized-velar Consonants

Christian Brickhouse*

brickhouse@stanford.edu

Working paper, rev. 28 May 2022

1 Introduction

The Pahoturi River family is a linguistic isolate comprising 6 languages spoken in the South Fly region of Papua New Guinea (see Figure 1 for geographic distribution). Languages in this family are categorized geographically into Eastern and Western varieties. The Western varieties are Idi and Taeme. The Eastern varieties are Agob, Em, Ende, and Kawam. All six languages exhibit phonemic velar stops, /k/ and /g/, while Western varieties additionally exhibit labialized velar stops which vary between labialized velar plosives /kʷ gʷ/ and coarticulated labiovelar plosives /k͡p g͡b/ (Schokkin et al., 2021).[1] The labialized velars are restricted in their distribution. Where plain velars can occur in all positions in the Pahoturi River langauges, labialized velars are infrequent in the Western varieties, and only occur in initial and intervocalic positions.

Pahoturi River languages are spoken in southwest Papua New Guinea, south of the Fly River Delta. Speakers are in contact with a number of other Papuan languages. Neighboring families include the Yam, Trans-New Guinea, Eastern Trans-Fly, and Pama-Nyungan. For this analysis, the Yam languages are of greatest interest as they are the only other language in the area with phonemic labialized velars. Nen,[2] for example has both velar plosives /k g/ and coarticulated labiovelar plosives /k͡p g͡b/ (Evans and Miller, 2016). It may be that the labialized velars observed in Western Pahoturi River languages are related in some way. The contact situation and difference between Eastern and Western varieties raises an obvious question: are labialized velars conservative or innovative?

We consider two main hypotheses: the Western innovation hypothesis and the Western conservation hypothesis. The WESTERN INNOVATION HYPOTHESIS is primarily motivated by language contact. As seen in figure 1, the Western varieties are in contact

*Based on joint work with Kate Lindsey. Thanks to Arto Antilla for comments on earlier versions of this paper. Any errors or omissions are my own.

[1]The variation appears to be largely by person rather than allophonic.

[2][ISO 639-3: nqn, glottocode: nenn1238]

	Idi	Taeme	Ende	Kawam	Em	Agob	Gloss	YF[3]
a.	kʷɪʈ	kʷɪʈ	kuʈ	kut͡ʃ	kuʈ	kuʈ	‘bone’	13
b.	tikəp	tikəp	tikop	tikop	tikop	tikop	‘heart’	23
c.	gʷəg	gʷəg	gogo	gogo	gogo	gogo	‘erect’	324
d.	gəz	gəz	gəz	god͡ʒ	goz	goz	‘kill’	318

Table 1: Cognate sets for labiovelars preceding vowels

with the Yam languages Nen and Len. These languages feature coarticulated labiovelar plosives similar to those seen in Western Pahoturi River languages. This influence from neighboring languages could thus explain the development of labialized velar plosives not present in proto-Pahoturi River. The WESTERN CONSERVATION HYPOTHESIS is motivated by internal systematicity. As we see in table 1, the distribution of labialized velars in Western varieties appears systematic. Plain velars may appear before rounded or unrounded vowels (sets 1 through 4), but labialized velars may appear only before unrounded vowels (sets 7 and 8). Additionally, this distributional gap seems to coincide with asymetrical vowel correspondences between Eastern and Western varieties. In most cases, the roundedness of a post-velar vowel is the same across both Eastern and Western langauge varieties, but as seen in sets 5 and 6, there are cognates where plain velars correspond but the following vowels differ in their roundedness. The Western conservation hypothesis argues that this systematic and restricted distribution is better explained through a historical process of regular sound change rather than the introduction of a new segment.

In this paper we provide evidence for the Western conservation hypothesis by presenting a historical analysis of Pahoturi River labialized velars. We hypothesize three synchronic stages of Pahoturi River phonology (see other reconstruction efforts by Lindsey 2017, Evans et al., 2019, Chon and Lindsey forthcoming):

1. A unified proto-language.

2. Contextual neutralization of labialized velars through assimilation. This stage introduces regional variation in the direction of assimilation predicting synchronic variation.

3. Dissimilation leading to divergent phonological inventories.

In the second section of the paper we motivate these changes through a factorial typology of OT constraints. We propose a set of constraints which yield the surface forms observed, and using OTSoft (Hayes, Tesar, and Zuraw 2013) evaluate the possible patterns for languages given all logical arrangements of the constraints. This serves as a cross-check on our reconstruction hypothesis. If the historical changes we propose are possible, then each historical stage should correspond to one of the possible patterns observed in the factorial typology.

[3] YF refers to the lexical item number in the Yamfinder list, a lexical database which includes 338 words that are relevant specifically to the region of Southern New Guinea (Carroll et al., 2016).

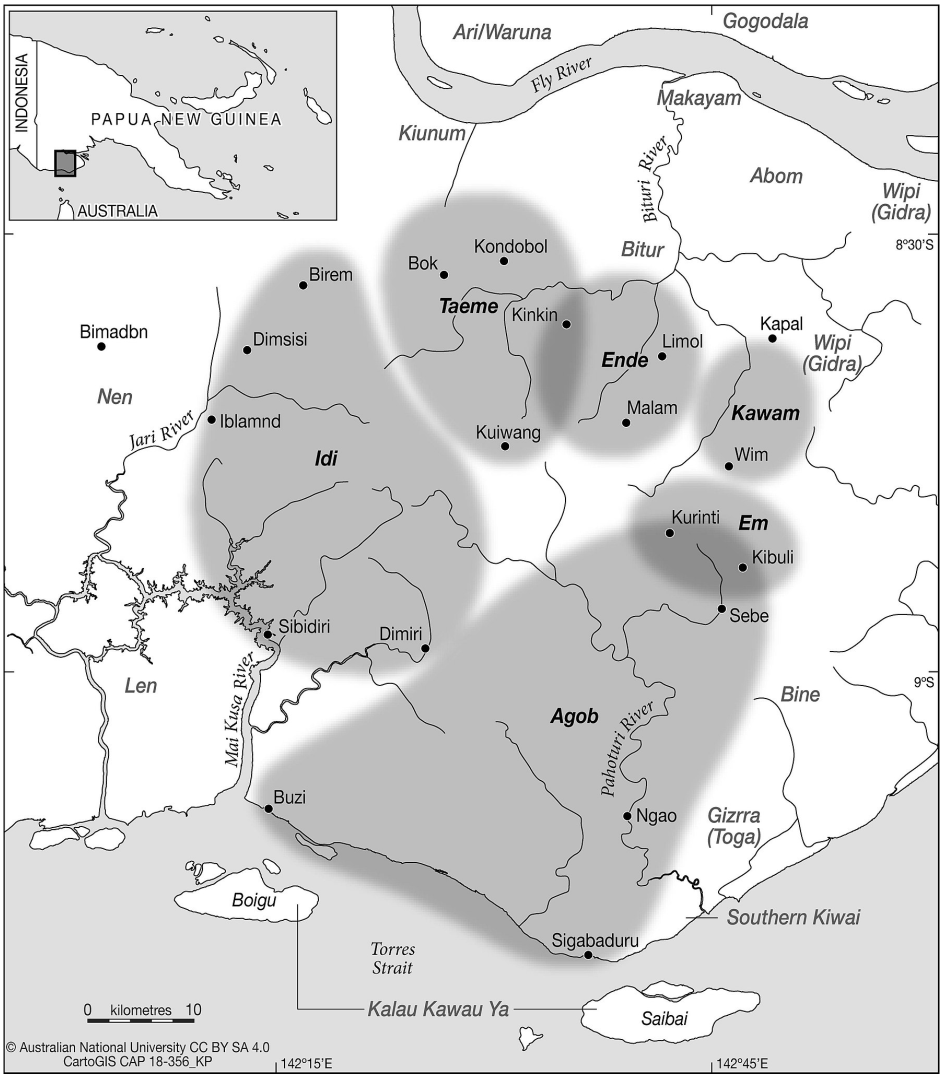

Figure 1: Villages where Pahoturi River languages are primarily spoken

Set	Western PR	Eastern PR	Idi (W)	Em (E)	Gloss
1	$\mathrm{k}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	$\mathrm{k}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	mə**ko**	mo**ko**	‘sweet’
2	$\mathrm{g}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	$\mathrm{g}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	*non-cognate*	**gu**ɽem	‘snake’
3	$\mathrm{k}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{k}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	bər**ke**	bor**ke**	‘parrot’
4	$\mathrm{g}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{g}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	**gə**b	**gə**ba	‘shade’
5	$\mathrm{k}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{k}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	ti**kə**p	ti**ko**p	‘heart’
6	$\mathrm{g}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{g}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	**gɐ**d͡ʒ	**go**z	‘kill’
7	$\mathbf{k^{w}}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{k}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	**k^{w}a**k	**ko**k	‘moon’
8	$\mathbf{g^{w}}\,^{\mathrm{V}}_{[-\mathrm{labial}]}$	$\mathrm{g}\,^{\mathrm{V}}_{[+\mathrm{labial}]}$	**g^{w}ə**g	**go**go	‘build’

Table 2: Eight correspondence sets

Pattern	Proto-PR	Western PR	Eastern PR
1.	*k^{w}o	k^{w}ə	ko
2.	*k^{w}ə	kə	ko
3.	*ko	ko	ko
4.	*kə	kə	kə

Table 3: Reconstruction of voiceless (labialized) velars

2 Reconstruction

Our data come from the Yamfinder word list (Carroll et al., 2016) collected by Lindsey and Schokkin. The Yamfinder list comprises 338 words list specifically relevant to the region of Southern New Guinea. There were 89 items that contained velars /k g/ from which we identified seven correspondence sets with a hypothesized eighth set (see table 2). From the contemporary distribution, we identify four patterns (see 3 for a summary).

The first correspondence pattern can be seen in sets 1 and 2. In these sets, a plain velar is followed by a rounded vowel across all langauges. These contrast with the second pattern in sets 3 and 4. The second pattern shows plain velars preceding unrounded vowels in all languages. From these four correspondence sets, we can reliably argue that the proto language had a series of plain velar stops which could be followed by both rounded and unrounded vowels.

The third pattern, illustrated by sets 5 and 6, involves an alternation in vowel forms across languages. Across all languages, the consonant is the same, a plain velar, but

Pattern	*PR	*West PR	*East PR
1.	$*k^w o$	$*k^w o$	$*k^w o$
2.	$*k^w ə$	*kə	$*k^w o$
3.	*ku	*ku	*ku
4.	*kə	*kə	*kə

Table 4: Reconstruction after the assimilation changes.

the Western language varieties have an unrounded vowel where the Eastern language varieties have a rounded vowel. Given the correspondences in sets 1 through 4, this vowel alternation would be difficult to explain. That is, we see that the vowel quality following a plain velar is retained across languages, so if the preceding consonant in sets 5 and 6 was also a plain velar, then we would be unable to explain the conditioning environment for the observed vowel alternation. Therefore we hypothesize that the proto-language had another consonant series which resulted in sets 5 and 6. This hypothesized series conditioned the alternation in sets 5 and 6 and then merged with the plain velar series.

The fourth pattern, illustrated by sets 7 and 8, sheds light on the quality of this hypothesized consonant series. In these series we see the same vowel alternation as in pattern 3, but we also see an alternation in the consonants. Where Western varieties have a labialized velar, the Eastern varieties have a plain velar, but the vowel alternation also demonstrates a distributional gap for labialized-velars. In Western varieties, the labialized velars are only ever followed by unrounded vowels. This set raises a number of questions which our recosntruction will need to resolve. Was this restricted distribution part of the proto-language? If not, what happened to labialized-velars before rounded vowels? We propose that Proto-Pahtouri River had two velar consonant series with unrestricted distribution, and that the contrast in vowel quality following labialized velars was neutralized in languages which retained them.

(1) $\underset{\text{[-lab]}}{\text{V}} \rightarrow \underset{\text{[+lab]}}{\text{V}} \,/\, \_\underset{\text{[+lab]}}{\text{C}}$

(2) $\underset{\text{[+lab]}}{\text{C}} \rightarrow \underset{\text{[-lab]}}{\text{C}} \,/\, \underset{\text{[-lab]}}{\text{V}}\_$

The first stage after the Proto-language is the result of differing assimilation patterns in the two branches. That is, the labialized-velar and unrounded vowel sequence becomes disfavored leading to a sound change. The Eastern and Western branches differ in the direction of assimilation. Eastern varieties assimilate the vowel to match the rounding of the preceding labialized velar as seen in (1). By contrast, Western varieties assimilated the consonant to the roundedness of the following vowel as seen in (2). A summary of the results of these processes are given in table 4. Taken together this results in the loss of labialized velars before unrounded vowels. While Eastern varieties still have labialized velars at this stage, when those segments are eventually lost this assimilation process will explain the distribution seen in correspondence sets 5 and 6.

(3) $\underset{\text{[+labial]}}{\text{C}} \rightarrow \text{[-labial]} \,/\, \_\text{[+labial]}$

(4) $\underset{\text{[+labial]}}{\text{V}} \rightarrow \text{[-labial]} \,/\, \text{[+labial]}\_$

Pattern	Proto-PR	Western PR	Eastern PR
1.	*kʷo	kʷə	ko
2.	*kʷə	ko	ko
3.	*ko	ko	ko
4.	*kə	kə	kə

Table 5: Language patterns after the second sound changes.

Proto-Pahoturi River							
*kʷo	*kʷə	*ko	*kə	*kʷo	*kʷə	*ko	*kə
Proto-Western PR				Proto-Eastern PR			
*kʷo	*kə	*ko	*kə	*kʷo	*kʷo	*ko	*kə
Western PR				Eastern PR			
kʷə	kə	ko	kə	ko	ko	ko	kə

Table 6: Summary of language patterns at each hypothesized stage.

Following the assimilation of labialized-velar and unrounded vowel sequences, the second stage occurs after the reanalysis of the remaining sequences of labialized-velar and rounded vowel segments. At this point the only remaining sequences involve two adjacent labial segments, and due to the contextual neutralization of the velar contrast before unrounded vowels, language learners may misattribute the labialization as the result of coarticulation. We hypothesize that such a reanalysis occurred in both branches of Proto-Pahoturi River, but like the last stage, the Eastern and Western branches differed in their reanalysis. Following the rule in (3), the Eastern varieties reanalyzed the rounding as part of the vowel and unlabialized their velars, thus losing the contrast completely. The Western varieties, following (4) attributed the rounding to the labialized velar and unrounded the following vowel, preserving the labialzed velar contrast through a chain-shift-like process. A summary of the result of these sound changes is given in table 5. Taken together these reanalyses account for the correspondences in sets 7 and 8.

3 Factorial typology

In the previous section we proposed a reconstruction of the Pahoturi River language family which hypothesized three stages of linguistic change (summarized in table 6). Our analysis predicts two unobserved proto-languages—Proto-Western and Proto-Eastern Pahoturi River—which were intermediate to the contemporary languages and their common ancestor. While we motivated the particular changes in terms of naturalistic language patterns (assimilation and reanalysis), how can we demonstrate that these hypothesized languages are reasonable? Further, while we predict these prior languages, what other possible languages *could* have occurred but may not be accounted for? To address these questions, we provide an optimality theoretic account of the Pahoturi River data and construct a factorial typology of the possible language predicted by our account.

Our OT analysis relies on two main assumptions: labial features may not be associated with more than one segment and that labialized velars are more marked when followed by unrounded vowels. In autosegmental phonology, from which we take the Obligatory Contour Principle (OCP) constraint, certain features exist on a tier separate from the segments, and links between these features and the segments determine how these features surface in the output. These links may take many shapes, but the linking patterns important for our analysis are shown in (5). Our constraint in (6a) forbids the construction in (5c), but our assumption is that constructions like (5b) are not possible in these languages.

```
(5)  a.  Lab        b.  Lab         c.  Lab  Lab
          |             /  \             |    |
          x            x    x            x    x
```

This solution seems *ad hoc*, but there are two ways to motivate this analysis. Fukazawa (1999) makes a similar argument against double linking of features in Yucatec Mayan. Fukazawa argues that a high ranked UNIFORMITY[F] constraint (McCarthy and Prince 1995) prevents the double linking of features, and a similar analysis is possible here. If we assume that UNIFORMITY(LABIAL) is highly ranked in these languages, then we can exclude the construction in (5b) in a principled manner. Alternatively, we can dispense with an autosegmental analysis all-together and account for the OCP-like pattern using context-sensitive markedness constraints (similar to 6g). Alderete (1997) accounts for dissimilation effects through local conjunction of markedness constraints, obviating the need for autosemgental accounts. This analysis would propose that adjacent labial segments in a local context (likely a syllable) incur a violation, resulting in a similar pattern to the OCP constraint in (6a). We assume the former analysis and leave the decision between the two options to future work.

The second major assumption of our analysis is that labialized velars are more marked when preceding an unrounded vowel than when preceding a rounded vowel. This is captured by our constraint in (6g). Labialized velar segments are highly marked compared to other segments given their restricted distribution cross-linguistically. We hypothesize though that these segments likely arise through coarticulatory effects from following rounded vowels. That is, a velar segment before a rounded vowel may become labialized, and this labialized velar may become phonologized after a secondary split. Under this account then, the labialized velar before an unrounded vowel would be more marked than the rounded vowel for distributional and articulatory reasons.

We propose the constraints in (6) in order to account for the distribution of labialized velars in the various languages. From these we construct a factorial typology, and consider how languages may move between these states. The seven constraints in (6) have 5040 logically possible rankings, and from these rankings 8 output patterns emerge, summarized in table 7.

(6) a. OCP(L)
Segments with labial features may not be adjacent.[4]

[4]An issue to consider is that Ende resolves vowel hiatus by insertion and one inserted segment is /w/. This /w/ insertion could interact with the OCP analysis used here if it occurs adjacent to rounded vowels. See Kate's dissertation.

Input	1	2	3	4	5	6	7	8
kʷo	-	ko	-	kʷə	ko	-	-	ko
kʷə	-	kə	kʷo	-	-	kə	ko	ko
ko	-	-	-	-	-	-	-	-
kə	-	-	-	-	-	-	-	-

Table 7: Summary of 8 output patterns. For simplicity, outputs are omitted where they are identical to the input.

b. IDENT(V)
Vowels in the input must be identical in the output.

c. IDENT(C)
Consonants in the input must be identical in the output

d. DEP(L)
Labial features in the output must correspond to labial features in the input.

e. MAX(L)
Labial features in the input must correspond to labial features in the output.

f. $*P_{LV}$
Labialized velar plosives are marked.

g. $*P_{LV}V_{\text{-L}}$
Labialized velar plosives are marked before unrounded vowels.

3.1 Pattern 1

(7) a.

$k^w o$	MAX(L)	DEP(L)	ID(V)	ID(C)	OCP(L)	$*P_{LV}V_{\text{-L}}$	$*P_{LV}$
☞ a. $k^w o$					*		*
b. $k^w ə$	*!		*			*	*
c. ko	*!			*			
d. kə	*!*		*	*			

b.

$k^w ə$	MAX(L)	DEP(L)	ID(V)	ID(C)	OCP(L)	$*P_{LV}V_{\text{-L}}$	$*P_{LV}$
a. $k^w o$		*!	*		*		*
☞ b. $k^w ə$						*	*
c. ko			*!	*			
d. kə	*!			*			

c.

ko	MAX(L)	DEP(L)	ID(V)	ID(C)	OCP(L)	$*P_{LV}V_{\text{-L}}$	$*P_{LV}$
a. $k^w o$		*!		*	*		*
b. $k^w ə$			*!	*		*	*
☞ c. ko							
d. kə	*!		*				

d.

kə	MAX(L)	DEP(L)	ID(V)	ID(C)	OCP(L)	$*P_{LV}V_{-L}$	$*P_{LV}$
a. k^wo		∗!∗	∗	∗	∗		∗
b. k^wə		∗!		∗		∗	∗
c. ko		∗!	∗				
☞ d. kə							

3.2 Pattern 2

(8) a.

k^wo	OCP(L)	ID(V)	$*P_{LV}$	$*P_{LV}V_{-L}$	DEP(L)	MAX(L)	ID(C)
a. k^wo	∗!		∗				
b. k^wə		∗!	∗	∗		∗	
☞ c. ko						∗	∗
d. kə		∗!				∗∗	∗

b.

k^wə	OCP(L)	ID(V)	$*P_{LV}$	$*P_{LV}V_{-L}$	DEP(L)	MAX(L)	ID(C)
a. k^wo	∗!	∗	∗		∗		
b. k^wə			∗!	∗			
c. ko		∗!					∗
☞ d. kə						∗	∗

c.

ko	OCP(L)	ID(V)	$*P_{LV}$	$*P_{LV}V_{-L}$	DEP(L)	MAX(L)	ID(C)
a. k^wo	∗!		∗		∗		∗
b. k^wə		∗!	∗	∗			∗
☞ c. ko							
d. kə		∗!				∗	

d.

kə	OCP(L)	ID(V)	$*P_{LV}$	$*P_{LV}V_{-L}$	DEP(L)	MAX(L)	ID(C)
a. k^wo	∗!	∗	∗		∗∗		∗
b. k^wə			∗!	∗	∗		∗
c. ko		∗!			∗		
☞ d. kə							

3.3 Pattern 3

(9) a.

k^wo	ID(C)	$*P_{LV}V_{-L}$	MAX(L)	OCP(L)	ID(V)	$*P_{LV}$	DEP(L)
☞ a. k^wo				∗		∗	
b. k^wə		∗!	∗		∗	∗	
c. ko	∗!		∗				
d. kə	∗!		∗∗		∗		

b.

k^wə	ID(C)	$*P_{LV}V_{-L}$	MAX(L)	OCP(L)	ID(V)	$*P_{LV}$	DEP(L)
☞ a. k^wo				∗	∗	∗	∗
b. k^wə		∗!				∗	
c. ko	∗!				∗		
d. kə	∗!		∗				

	ko	Id(C)	$*P_{LV}V_{-L}$	Max(L)	OCP(L)	Id(V)	$*P_{LV}$	Dep(L)
c.	a. k^wo	*!			*		*	*
	b. $k^wə$	*!	*			*	*	
	☞ c. ko							
	d. kə			*!		*		

	kə	Id(C)	$*P_{LV}V_{-L}$	Max(L)	OCP(L)	Id(V)	$*P_{LV}$	Dep(L)
d.	a. k^wo	*!			*	*	*	**
	b. $k^wə$	*!	*				*	*
	c. ko					*!		*
	☞ d. kə							

3.4 Pattern 4

	k^wo	Id(C)	Dep(L)	OCP(L)	$*P_{LV}V_{-L}$	Id(V)	$*P_{LV}$	Max(L)
(10) a.	a. k^wo			*!			*	
	☞ b. $k^wə$				*	*	*	*
	c. ko	*!						*
	d. kə	*!				*		**

	$k^wə$	Id(C)	Dep(L)	OCP(L)	$*P_{LV}V_{-L}$	Id(V)	$*P_{LV}$	Max(L)
b.	a. k^wo		*!	*		*	*	
	☞ b. $k^wə$				*		*	
	c. ko	*!				*		
	d. kə	*!						*

	ko	Id(C)	Dep(L)	OCP(L)	$*P_{LV}V_{-L}$	Id(V)	$*P_{LV}$	Max(L)
c.	a. k^wo	*!	*	*			*	
	b. $k^wə$	*!			*	*	*	
	☞ c. ko							
	d. kə					*!		*

	kə	Id(C)	Dep(L)	OCP(L)	$*P_{LV}V_{-L}$	Id(V)	$*P_{LV}$	Max(L)
d.	a. k^wo	*!	**	*		*	*	
	b. $k^wə$	*!	*		*		*	
	c. ko		*!			*		
	☞ d. kə							

3.5 Pattern 5

	k^wo	OCP(L)	Id(V)	Dep(L)	Id(C)	Max(L)	$*P_{LV}V_{-L}$	$*P_{LV}$
(11) a.	a. k^wo	*!						*
	b. $k^wə$		*!			*	*	*
	☞ c. ko				*	*		
	d. kə		*!		*	**		

b.

k^wə	OCP(L)	Id(V)	Dep(L)	Id(C)	Max(L)	*$P_{LV}V_{-L}$	*P_{LV}
a. k^wo	*!	*					*
☞ b. k^wə						*	*
c. ko		*!		*			
d. kə				*!	*		

c.

ko	OCP(L)	Id(V)	Dep(L)	Id(C)	Max(L)	*$P_{LV}V_{-L}$	*P_{LV}
a. k^wo	*!		*	*			*
b. k^wə		*!		*		*	*
☞ c. ko							
d. kə		*!			*		

d.

kə	OCP(L)	Id(V)	Dep(L)	Id(C)	Max(L)	*$P_{LV}V_{-L}$	*P_{LV}
a. k^wo	*!	*	**	*			*
b. k^wə			*!	*		*	*
c. ko		*!	*				
☞ d. kə							

3.6 Pattern 6

(12) a.

k^wo	*$P_{LV}V_{-L}$	Id(V)	Dep(L)	Id(C)	Max(L)	OCP(L)	*P_{LV}
☞ a. k^wo						*	*
b. k^wə	*!	*			*		*
c. ko				*!	*		
d. kə		*!		*	**		

b.

k^wə	*$P_{LV}V_{-L}$	Id(V)	Dep(L)	Id(C)	Max(L)	OCP(L)	*P_{LV}
a. k^wo		*!	*			*	*
b. k^wə	*!						*
c. ko		*!		*			
☞ d. kə				*	*		

c.

ko	*$P_{LV}V_{-L}$	Id(V)	Dep(L)	Id(C)	Max(L)	OCP(L)	*P_{LV}
a. k^wo			*!	*		*	*
b. k^wə	*!	*		*			*
☞ c. ko							
d. kə		*!			*		

d.

kə	*$P_{LV}V_{-L}$	Id(V)	Dep(L)	Id(C)	Max(L)	OCP(L)	*P_{LV}
a. k^wo		*!	**	*		*	*
b. k^wə	*!		*	*			*
c. ko		*!	*				
☞ d. kə							

3.7 Pattern 7

(13) a.

k^wo	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	MAX(L)	DEP(L)	OCP(L)	ID(V)	ID(C)	$*\text{P}_{\text{LV}}$
☞ a. k^wo				∗			∗
b. $\text{k}^w\text{ə}$	∗!	∗			∗		∗
c. ko		∗!				∗	
d. kə		∗!∗			∗	∗	

b.

$\text{k}^w\text{ə}$	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	MAX(L)	DEP(L)	OCP(L)	ID(V)	ID(C)	$*\text{P}_{\text{LV}}$
a. k^wo			∗!	∗	∗		∗
b. $\text{k}^w\text{ə}$	∗!				∗		∗
☞ c. ko					∗	∗	
d. kə		∗!				∗	

c.

ko	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	MAX(L)	DEP(L)	OCP(L)	ID(V)	ID(C)	$*\text{P}_{\text{LV}}$
a. k^wo			∗!	∗		∗	∗
b. $\text{k}^w\text{ə}$	∗!				∗		∗
☞ c. ko							
d. kə		∗!			∗		

d.

kə	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	MAX(L)	DEP(L)	OCP(L)	ID(V)	ID(C)	$*\text{P}_{\text{LV}}$
a. k^wo			∗!∗	∗	∗	∗	∗
b. $\text{k}^w\text{ə}$	∗!		∗			∗	∗
c. ko			∗!		∗		
☞ d. kə							

3.8 Pattern 8

(14) a.

k^wo	OCP(L)	$*\text{P}_{\text{LV}}$	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	DEP(L)	ID(C)	MAX(L)	ID(V)
a. k^wo	∗!	∗					
b. $\text{k}^w\text{ə}$		∗!	∗			∗	∗
☞ c. ko					∗	∗	
d. kə					∗	∗∗!	∗

b.

$\text{k}^w\text{ə}$	OCP(L)	$*\text{P}_{\text{LV}}$	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	DEP(L)	ID(C)	MAX(L)	ID(V)
a. k^wo	∗!	∗		∗			∗
b. $\text{k}^w\text{ə}$		∗!	∗				
☞ c. ko					∗		∗
d. kə					∗	∗!	

c.

ko	OCP(L)	$*\text{P}_{\text{LV}}$	$*\text{P}_{\text{LV}}\text{V}_{\text{-L}}$	DEP(L)	ID(C)	MAX(L)	ID(V)
a. k^wo	∗!	∗		∗	∗		
b. $\text{k}^w\text{ə}$		∗!	∗		∗		∗
☞ c. ko							
d. kə						∗!	∗

d.

kə	OCP(L)	$*P_{LV}$	$*P_{LV}V_{-L}$	DEP(L)	ID(C)	MAX(L)	ID(V)
a. k^wo	*!	*		**	*		*
b. k^wə		*!	*	*	*		
c. ko				*!			*
☞ d. kə							

4 General discussion

In this paper we presented a reconstruction of labialized velars in the Pahoturi River langauge family, and validated our hypothesized language stages through a factorial typology of phonological constraints. Our reconstruction argues that labialized velars were fully contrastive in the proto-language. An assimilation process results in a split between the Western and Eastern varieties which diverge further following a reanalysis of the adjacent labial features. This reconstruction proposes 5 distinct languages which can be accounted for using 7 constraints. A factorial typology of these constraints results in 8 output patterns.

All hypothesized stages are accounted for by our factorial typology. Our hypothesized proto-language is accounted for by pattern 1. In these typological rankings, the faithfulness constraints out-rank the markedness constraints. This is expected, as the domination of markedness constraints allows for the surfacing of a full phonological contrast. The hypothesized proto-Western Pahoturi River language is consistent with pattern 6. Pattern 6 is similar to pattern 1 where faithfulness constraints outrank markedness constraints except in pattern 6 the context-sensitive markedness constraint $*P_{LV}V_{-L}$is in the first stratum. Additionally, pattern 6 has a dominance relationship between faithfulness constraints: IDENT(VOWEL) and DEP(LABIAL) outrank IDENT(CONSONANT) and MAX(LABIAL). The hypothesized proto-Eastern Pahoturi River language is consistent with pattern 3. This pattern is rather different from patterns 1 and 6. In those patterns all faithfulness constraints dominate at least one markedness constraint, but in pattern 3 there are some faithfulness constraints which do not dominate a markedness constraint. In proto-Eastern Pahoturi River, only IDENT(CONSONANT), $*P_{LV}V_{-L}$, and MAX(LABIAL) are active, dominating the other faithfullness and markedness constraints.

(15) Alterations to the constraint hierarchy (Hutton, 1996)
  a. Promotion of constraints
  b. Demotion of constraints
  c. Creation of new connections between constraints (A,B > A»B)
  d. Dissolution of connections between constraints (A»B > A,B)
  e. Alteration of the dominance relationship between constraints (A»B > B»A)

(16) SYNCHRONIC BASE HYPOTHESIS All input candidates produced by GEN are based on the current output form. Earlier forms of the language are no longer available as underlying representations on which GEN operates.

This relationship is interesting from the perspective of historical accounts of optimality theory. Optimality theoretic analyses of historical sound changes are constrained by the specifics of the theory in a way that rewrite rules are not. OT is a theory of universal constraints and their interactions, and changes in the surface must derive from the reorganization of preexisting features of the language. Specifically, changes in surface structure are always due to changes in the organization of constraints and so broader historical patterns such as lenition, assimilation, and deletion are emergent from the process of constraint reranking. Within this theory we are restricted to the operations in (15) when moving between historical grammars.

We can account for the change between pattern 1 and patterns 3 and 6 through more fine-grained changes in the dominance hierarchy which only became relevant when $*P_{LV}V_{-L}$was promoted. Pattern 1 arises from any relative ranking of the faithfulness constraints, and so it is possible that there was variation in the proto-language as to the underlying ranking of faithfullness constraints. Specifically, our analysis predicts that western speakers ranked DEP(LABIAL) and IDENT(VOWEL) above MAX(LABIAL) and IDENT(CONSONANT). Crucially, this would not affect the surface output. Then $*P_{LV}V_{-L}$is promoted to the top stratum across the entire speech community, and this underlying variation leads to the split between patterns 3 and 6.

The next stages are perplexing from the perspective of constraint rankings. The contemporary Western varieties are consistent with pattern 4, and the Eastern varieties are consistent with either patterns 5 or 8. In both cases it seems that multiple constraint re-rankings are required to move between the previous pattern and the current pattern, but how are we able to move between these patterns without positing intermediate typological changes? In the proto-Western variety for example, if OCP(LABIAL) is promoted first, the language would fall into pattern 5 and the last labialized velar would merge.

We can alleviate these problems by adopting the SYNCHRONIC BASE HYPOTHESIS. This hypothesis accounts for the lexical items available as inputs at a given stage of language change. Specifically, the only inputs available in a later stage are the outputs of the earlier stage. This accounts nicely for mergers as it makes unmerging by constraint re-ranking impossible. It also captures the genealogical insight of language change: later stages are learned by younger speakers, and their grammars have as input the early stage's output. In the proto-Western and proto-Eastern varieties, we hypothesize that labialized velars before unrounded vowels are lost. According to the synchronic base hypothesis then, sequences like kʷə would also be absent as inputs in later stages.

Given this more restricted set of inputs, a number of constraint re-rankings can occur without affecting the surface forms. Because labialized velars have been lost before unrounded vowels, $*P_{LV}V_{-L}$can become inactive and be demoted to the bottom stratum in both branches. This puts both branches back into pattern 1 where faithfulness constraints outrank markedness constraints, but this time sequences like kʷə are absent. As in the first stage, these faithfulness constraints can be freely ranked without affecting the surface contrast, and this property explains the substantial changes between the proto-Regional stages and their contemporary counterparts.

In both cases branches, the faithfulness constraints are reranked and then the OCP constraint comes to dominate the faithfulness constraints leading to further sound change and the contemporary language patterns. In the case of proto-Western Pahoturi River, the speakers first develop a relative ranking among the faithfulness constraints whereby IDENT(CONSONANT) and DEP(LABIAL) dominate IDENT(VOWEL) and MAX(LABIAL) all four

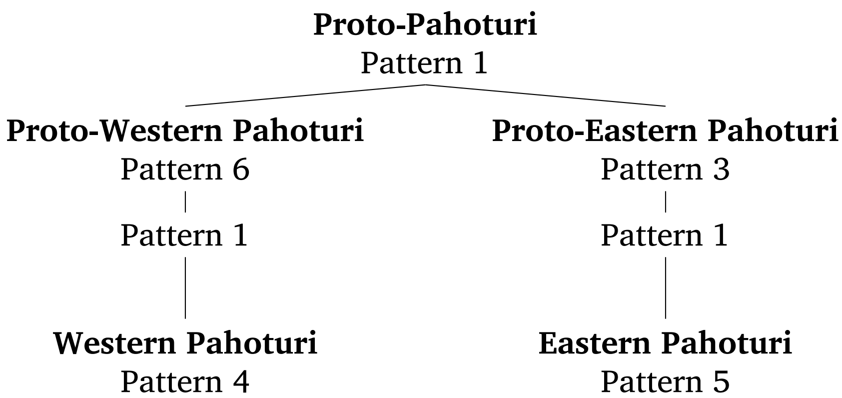

Figure 2: Tree of languages and typological patterns

outrank all markedness constraints). The OCP constraint then becomes active and is promoted to the first stratum resulting in a ranking consistent with pattern 4. The Eastern varieties need not go through the same relative reranking of faithfulness constraints; the promotion of OCP to the top stratum is sufficient to move it into pattern 5. This explanation also helps choose between patterns 5 and 8 which are both consistent with the data. If we were to argue that this is actually a case of pattern 8, then we would need to argue for a greater number of changes. Instead we prefer the simpler analysis.

Our analysis has been able to account for five of the eight patterns—the movements between them are summarized in figure 4—but what of the other three patterns? So far we have three patterns unaccounted-for: 2, 7, and 8. We would expect pattern 2 to arise by the demotion of the Ident(consonant) and Max(labial) constraints. This seems plausible, and the surface pattern seems consistent with what would be expected should a language lose labialized velars simultaneously. Pattern 7 would be most likely to arise from an alternate ranking of the faithfulness constraints in the proto-Pahoturi stage. That is, the Eastern and Western branches ranked the faithfulness constraints differently and this difference led to a split when the $*P_{LV}V_{-L}$constraint was promoted. Pattern 7 is similar, but Max and Dep are ranked highest. Pattern 8 was a hypothesis for the final ranking in the Eastern branch, but was rejected as less parsimonious. This also makes it difficult to predict how this constraint ranking would arise. It is similar to pattern 4 but with more defined dominance relationships and the promotion of the labialzed velar markedness constraints. If the Western varieties were to lose labialized velars, it would likely fall under this pattern.

5 Conclusion

In this paper we argued for a reconstruction of proto-Pahoturi River labialized velars and motivate this reconstruction using a factorial typology of OT contraints. The Pahoturi River language family can be divided into Eastern and Western varieties. For our purposes the division between these groupings is based on the distribution of labialized velars. Eastern PR varieties have no labialized velars while Western PR varieties do. These labialized velars are restricted in their distribution, only appearing before unrounded vowels. Additionally, in Western PR varieties some post-velar unrounded vowels correspond to post-velar rounded vowels in Eastern PR languages. From these distributional facts, we propose a set of sound changes which derive these contemporary languages from a proto-language with fully contrastive velar and labialized velars.

Our account begins with a proto-language which has both velars and labialized velars in contrastive distribution. This language splits following differential assimilation of labialized velar-unrounded vowel sequences. This yields two intermediate languages: proto-Western and proto-Eastern Pahoturi River languages. These inermediate languages undergo further sound changes whereby the labialized velar-rounded vowel sequences are reanalyzed resulting in the cojntemporary distributions.

In the second section of this paper we justify these stages using a factorial analysis which demonstrates the typological validity of each proposed language. We propose seven OT constraints which have 5040 logically possible rankings. Through a factorial analysis, we observe that all 5040 rankings result in one of 8 patterns. All of our hypothesized languages are accounted for by one of these patterns, and we are additionally able to account for the transition between each pattern. That is, while we are able to accoutn for the data through rewrite rules, we can also demonstrate that these rewrite rules arise from a minimal number of constraint rerankings. This factorial analysis leaves three patterns unaccounted for. Future work should consider whether these hypothesized patterns are accounted for in neighboring languages which may be a sign of genealogical relationship.

This reconstruction analysis and validation of the intermediate stages provides evidence for the argument that labialized velars are conservative in Western PR languages. If these segment were instead the result of contact or loans, then the orderly distribution and ability to reconstruct them would be unlikely. If these segments are related to neighboring languages, then the contact likely occurred before these sound changes occurred. Instead, it is more likely that the similarities between PR and its neighbors are genealogical or coincidental. Future work should further reconstruct the proto-Pahoturi River language in order to better situate Pahoturi River languages in their genealogical context.

References

Alderete, John. 2008. Dissimilation as local conjunction, .

Carroll, Matthew J, Nicholas Evans, I Wayan Arka, Christian Döhler, Eri Kashima, Volker Gast, Tina Gregor, Kate L Lindsey, Julia Miller, Emil Mittag, Bruno Olsson, Dineke Schokkin, Jeff Siegel, Charlotte van Tongeren & Kyla Quinn. 2016. Yamfinder: Southern New Guinea Lexical Database.

Evans, Nicholas. 2017. Quantification in Nen. In *Handbook of quantifiers in natural language. vol. 2*, 573–607. Springer Studies in Linguistics and Philosophy, vol 97.

Evans, Nicholas, Kate L Lindsey & Dineke Schokkin. 2019. Reconstructing liquids in proto-Pahoturi. Paper presented at the International Conference on Historical Linguistics (ICHL).

Evans, Nicholas & Julia Miller. 2016. Nen. *Journal of the International Phonetic Association* 46(3). 331–349. doi:10.1017/S0025100315000365.

Fukazawa, Haruka. 1999. Theoretical implications of ocp effects on features in optimality theory, .

Hutton, John. 1996. Optimality theory and historical language change. Paper presented at the 4th Phonology Workshop.

Lindsey, Kate L. 2017. A first look at the Pahoturi River family. Paper presented at the Austronesian and Papuan Languages and Linguistics Conference.

Lindsey, Kate L. 2021. Ende. *Journal of the International Phonetic Association* 1–21. doi: 10.1017/S0025100320000389.

McCarthy, John J. & Alan S. Prince. 1995. Faithfulness and reduplicative identity, .

Schokkin, Dineke, Volker Gast, Nicholas Evans & Christian Döhler. 2021. Phonetics and phonology of Idi. In Kate Lindsey & Dineke Schokkin (eds.), *Phonetic fieldwork in Southern New Guinea* Language Documentation & Conservation Special Publication No. 24, chap. 5, 76–107. University of Hawai'i Press.