COTOPAXI MEDIA LENGUA VOWELS: A PRELIMINARY ANALYSIS

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ABSTRACT

Although Media Lengua was first documented by linguists in Ecuador's Cotopaxi province, this study represents the first phonetic account of Media Lengua vowel production in that region, as subsequent research on Media Lengua has focused exclusively on the variety spoken in Imbabura province. This preliminary case study reveals that Cotopaxi speakers differ from Imbabura speakers in how they accommodate the five vowels of Media Lengua's Spanish-origin vocabulary into Quichua's three-vowel system. Imbabura speakers have been previously shown to maintain significant but minimal acoustic differences between high and mid-vowels i.e., /i/ versus /e/, and /u/ versus /o/. In contrast, our results show that Cotopaxi speakers differ from this pattern in two ways: a greater distinction is maintained between front /i/ and /e/ as compared with Imbabura speakers, but there is merger of the back vowels /u/ and /o/, suggesting these two varieties may have other as yet unstudied differences.

Keywords: Media Lengua, Cotopaxi, vowels, acoustic phonetics, dialectal variation

1. INTRODUCTION

Media Lengua (ISO-693: mue) is an endangered 'mixed' language spoken in the Ecuadorian Andes by an estimated 2,904 people [1]. Media Lengua is generally described as having systematic divisions between lexicon and grammar where approximately 90% of the vocabulary is Spanish in origin and nearly the entire morphosyntactic system is Quichua in origin. Example (1) provides an example of a Media Lengua utterance where the bolded elements are of Spanish origin.

(1)

Orth	***Asi juga**shpaca **peligrosu**mi.*		
IPA	**asi**	**xuga**-ʃpa-ka	**peligrosu**-mi
Parse:	like.that	play-GEN-TOP	dangerous-VAL
Sp:	*Jugando así es peligroso.*		
Q:	*Shina pucllashpaca pilirusumi.*		
En:	Playing like that is dangerous.		

Media Lengua was originally documented in the province of Cotopaxi in the 1970's by Pieter Muysken [2]–[4] and later in the province of Imbabura in the mid 2000's [5]. Since its original documentation in the 1970's numerous recent attempts to find Media Lengua speakers in Cotopaxi have failed [6]–[8] leading researchers to believe that it had since gone dormant in the region. However, in 2022 new fieldwork revealed that Media Lengua is still spoken by an estimated 1,703 people in Cotopaxi [1].

The Media Lengua vowel system has been of particular interest to phoneticians due to the interplay between its two source vowel systems; Spanish with five vowels (/i, e, u, o, a/) and Quichua with three vowels (/i, u, a/). To date, all published phonetic research on the vowel system comes from the Imbabura dialect of Media Lengua [9]–[12]. Results reveal a stratified yet highly overlapping vowel system on the F1xF2 dimensions. Here, high and low vowels of both Spanish and Quichua origin are shown to be significantly different, although clusters only differ by 10 to 20 Hz, suggesting near-mergers [9]. Meanwhile, Spanish origin mid-vowels and high vowels, from both source languages, are significantly different with enough distance in acoustic space that they could potentially be contrastive aurally even though there is still a substantial degree of overlap [9]. The perception of mid- and high vowels was later tested using a 2-forced choice identification task experiment which revealed that Media Lengua listeners were indeed able to reliably identify differences different between /i/ versus /e/ and /u/ versus /o/ [10]. Figure 1 uses a bagplot to illustrate the F1xF2 dimensions of the Imbabura Media Lengua vowel system.

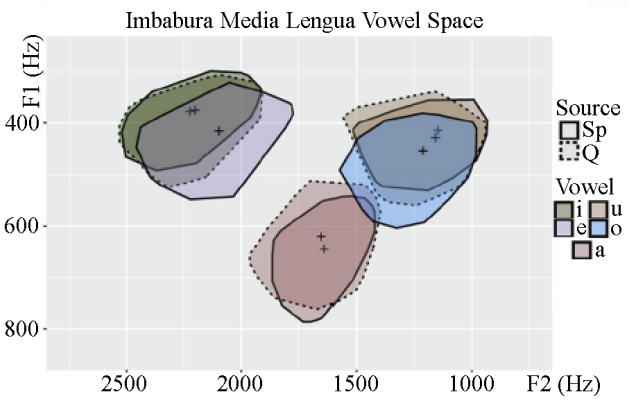

Figure 1: Imbabura Media Lengua vowel space based on [12].

Further analyses of Media Lengua's vowel system examined Spanish origin vowel sequences (diphthongs) [11]. Results revealed that Media Lengua speakers produce all Spanish origin vowel sequences but that these are adapted to Media Lengua's more compact vowel system (as compared to Spanish). Finally, it was shown that Media Lengua speakers make use of numerous cues beyond formant frequencies to identify the differences between mid and high vowels [12]. These primarily include speaker sex in addition to syllable structure and prosodic elements such as pitch.

Alongside these prior findings on the phonetic qualities of Imbabura Media Lengua vowels, this study provides a preliminary sketch of the Cotopaxi Media Lengua vowel system. F1xF2 measurements come by way of conversations from two women and is compared with previously analysed data from Imbabura Media Lengua. The goal of this study is twofold: (1) gain a general understanding of the shape of the Cotopaxi Media Lengua vowel system, especially with respect to the degree of overlap between mid- and high vowels and (2) infer how the vowel systems from these two speakers equate and/ or differ from the Imbabura Media Lengua vowel system.

2. METHOD

2.1. Participants

Given the recent and ongoing documentation of Cotopaxi Media Lengua, for the first time in approximately 40 years, we currently only have conversational data from two speakers. Both speakers are female, aged 29 and 37 respectively at the time of recording, and were born and raised in the community of Yacubamba, Cotopaxi, Ecuador.

For comparative purposes, previously analysed data from Imbabura Media Lengua was used [12]. These data come by way of five female speakers between the ages of 39 and 50 at the time of recording.

2.2. Data

F1 and F2 frequencies were extracted from the centre points of vowels. From the two Cotopaxi Media Lengua speakers, 516 tokens were extracted for analysis (Speaker 1 n = 257; Speaker 1 n = 259; /a/ n = 69, /e/ n = 136, /i/ n = 107, /o/ n = 141, /u/ n = 63). From the five Imbabura Media Lengua speakers, 420 tokens were extracted (Speaker 3 n = 59; Speaker 4 n = 42; Speaker 5 n = 96; Speaker 6 n = 36; Speaker 7 n = 191; /a/ n = 158, /e/ n = 56, /i/ n = 83, /o/ n = 90, /u/ n = 31).

2.3. Procedures

Data come from conversations recorded between Media Lengua speakers discussing daily life events. A Zoom H6 Handy Recorder was used to record the conversations in 16-bit WAV format with a sample rate of 44.1 kHz. Vowels were marked on a point tier in Praat [13] near the centre of the vowel where the F1 and F2 formants were at their most steady state. A Praat script was used to automatically extract the data points. The libraries *ggplot2* [14] and *LmerTest* [15] were used to analyse the data in R version 4.2.2 [16]. For each region, Cotopaxi and Imabura, linear mixed-effects regression (LMER) models were run on a per-formant basis with *Vowel* as fixed effect, and random intercepts for both *Speaker* and *Word*. For each model, the intercept was rotated between /i/ and /u/ to permit interpretation of high versus mid-vowel difference from the perspective of either the front or back regions of the vowel space. Additional cross-regional models were run for each formant by adding *Region* as a fixed effect, to examine cross-regional variation.

3. RESULTS

The LMER results for Cotopaxi F1 and F2 are shown in Table 1 (intercept = /i/) and Table 2 (intercept = /u/). Significant differences in one or both formants are sufficient to differentiate each vowel from all others in the system, although the formant differences between /u/ and /o/ (Table 2) are the least substantial, in particular for F1 where this difference is just above the significance threshold of p<0.05.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
(Intercept)	418.77	**<0.001**	2428.39	**<0.001**
Vowel [a]	384.26	**<0.001**	-653.35	**<0.001**
Vowel [e]	107.74	**<0.001**	-105.28	**0.004**
Vowel [o]	174.29	**<0.001**	-948.40	**<0.001**
Vowel [u]	131.70	**<0.001**	-1052.62	**<0.001**

Table 1: Linear mixed-effects regression results for Cotopaxi Media Lengua F1 and F2, intercept = /i/.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
(Intercept)	550.47	**<0.001**	1375.77	**<0.001**
Vowel [a]	252.56	**<0.001**	399.27	**<0.001**
Vowel [e]	-23.97	0.255	947.34	**<0.001**
Vowel [i]	-131.70	**<0.001**	1052.62	**<0.001**
Vowel [o]	42.58	0.050	104.22	**0.016**

Table 2: Linear mixed-effects regression results for Cotopaxi Media Lengua F1 and F2, intercept = /u/.

As in Cotopaxi, cross-vowel formant differences in Imbabura (Table 3 and Table 4) are significant for one or both formants, but are weaker in almost every case,

although notably the F2 difference between /u/ versus /o/ appears to be more robust than in Cotopaxi.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
(Intercept)	423.06	**<0.001**	2357.12	**<0.001**
Vowel [a]	280.11	**<0.001**	-598.92	**<0.001**
Vowel [e]	34.88	**0.018**	-151.62	**<0.001**
Vowel [o]	79.83	**<0.001**	-891.46	**<0.001**
Vowel [u]	43.14	**0.015**	-1081.36	**<0.001**

Table 3: Linear mixed-effects regression results for Imbabura Media Lengua F1 and F2, intercept = /i/.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
(Intercept)	466.20	**<0.001**	1275.76	**<0.001**
Vowel [a]	236.97	**<0.001**	482.43	**<0.001**
Vowel [e]	-8.26	0.666	929.74	**<0.001**
Vowel [i]	-43.14	**0.015**	1081.36	**<0.001**
Vowel [o]	36.69	**0.040**	189.90	**<0.001**

Table 4: Linear mixed-effects regression results for Imbabura Media Lengua F1 and F2, intercept = /u/.

The differences between regions are made clear via the cross-regional model (Table 5 and Table 6; to conserve space, only the interactions between *Vowel* and *Region* are displayed). From the perspective of Cotopaxi /i/ (Table 5), significant differences in F1 pertain to each Imbabura vowel, while from the perspective of /u/ (Table 6) this is only true relative to /i/; there are no significant cross-regional F2 differences at all.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
Vowel [a] × Region [Imbabura]	-102.87	**<0.001**	47.58	0.347
Vowel [e] × Region [Imbabura]	-73.08	**0.004**	-48.17	0.367
Vowel [o] × Region [Imbabura]	-93.60	**<0.001**	55.24	0.265
Vowel [u] × Region [Imbabura]	-88.44	**0.004**	-36.32	0.577

Table 5: Linear mixed-effects regression results for Media Lengua F1 and F2, intercept = Cotopaxi /i/.

	F1		F2	
Predictors	*Estimates*	*p*	*Estimates*	*p*
Vowel [a] × Region [Imbabura]	-14.43	0.637	83.91	0.195
Vowel [e] × Region [Imbabura]	15.35	0.626	-11.85	0.859
Vowel [i] × Region [Imbabura]	88.44	**0.004**	36.32	0.577
Vowel [o] × Region [Imbabura]	-5.17	0.865	91.56	0.154

Table 6: Linear mixed-effects regression results for Media Lengua F1 and F2, intercept = Cotopaxi /u/.

Visualization of the vowel distribution differences between regions is provided using two methods. Two-dimensional density estimates (Figure 2) portray the central region of each vowel's token distribution via opacity, with less dense regions being more transparent. Bag (or bag-and-loop) plots (Figure 3), being bivariate equivalents of box-and-whisker plots [17], show the central 50% of tokens in the opaque 'bag', with remaining tokens (excluding statistical outliers) contained in the larger, more transparent 'loop'.

Although these two methods are non-equivalent, they both illustrate the same pattern. Cotopaxi Media Lengua's front vowels are more distinct in the height dimension i.e., in F1, relative to Imbabura, while the back vowels are almost completely merged. In contrast, the Imbabura Media Lengua vowel space is more vertically compact with a large degree of overlap between high and mid-vowels, but with more front-to-back differentiation i.e., in F2.

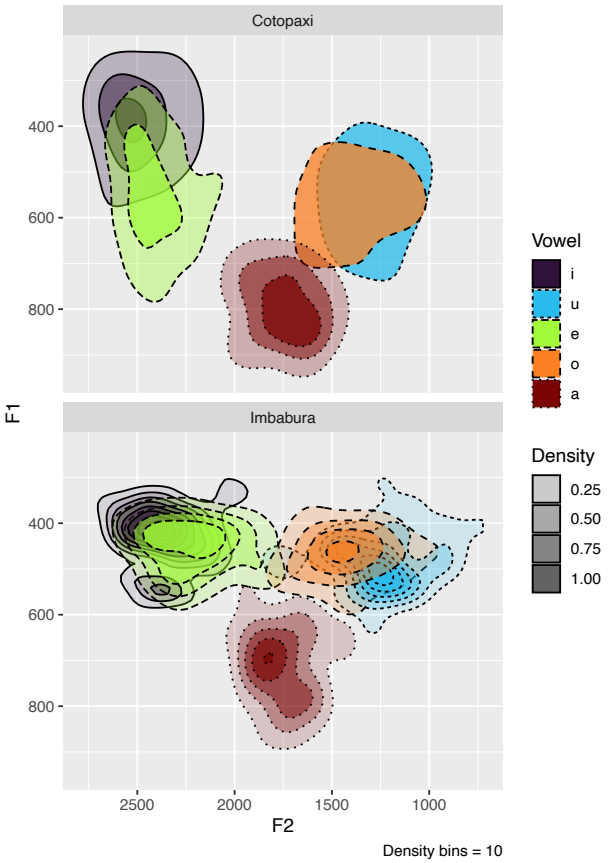

Figure 2: Density plots of Media Lengua vowels by region.

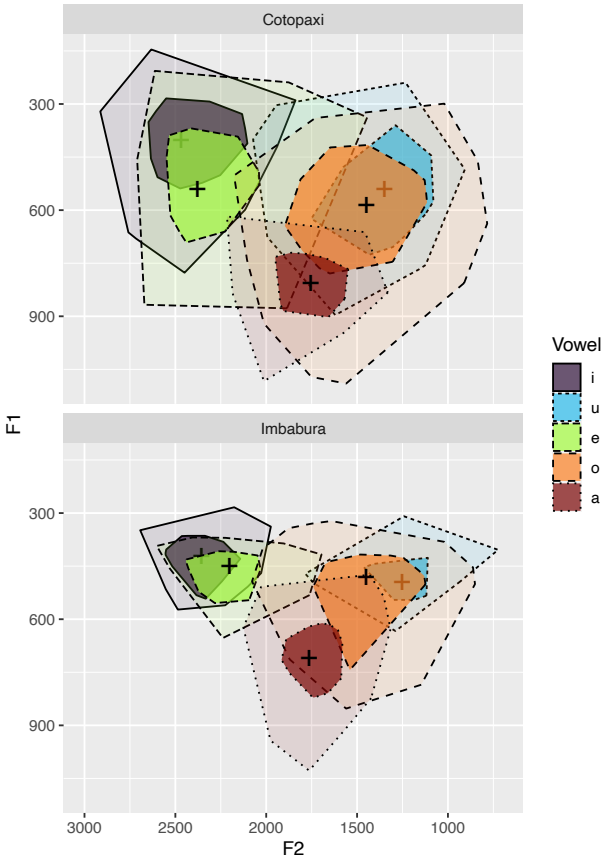

Figure 3: Bag plots of Media Lengua vowels by region.

4. DISCUSSION

Results from this study are still preliminary given the small sample size of speakers from Cotopaxi. Yet, they provide insights into how the Cotopaxi Media Lengua vowel system might differ from that of Imbabura.

Most noticeably, the back vowels in Cotopaxi show substantial overlap in F1xF2 acoustic space with no significant difference revealed in the statistical model (Table 2). Contrarily, Imbabura back vowels show significant, though not substantial, separation in F1 with /o/ being on average 37 Hz higher than /u/. Additionally, the back vowels from both Cotopaxi speakers are significantly lower in F1xF2 acoustic space compared to those from Imbabura suggesting that they have lowered and merged /u/ with /o/. This is substantiated by the statistical models which reveal that /u/ is significantly and substantially higher in F1 frequency compared to /i/ by, on average, 131 Hz and that /e/ and /o/ have similar average F1 frequencies, differing, non-significantly, by only 23 Hz (Table 2). Additionally, when comparing Cotopaxi /u/ to Imbabura /o/, the F1 averages are virtually identical only differing non-significantly, by 5 Hz.

Contrarily, both Cotopaxi speakers show significantly and substantially different F1 frequencies for /i/ and /e/, by on average, 107 Hz. While the average difference between /i/ and /e/ in Imbabura is also significant, the distance between the averages is only approximately a third of that in Cotopaxi /i/ and /e/ at 35 Hz.

These results suggest that these speakers of Cotopaxi Media Lengua are operating a four-vowel system with two front vowels (/i/ & /e/), a single mid-back vowel (/o/), and a low (/a/), while speakers of Imbabura are operating a five-vowel system, but with substantial overlap between mid and high vowel pairs (e.g., /i/ & /e/ and /u/ &/o/).

These results are interesting in that they may have implications for the origins of contact language phonology given the heterogeneity of the Cotopaxi and Imbabura vowel systems. Specifically, it appears that speakers of different dialects of the same mixed language have dealt with Spanish origin vowels in different ways. Both speakers from Cotopaxi seem to have placed substantially greater importance in differentiating /i/ from /e/ compared to Imbabura speakers, while at the same time the Cotopaxi speakers have almost completely ignored the differences between /u/ and /o/ while Imbabura speakers still maintain some degree of separation.

It is not yet known whether this is an effect of the underlying Quichua vowel systems from each region or innovations unique to Media Lengua. However, results from /o/ and /e/ in Spanish borrowings from Imbabura Quichua show a similar arrangement in acoustic space to that of Imbabura Media Lengua ([9]), therefore, it might stand to reason that /e/ and /o/ in Spanish borrowings in Cotopaxi Quichua might show clear separation between /i/ and /e/ while, /o/ and /u/ merge. Further investigation into the different phonetic realizations of the Quichua varieties spoken in each region may provide significant insight into how aspects of phonetics and phonology influence each other in the development of mixed languages.

Given the limitations inherent in a small sample size, we cannot at this stage make definitive statements regarding the differences between Media Lengua as spoken in Cotopaxi versus Imbabura, nor draw conclusions about how these differences arose. Nonetheless, the results described in this study suggest that regional differences do exist in Media Lengua, the extent and causes of which can only be guessed at presently.

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