

# The Labial Plosive in Kiribati

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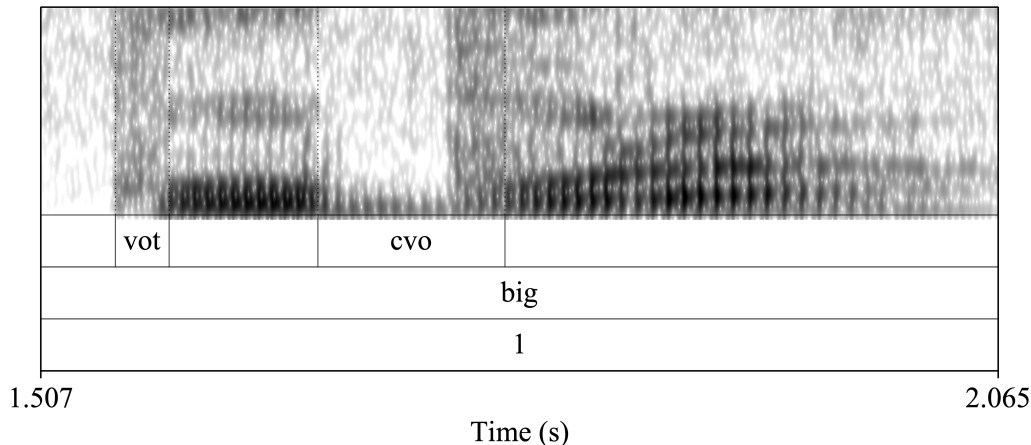
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## 1 Introduction

This squib reports acoustics of labial plosive in Kiribati, a Micronesian language spoken by about 100,000 people in the Republic of Kiribati, Nui in Tuvalu, Rabi island in Fiji and Gizo in the Solomon Islands. The language is also called Gilbertese when Kiribati was known as the Gilbert islands. Kiribati orthography displays an asymmetry between labial and non-labials, in that the labial plosive is a voiced ‘b’, whereas the non-labial plosives are voiceless ‘t’ and ‘k’. If taken at the surface value, this plosive system is uncommon because the voiced ‘b’ is present in the absence of the voiceless ‘p’. In Blevins and Harrison (1999), the labial plosive is transcribed with [p], suggesting that the orthographic ‘b’ not to be taken as a phonetic form.

Data from the second author in (1) shows that acoustic realizations of the orthographic ‘b’ are not uniformed. While the first ‘b’ in *bubura* ‘big’ is pronounced as a voiceless [p] (voice onset time (vot) = 31 ms), the second ‘b’ shows continuous voicing and is a voiced [b]. Labial plosives may have positionally dependent allophones; voiceless in the word-initial position, voiced in the word-medial position. While Korean also exhibits the positionally-conditioned voicing alternation, Kiribati would be unique if such a voicing alternation is limited to labial plosives.

(1) Spectrogram of *bubura* [pubura] ‘big’



The rest of this squib is organized as follows. First, examples with labial plosives will be presented. An acoustic analysis of sample words taken from the Swadesh list will show the variable nature of voicing in the labial plosive of Kiribati. Results show that ‘b’ is mainly pronounced as [p] and occasionally as [b]. The voicing variation found in Kiribati ‘b’ supports the need for detailed acoustic studies on descriptions that are mainly available through orthographic representations.

## 2 The labial plosive in Kiribati

The Kiribati orthography was developed by an American missionary Rev. Hiram Bingham. He also compiled a Kiribati-English dictionary (Bingham 1908). The consonant system is shown in (1). Blevins and Harrison (1999) recognizes that the labial plosive is voiceless [p]. This squib aims to fill the gap in the literature by adding acoustic

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evidence that shows whether ‘b’ is voiceless or voiced.

(2) Kiribati consonant system (Blevins and Harrison 1999: 205)

	Bilabial	Apical	Velar	Velarized-labial
Stop	b [p]	t	k	bw [p <sup>w</sup> ]
Nasal	m	n	ng [ŋ]	mw [m <sup>w</sup> ]
Flap/Fricative		r		w [β <sup>w</sup> ]

The labial plosive occurs frequently in Kiribati. In (3), examples with a labial plosive are shown. These 54 examples are taken from a Swadesh list collected in spring 2018 during a field methods course with the second author. Each example is followed by a gloss and the Kiribati spelling. The number at the end of each row is based on the Swadesh list available in Lee et al. (2019). Some words have more than one labial plosive that may or may not be realized identical. In (3a), labial plosive in the word-initial position is realized as voiceless [p], but in morpheme-initial position shown in (3b), after the article [te], two tokens are produced with voicing [b]. When multiple labial plosives occur in a single word in (3c), the voicing of it seems to be in free variation.

(3) Labial plosive in the initial position

a. word-initial

p	[po:u]	‘new’	bou	13
	[pua:χaχa]	‘bad’	buakaka	16
	[pua:k <sup>h</sup> ak <sup>h</sup> a]	‘rotten’	buakaka	17
	[pɛrek <sup>h</sup> a]	‘dirty’	bareka	18
	[po:roi]	‘smooth’	booraoi	23
	[pukin te meŋ]	‘tail’	bukin te men	45
	[pɛware]	‘spit’	baware	72
	[pɛn te aroka]	‘leaf (1)’	bwan te aroka	93
	[puro:ki]	‘freeze (2)’	buraoki	98
	[pɛrekareka]	‘dust (2)’	barekareka	110
	[pue]	‘burn’	bue	121
	[pu:n te ma:ne]	‘wife (2)’	buun te mwaane	128
	[pu:n te aine]	‘husband (2)’	buun te aine	129
	[paka]	‘fall’	bwaka	157
	[pesi]	‘float’	beti	158

b. morpheme-initial

p	[te punnimoa]	‘egg’	te bunnimoa	43
	[te pairi]	‘nose’	te bwairi	51
	[te pei]	‘hand’	te bai	59
	[te pei ni kipe]	‘wing’	te bai ni kibe	60
	[te piroto]	‘belly’	te biroto	61
	[te puakonikai]	‘forest’	te buakonikai	89
	[te pɛannikai]	‘leaf (2)’	te bannikai	93
	[te pokia]	‘wash (1)’	te bokia	202
	[wareki pa:i]	‘count (1)’	wareki baai	148

b	[te burɛnimɛŋ]	‘feather’	te buraeniman	46
	[te buro:]	‘heart’	te buro	66

c. multiple labial plosives

p/b	[pubura]	‘big’	bubura	1
	[pɛpopo]	‘yellow’	babobo	81
	[pupu:ja]	‘rub’	bubuia	201
	[te bupua nu we]	‘knee’	te bubua ni wae	58
	[te pubu]	‘dust (1)’	te bubu	110
	[te bubu]	‘smoke’	te bubu	118

Labial plosive in the medial position is in (4a) realized as voiceless [p] as well. Multiple occurrences of labial plosives in (4b) show some variation where a labial plosive in the final syllable is voiced. Such a voiced [b] in the final syllable would be an avoidance of a devoicing observed in (4c). When a voiceless labial plosive is followed by a high vowel [u], the vowel is devoiced. This kind of devoicing is not observed when the final vowel is a mid vowel: [te ɔnnapɛ] ‘earth’.

(4)	Labial plosive in the medial position			
a.	word-medial			
	p	[hapue]	‘warm’	abue 10
		[kapæja]	‘tie’	kabaea 207
		[seki ni kapene]	‘not’	tiaki ni kabene 183
		[ni kapene]	‘all’	ni kabane 184
		[tapemɛŋ]	‘some (3)’	tabeman 186
		[tapeai]	‘some (4)’	tabei 186
		[tapemɛŋ]	‘other’	tabeman 188
		[riki ni paniŋ]	‘freeze (1)’	riki ni bwanin 98
		[warepai]	‘count (2)’	warebai 148
		[te mennikipe]	‘bird’	te mennikiba 33
		[te ukinipei]	‘fingernail’	te ukinibai 55
		[te ɔnnapɛ]	‘earth’	te aonnaba 111
		[kippe]	‘fly (v)’	kiba 150
		[kaposu]	‘dull (2)’	kabotu 22
	b	[sibutau]	‘swell’	tibutau 135
		[ibukina]	‘because’	ibukina 87
b.	multiple labial plosives			
	p	[rapepe]	‘wide’	rababa 3
		[kapupu]	‘dull (1)’	kabubu 22
	b	[te meapubu]	‘fog’	te mwaabubu 113
c.	high vowel devoicing after a labial plosive			
	p	[sɪnepu]	‘heavy’	tinebu 5
		[te asi:pu]	‘stone’	te atibu 108
		[te ro:pu]	‘rope’	te robu 197

To summarize, out of 64 occurrences of a labial plosive in our Kiribati data set, 54 instances of voiceless [p] were observed, supporting the description in Blevins and Harrison (1999). The voiced [b] appeared 10 times (about 15 % of the data), but never in the word-initial position. After reporting acoustic results based on the speech of the second author in section 3, we will reexamine the status of labial plosive in section 4.

### 3 Phonetics of the labial plosive

**3.1 Data and processing** The acoustic data of Kiribati analyzed in this squib are recorded by the second author. Taken from the complete Swadesh list, each word was produced three times in a row without pause between the sequences. The first author annotated the data and extracted durations of closure and voice onset time (vot) using Praat (Boersma and Weenink 2001). The results were processed using R (R Core Team 2019). For the voiced plosive [b], the interval of closure voicing was marked. Both closure (clo) and vot were annotated for the voiceless plosive [p].

**3.2 All labials** In Figure 1, measurements from each category are plotted. The voiced plosive [b] shows robust prevoicing in Kiribati (mean = -97.54 ms, s.d.=20.5). The voiceless [p] has a long closure duration (mean = 94.5 ms, s.d.= 17.6), and moderately length of vot (mean = 28.39 ms, s.d.=13.5). The distribution of acoustic measures of [b] and [p] suggests that the two categories are produced as distinctive sounds.

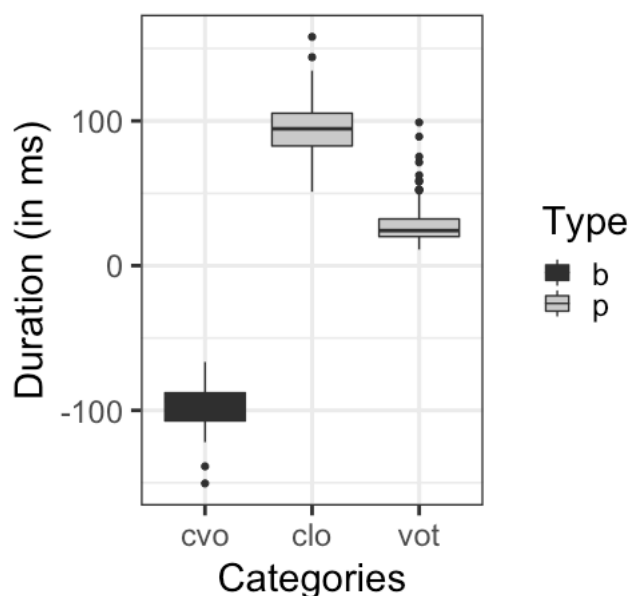


Figure 1. [b] with closure voicing (cvo) and [p] with closure (clo) and voice onset time (vot)

**3.3 Voiceless [p]** We examined the duration of the closure as well as vot of the voiceless labial by position in a word. As shown in Figure 2a, the vot data shows that there is significant difference of [p] by the position it occurs ( $t(113.9)=4.13$ ,  $p<0.01$ ), though this statistical significance is probably due to the outliers. When the closure duration was measurable, the difference of the closure duration is not significantly different between word-initial position and word-medial position ( $t(43.1)=1.09$ ,  $p=0.28$ ).

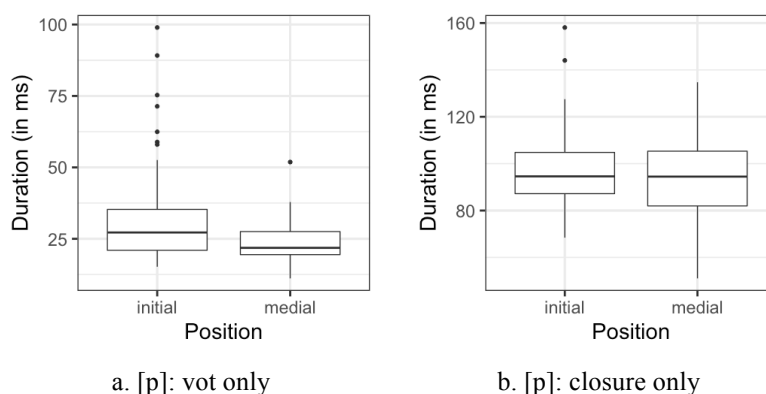


Figure 2. Duration of closure (a) and vot (b) by position in a word

The closure data of voiceless [p] includes two separate environments as shown in (3) and (4): morpheme or word. In word-initial position, the closure data was not measurable when an item was the first repetition of the three repetitions. When [p] occurs in the initial-position of a morpheme, or non-initial repetition of a sequence of recordings (word-initial), the closure duration was measurable. In Figure 3, the closure duration of each boundary type based on position was shown.

As shown in Figure 3, the type of boundary where a sound occurs suggest a difference in the closure duration. For morpheme boundary, the closure duration is not different between the initial position and the medial position ( $t(2.34)=0.36$ ,  $p=0.7$ ). When [p] appears at the word boundary, the difference of closure duration approaches statistical significance ( $t(1.18)=7.84$ ,  $p=0.05$ ). This statistical significance, however, may be due to the effect of how the data was collected. The duration in the word-initial condition in figure 3 is obtained from second and third repetitions of continued recordings. While there was almost no pause, repeating three words may still contribute to an artifact of a longer duration of a word-initial closure duration in Kiribati.

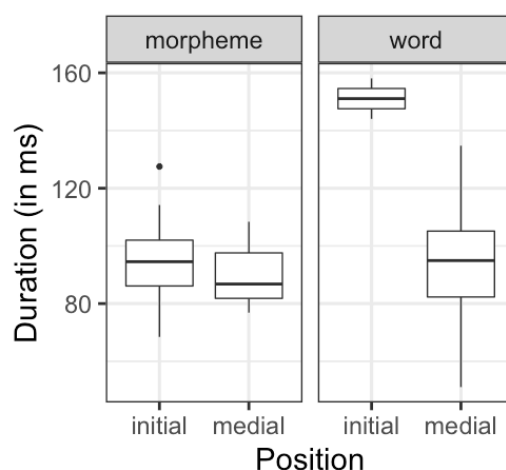


Figure 3. Duration of closure of [p] by boundary type: morpheme vs. word

**3.4 Voiced [b]** Voiced plosives do not show any durational difference in closure voicing ( $t(22.7)=0.62$ ,  $p=0.5$ ). The voicing persists throughout the closure part showing full voicing of the stops as show in Figure 4.

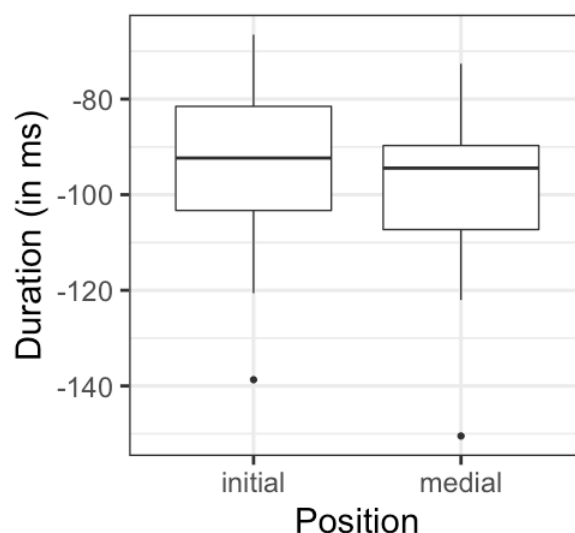


Figure 4. Duration of closure voicing of [b] by position

**3.4 Summary** Acoustic measures associated with the voicing of labial plosives have been reported. We have reported that a boundary is morpheme-initial or word-initial in voiceless plosive [p] shows statistically significant durational differences, but this may result from a task effect.

## 4 Discussion

**4.1 Plosive system of Kiribati** We have shown that the Kiribati speaker, the second author, produces a robust voiceless labial [p] as well as a robust voiced labial [b]. The orthography ‘b’ in the absence of ‘p’ has given the impression that Kiribati belongs to a group of languages with a non-symmetrical voicing system in the plosive series. Blevins and Harrison (1999) have suggested that the orthographic ‘b’ is in fact a [p]. The current study complements previous studies by showing that the orthographic ‘b’ is produced either as a [b] or as a [p], with a dominance of [p], confirming Blevins and Harrison (1999).

Even so, the occurrence of [b] is non-trivial. In most contexts where [p] is found, [b] is also found. No [b] is observed in two conditions: the word-initial condition in (3a), and the condition when [p] triggers high vowel devoicing in (4c). There is at least one apparent minimal pair involving the [p]/[b] alternation as shown in (5). It is possible to argue ‘dust’ and ‘smoke’ have semantic affinity. If so, it would be the case that [p] and [b] are in free variation rather than a minimal pair.

## (5) Minimal pairs

a. [te pubu]	‘dust (1)’	te bubu	110
b. [te bubu]	‘smoke’	te bubu	118

One important aspect to note is that Kiribati speakers are often fluent in English that has a voicing contrast. The second author is a fluent speaker of English, which may contribute to the co-occurrence of [p] and [b] in his Kiribati. Recordings of monolingual Kiribati speakers will need to be conducted in order to understand realizations of voicing in labial plosives in the Kiribati speech community, and in order to understand the nature of variation in the production of labial plosives (cf. Hibiya 1999).

**4.2 Why an orthographic ‘b’?** The results of this study show that the labial plosive in Kiribati is mainly voiceless with no aspiration (based on the small vot). A question arises why the orthography employs the symbol ‘b’. The orthography of Kiribati was proposed by Hiram Bingham, a missionary from the United States, whose native language was English (Bingham 1980). The orthography played an important role in establishing a written form of Kiribati, but it also created a system that Kiribati is a language that has a voiced plosive in the labial articulation, but voiceless plosives in coronal and dorsal.

The acoustic features of ‘b’ reported in this squib provides a hint as to why Bingham decided to employ ‘b’ instead of ‘p’ for the labial plosive. The vot of the voiceless plosive is in general small (mean = 28.39 ms) indicating an absence of aspiration. As such, word-initial labial plosives would have sounded like an English ‘b’ because a word-initial voiceless labial plosive ‘p’ in English is accompanied with aspiration (i.e. vot longer than 70 ms). Anecdotally, two native speakers of English in a field methods class on Kiribati reported that they perceived the labial plosive in Kiribati as a [b]; Bingham’s perception of the labial plosive would have been identical.

Although the orthographic ‘b’ is acoustically pronounced as [p] in most cases, this study is not committal in terms of choices concerning the orthography. The current orthography has been established some time ago and is currently being used in education and publications. However, knowing that the acoustic value of ‘b’ is a [p] is something that would need to be part of the awareness of Kiribati teachers.

## 5 Conclusion

This squib is a detailed version of a section in Lee & Timee (2019) that expands acoustic results of an analysis of voicing in the labial plosive in Kiribati. The results have shown that the orthographic ‘b’ has two phonetic realizations: a voiced [b] and an unaspirated voiceless [p] with no distinct pattern that accounts for the distribution of these two voicing varieties. More [p]’s are observed than [b]’s suggesting that the unmarked production of ‘b’ is [p], confirming Blevins and Harrison (1999). Moreover, the results reported in this squib provide cautions for researchers working on sound inventory if they were to use Kiribati as a language with an asymmetric voicing by place of articulation based on orthographic representations of the labial (cf. section 3.1 in de Lacy 2009).

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