P’urépecha fortis v. lenis consonants*

Alison Zerbe

Department of Linguistics, University of Washington
Box 354340
Seattle, WA 98195-4340
zerbea@uw.edu

Summary: This paper examines the stop and affricate phonemes in P’urépecha, a language isolate from Michoacán, Mexico previously described as having a fortis and lenis contrast. Using data collected from two native speakers, the current investigation considers VOT, burst amplitude as compared to vowel amplitude (normalized amplitude), and f0 development as possible distinguishing factors of the contrast to more accurately describe the phonemes. The research presented in this paper finds that VOT significantly distinguishes the phoneme pairs, while pitch and normalized energy were not found to have an effect.

Keywords: fortis, lenis, VOT, fundamental frequency, normalized amplitude

*Acknowledgements: I would like to thank Dr. Sharon Hargus for her input and assistance in this investigation, without which I would not have been able to complete the project. Additionally, thank you to the speakers who graciously participated in the data recording and Khia Johnson for aligning a sample of tokens for VOT analysis.

University of Washington, Working Papers in Linguistics (UWWPL), Volume 31 (2013),

1 Background

P'urépecha (ISO 639-3: tsz) is a language isolate from Michoacán, Mexico spoken by approximately 40,000 speakers (Lewis 2009). The language was formerly referred to as Tarascan, retained in the language code, but has lately been termed P'urépecha per speakers' preferences.

While in recent years P'urépecha has experienced a revival that has resulted in attempts to implement the language in education forums, including the university level (Zavala 2010), the population has been considerably divided through immigration to California, Arizona, Oregon and Texas (Kemper & Adkins 2006). This demarcation of the community of speakers combined with the encroachment of Spanish is resulting in a language atmosphere in which the language is changing rapidly and is vulnerable to becoming obsolete (Ragone & Marr 2006, Chamoreau 2002).

1.1 Previous linguistic descriptions

The earliest written record of P'urépecha is a dictionary compiled by a missionary (Gilberti 1559). Contemporary research into the language has produced further dictionaries including *Diccionario de la Lengua Michhuaque (*Cervantes & Felipe 2009) and the online dictionary supported by the Summer Institute of Linguistics (SIL) *Vocabulario del Idioma Purépecha* (Lathrop 2007).

Grammatical research has been limited to morphological and semantic studies (Friedrich 1984, 1969, 1970; Mendoza 2007; Garza 2011) and impressionistic phonetic descriptions. The first modern linguistic grammar of P'urépecha (Foster 1969), offers an overview of the phonology`, agglutanization processes, and syntax. In her discussion of the phonemic system in the language, Foster asserts that the consonant system of P'urépecha contains a distinction between voiceless aspirated and voiceless unaspirated stops and affricates at several places of articulation, as seen in Table 1.

Table 1: P'urépecha Consonant Inventory (after Foster 1969)

	Bilabial	Alveolar	Post-Alveolar	Palatal	Velar
Stop	pʰ p	tʰ t			kʰ k
Fricative		s	ʃ		x
Affricate		tsʰ ts	tʃʰ tʃ		
Approximant	w	ɹ		j	
Nasal	m	n			

Consonants in bold-type are of interest to the research

The P'urépecha vowel inventory that she provides is given in Table 2.

Table 1: P'urépecha Vowel Inventory

	Front	Central	Back
High	i	ɨ	u
Mid	e		o
Low		ɐ	

The claim that the stop and affricate series contains distinct phonemes differing in their aspiration is sustained in Friedrich's grammar of the language in which he describes the obstruent series as being comprised of lenis and fortis consonants (1975). A recent synchronic study of the language similarly describes obstruent phoneme pairs as differing in their aspiration (Chamoreau 2002). According to Foster (1969), aspirated obstruents are de-aspirated when following a consonant. While the stop series underlying contains only voiceless phonemes, unaspirated phonemes are realized as voiced when following a nasal consonant (Foster 1969).

1.2 "Fortis" and "Lenis"

The terms "fortis" and "lenis" have been the source of controversy in phonetic and phonological descriptions. At the base of this controversy are vague definitions of the terms themselves. Jaeger 1983 claims that fortis consonants are produced with greater "force of articulation" than their lenis counterparts. The assertion that fortis/lenis pairs differ in their force of articulation implies that fortis phonemes are produced with greater constriction of the articulators (DiCanio 2012). While tension of the articulators could be measured directly, for example with the use of electropalatography, many linguistic research studies are confined to examining the acoustical relationships of such articulator tension in the lack of such equipment. Acoustically, greater constriction of the articulators is expected to begin with greater pulmonic effort which generates a greater airflow through the oral passage. The increased build-up in pressure during a fortis stop closure will produce indirect correlates of voice onset timing, amplitude and intensity (Leander 2012). Through examining acoustic features in fortis/lenis pairs, linguists aspire to ascertain a correspondence of an independently controlled phonetic parameter to accurately employ these terms (Jaeger 1983).

In their cross-language comparison of stop voicing, Lisker and Abramson (1964) assert that the terms “lenis” and “fortis” are ambiguous classifications and propose that aspiration and voicing information could serve as acoustic correlates that distinguish fortis and lenis pairs. Their study determined that aspiration and voicing are best examined through observing duration between the release of closure and onset of voicing in spectrograms. Cho and Ladefoged (1999) further the concept of the stop voicing ambiguity in their cross-linguistic survey of variation in voice onset timing of stop phonemes, concluding that the feature +/-aspiration may not be sufficient for accurately describing a language.

As identified by Cho and Ladefoged (1999), voice onset timing does not conclusively distinguish fortis/lenis phoneme pairs. In addition to this cross-linguistic survey of voice onset timing is the recognition that timing of gestures is controlled independently and voluntarily; therefore voice onset timing does not necessarily result from a greater “articulatory force” that is inherent in the definition of the terms fortis and lenis (Jaeger 1983).

2 Research questions, hypotheses and measures

While the available corpus of P’urépecha phonetic descriptions attests that the feature of aspiration distinguishes obstruent phonemes, thus far no formal measuring of this differentiation has been undertaken.

Main RQ: What is the nature of the Fortis/lenis contrast in P’urépecha and how does it interact with other phonetic dimensions (Place of articulation, Manner of articulation)?

Since previous cross-linguistic studies of VOT have uncovered regularities in VOT variation according to place of articulation; this study will also investigate the effect of Place of articulation on VOT of word-initial stops and affricates.

RQ1: Is the Fortis/lenis distinction in P'urépecha differentiated by VOT?

H1: It is expected that a difference in VOT will distinguish fortis and lenis word-initial stops in P'urépecha. Fortis consonants are expected to have a longer voicing lag than their lenis counterparts. The well-known effect of Place of articulation on VOT variation is expected to be found. Therefore, bilabial stops are presumed to have the shortest VOT and velar stops the longest.

Because voice onset timing alone does not determine fortis and lenis, additional acoustical measures are necessary to classify the phoneme pairs. It is expected that the increased muscle tension and greater oral air pressure present in the production of fortis phonemes will result in increased amplitude of release bursts of fortis obstruents (DiCanio 2012). To produce comparable amplitudes across and within speakers, release bursts have historically been analyzed as Normalized amplitude. Previous research by Hargus (2011), Vicenik (2010), and DiCanio (2012) have normalized the amplitude of the burst through comparison with the amplitude of the following vowel. These normalized measures allow for the amplitude of release bursts to be analyzed as possible contributions to Fortis/lenis distinctions.

RQ2: Does Burst amplitude/vowel amplitude contribute to the Fortis/lenis distinction?

H2: It is predicted that Burst amplitude and vowel amplitude will vary in the production of word initial fortis and lenis stops. Through comparing Burst amplitude and vowel amplitude, fortis stops are expected to display a greater burst and vowel amplitude than their lenis counterparts.

A final acoustical measurement that has been found to correlate to the Fortis/lenis distinction is the onset value and pattern of development of f0 (Han & Weitzman 1970). As noted by Ohde (1983) in his discussion of physiological properties of speech, vocal cord tension can be directly correlated to differences in f0. Therefore, it is expected that the "force of articulation" which differentiates fortis and lenis phonemes would result in varying f0 in the production of phonemes. In producing their perception study of the contribution of f0 to distinguishing consonants with ambiguous VOT times, Whalen et al (1992) determined that stop manner affects the f0 of the vowel following the stop release as well as concluding that f0 is an acoustic feature crucial in identifying phonemes along a VOT continuum. Research into the effect of onset values of the fundamental frequency on fortis/lenis pairs has found that vowels preceded by a fortis consonants display a higher f0 at onset than their lenis counterparts (Han & Weitzman 1970). Additionally, f0 development throughout the vowel has been found to systematically develop in different manners following a fortis and lenis stop (Han &Weitzman 1970). While results have varied according to language, aspirated fortis stops tend to display a falling f0 throughout the production of the vowel. In order to determine if f0 contributes to the Fortis/lenis distinction in P'urépecha, this study will compare the f0 development among fortis and lenis tokens.

RQ3: Does f0 contribute to the Fortis/lenis distinction?

H3: It is expected that f0 differences in fortis and lenis consonants may be found. As observed in other languages with a Fortis/lenis distinction, lenis stops rise from a low f0 to a higher fundamental frequency in the first 50-100 ms of periodicity while fortis consonants displayed a converse pattern. The stops of P'urépecha are anticipated to show the same correlations between the Fundamental frequency and Fortis/lenis.

3 Procedures

The data presented in this study are taken from recordings of two native adult male speakers of P'urépecha. To examine Fortis/lenis in P'urépecha, the speakers were recorded reading wordlists comprised of near minimal pairs containing lenis and fortis stops in word-initial position. The minimal pairs on the list contained equal numbers of all places of articulation and controlled for following vowel quality, stress and syllable structure when possible (*see Appendix*). A portion of the tokens included on the wordlist are single words while the remaining are two-word constructions intended to examine the phonological interaction of preceding nasals and consonants on word-initial lenis and fortis stops. As the research questions presented in this paper do not involve phonological alternations, the data included in this study are taken from the single-word utterances included on the wordlist. Additionally, the wordlist recorded by Speaker 2 contains supplementary words to examine fortis and lenis consonants inter-vocalically at a later date. The tokens analyzed in this study are only the words presented to both speakers which feature obstruents in word-initial position

Speakers were presented with separate randomizations of the wordlists each containing distractor words page initially and at page breaks to reduce the effect of list intonation. Prior to recording, the speaker and investigator reviewed the wordlists to ensure the speaker's familiarity with the included words as well as the orthography of the language, which is not commonly read by many speakers. Three consecutive repetitions of each token were recorded using the portable digital recorder Zoom H4n at a 44.1 Hz sampling rate and 16 bit rate with external microphones arranged in the stereo setting.

3.1 VOT data analysis

VOT was analyzed using Praat version 5.3 (Boersma & Weenink), in a 225 ms window using the standard settings of maximum formant height 5500 Hz with overlaid 5 coefficient LPC, window size of 25ms, dynamic range of 30 dB, and dot size of 1mm. The parameters for measurements were chosen after viewing all recorded tokens and estimating these settings appropriate to offer a consistent analysis. VOT was measured from the onset of the release burst to the onset of periodicity of the following vowel. This decision was based on a review of the literature regarding VOT duration which asserts that the duration of the release burst until the point of periodicity best describes VOT (Han & Weitzman 1970, Hardcastle 1973, Kim 1965, 1970, Lisker & Abramson 1964, Cho & Ladefoged 1999; Árnason 2011). The onset of periodicity of fricative tokens was determined by the onset of F2. All three samples of each word, excluding distractor words, words which displayed word-initial consonant clusters or instances of high noise interference, were measured for a total of 268 measured tokens.

Using the same criteria for measurement, a second investigator independently aligned 8% of the recorded tokens to ensure accuracy. The aligned subset of data contained instances of fortis and lenis consonants in all places of articulation. The measurements taken by the second investigator were compared to those of the principal researcher and disagreements were resolved to guarantee that all data were consistently measured to answer the research questions.

3.2 Normalized energy data analysis

As with VOT measurements, Normalized energy was analyzed in Praat (version 5.3) using the standard settings of maximum formant height 5500 Hz with overlaid 5 coefficient LPC, window size of 25ms, dynamic range of 30 dB, and dot size of 1mm. The standard intensity settings of 50 – 100 dB range, mean energy averaging method and subtracted mean pressure were retained for the analysis. Burst amplitude measurements were taken from the high point of peak intensity. Vowel amplitude was determined as the mean energy of a 30 ms window centered around the point of highest intensity in the vowel. Peak energy of vowels was established through requesting the intensity listings of the entire vowel. To normalize amplitude, burst amplitude was subtracted from the mean vowel amplitude peak:

Normalized amplitdue: $vowel_{peak\ intensity} – burst_{peak\ intensity}$

As discussed in *2*, normalization of energy was determined to regulate amplitude variations across as well as within speakers (Hargus 2011, Vicenik 2010, & DiCanio 2012). All three samples of each word, excluding distractor words, words which displayed word-initial consonant clusters or instances of high noise interference, were measured for a total of 273 measured tokens.

3.3 f0 data analysis

Analyzed in Praat (version 5.3), development of pitch was examined through comparing the development of f0 in the vowel following the fortis or lenis consonant. Pitch measurements were taken using a 500 ms window beginning at the onset of the vowel. Within this window mean pitch was extracted from a 25 ms window at vowel onset. One token was hand measured because the Praat automatic pitch tracker was unable to calculate pitch at the vowel onset. Hand measurement of this token consisted of using a 25 ms window starting at vowel onset and counting the peaks within the window. The total number of simple periodic wave peaks was then divided by the window size, 0.025. The result of this hand measurement matched the expected pitch for this token as compared to the other 2 instances of the word.

A second pitch measurement was taken in a 25 ms window centered around vowel midpoint. Mean pitch from vowel onset and vowel midpoint were then normalized to make the results comparable within speaker and across speaker. By subtracting the vowel onset from the vowel midpoint, positive normalized pitch results will indicate that pitch was raised throughout the production of the vowel as expected in H3.

Normalized pitch = $vowel\ midpoint_{mean\ pitch}$ - $vowel\ onset_{mean\ pitch}$

Calculating the pitch in this manner allows for the analysis to examine how pitch develops from the vowel onset to the midpoint of the vowel. Positive normalized pitch results indicate that pitch was less at vowel onset than at vowel midpoint, or pitch increased throughout the realization of the vowel. Negative normalized pitch results indicate that pitch was greater at vowel onset than vowel midpoint, indicating a pitch decrease.

In addition to distractor words, tokens with vowels shorter than 50 ms were not analyzed because the overlap in pitch windows was found to misconstrue the results and not accurately describe pitch change over the vowel.

4 Results

Results for each measure were submitted to two 2-factor ANOVAs with an alpha value of 0.05. In one ANOVA the independent variables were Place of articulation and Fortis/lenis. In another ANOVA the independent variable were Manner of articulation and Fortis/lenis. It was necessary to use two 2-factor ANOVAs (rather than one 3-factor ANOVA) because not all manner distinctions (stop vs. affricate) are found at each of the places of articulation (bilabial, alveolar, velar) as seen in Table 1

Results for each speaker are presented separately so as to avoid the possibility of type 1 error (specifically, inflation cause by pooling results for the two speakers). Figures contain error bars of 1 standard deviation.

4.1 VOT results

Effect of Fortis/lenis and Place on VOT for Speaker 1

For Speaker 1, fortis consonants had significantly longer ($F\ [1,83] = 23.521$; $p<.0001$) VOT than lenis. A significant effect was also found for Place of articulation on VOT ($F\ [2,83]= 16.803$; $p<.0001$). No reliable interaction effect was found.

Turning to significant differences between places of articulation, results submitted to Fisher's PLSD post hoc test reveal that bilabial stops have significantly longer VOT than alveolar ($p = .0028$). Velar stops were found to be significantly longer than alveolar and bilabial stops (velar v. alveolar $p<.0001$, velar v. bilabial $p = .0152$). Results are illustrated in Figure 1.

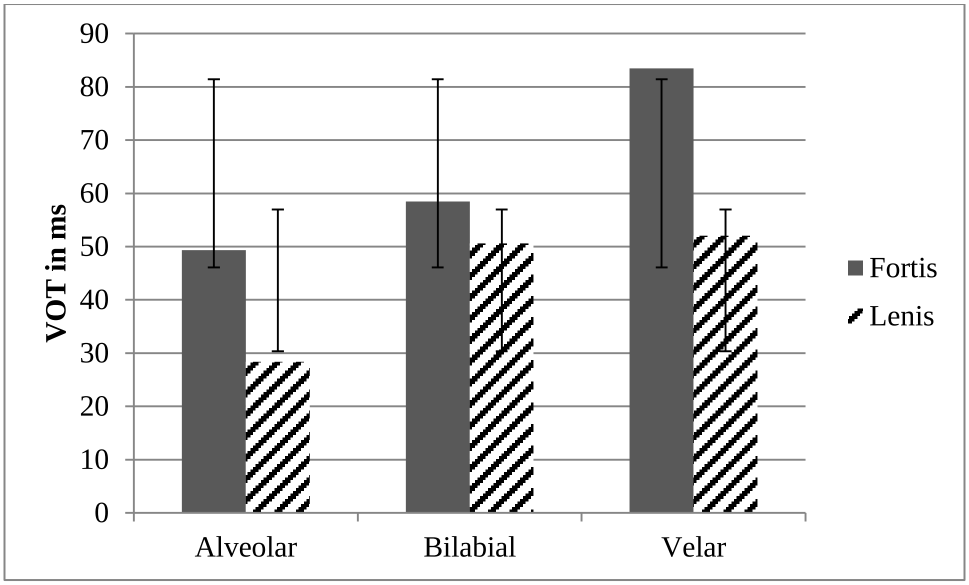

Figure 1: Speaker 1 VOT and Place of Articulation

Speaker 1 Variability

The following spectrograms are included to illustrate the intraspeaker variability found for Speaker 1 VOT in fortis alveolar, lenis alveolar, and fortis bilabial tokens.

Fortis alveolar stops

To illustrate the intraspeaker variability found for Speaker 1, Figures 2 and 3 show the range of VOT values found for Speaker 1 Fortis alveolar tokens with spectrograms. Figure 2 depicts the short VOT of “t’amk’u,” (34 ms.), while Figure 3 demonstrates the long VOT (78 ms.) for “t’ireni.”

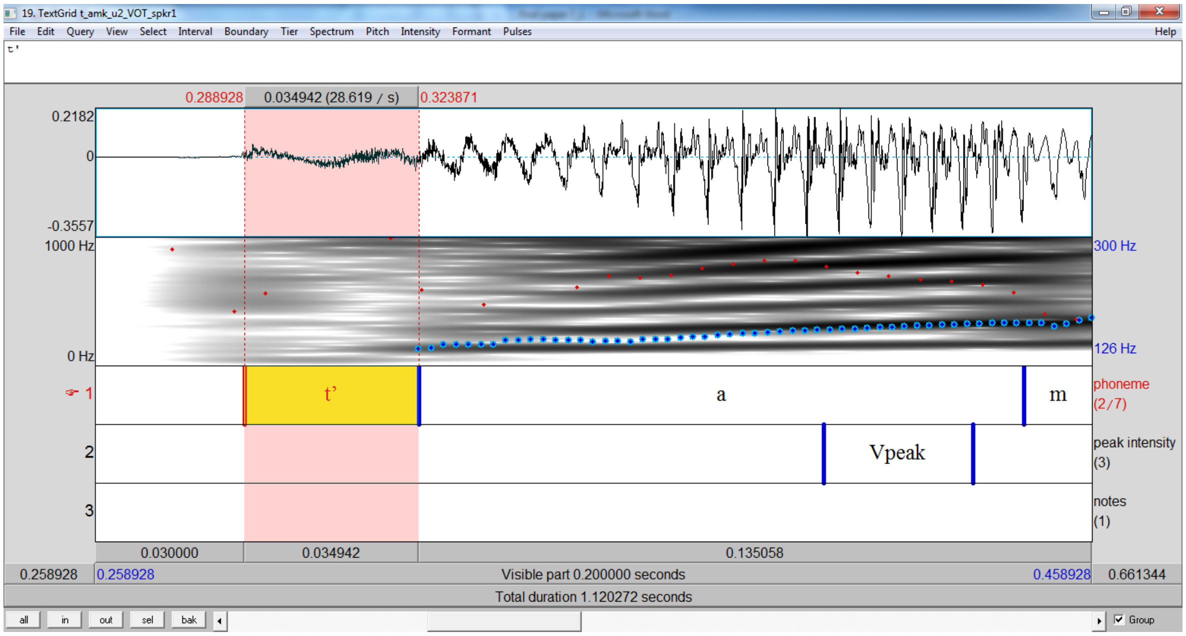

Figure 2: Speaker 1 “t’amk’u”

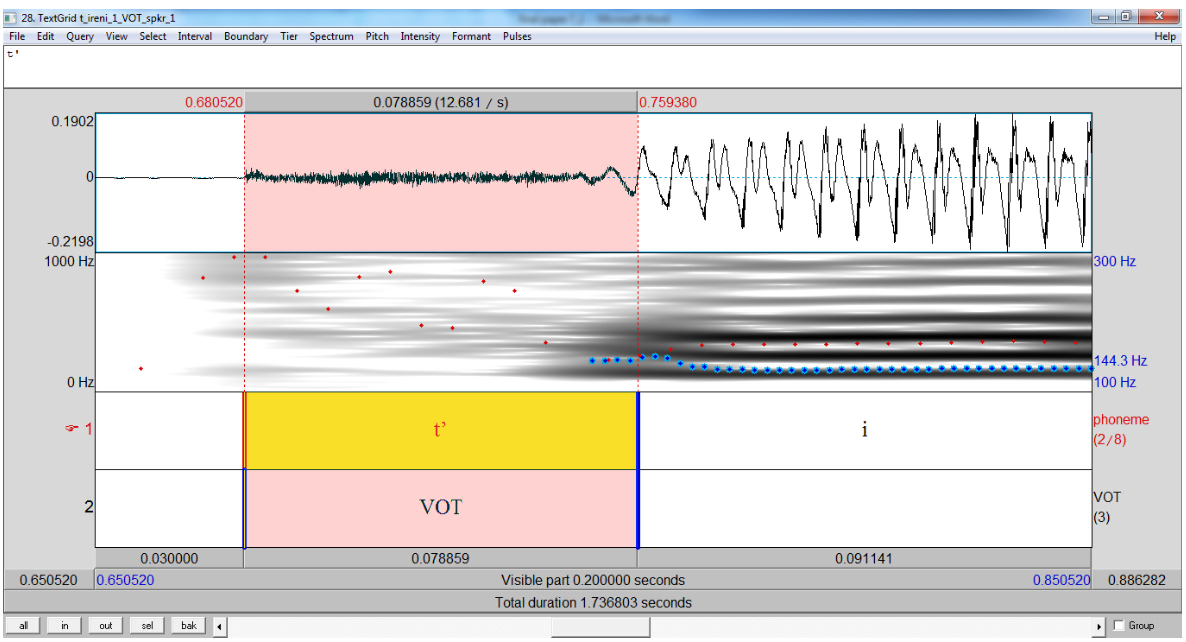

Figure 3: Speaker 1 “t’ireni”

Lenis alveolar stops

Due to the variability found within Speaker 1 lenis alveolar tokens, the following spectrograms show the extremes found within this category for the speaker. The spectrogram found in Figure 4 illustrates the relatively short VOT found in “tumina” (11 ms.) compared to the longer VOT of “tirhimuni” (73 ms.) in Figure 5.

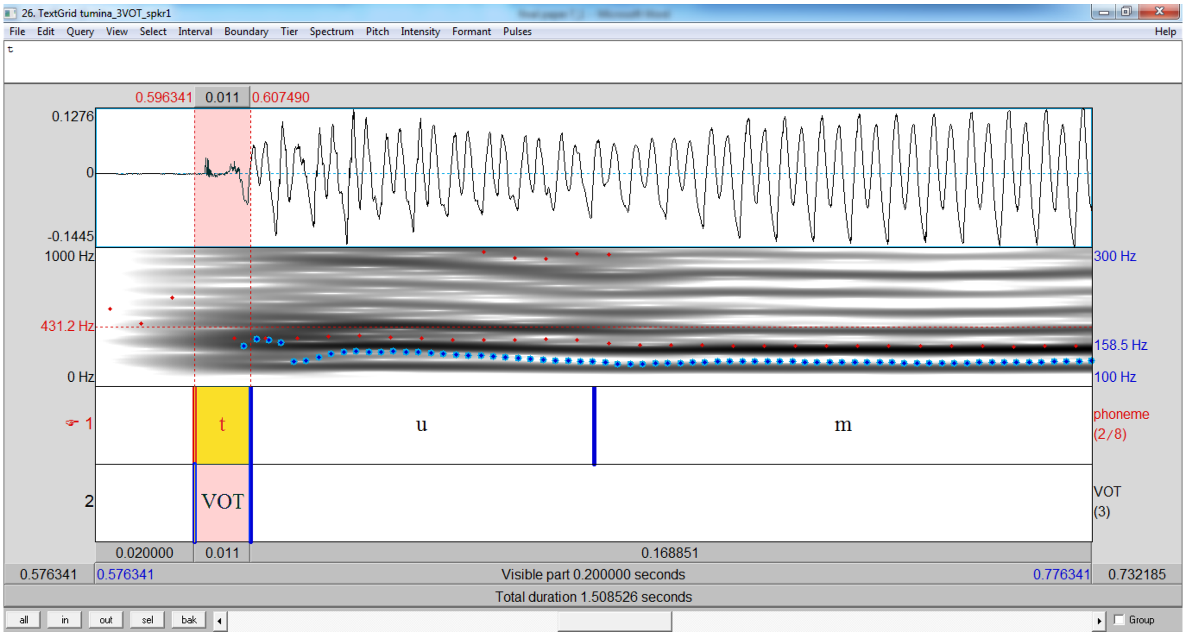

Figure 4: Speaker 1 "tumina"

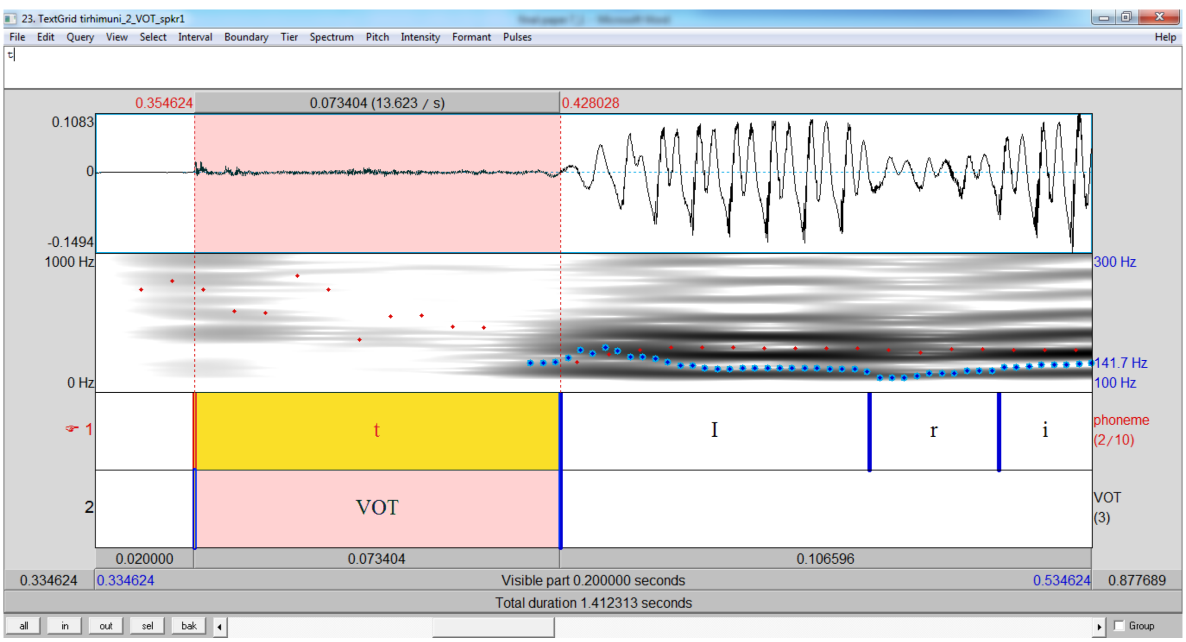

Figure 5: Speaker 1 "tirhimuni"

Fortis bilabial stops

Figures 6 and 7 illustrate the variability found for Speaker 1 within the fortis bilabial stop tokens. Figure 6 demonstrates the short VOT of "p'arini" (28 ms.) compared with the relatively long VOT found in Figure 7, "p'irani" (74 ms.).

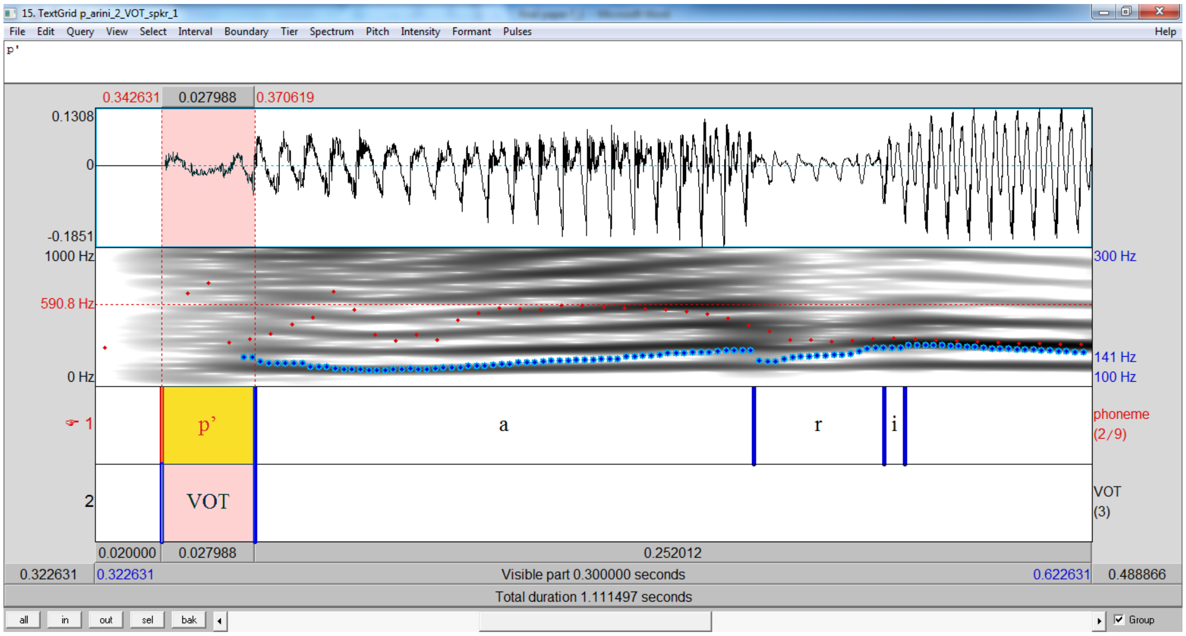

Figure 6: Speaker 1 "p'arini"

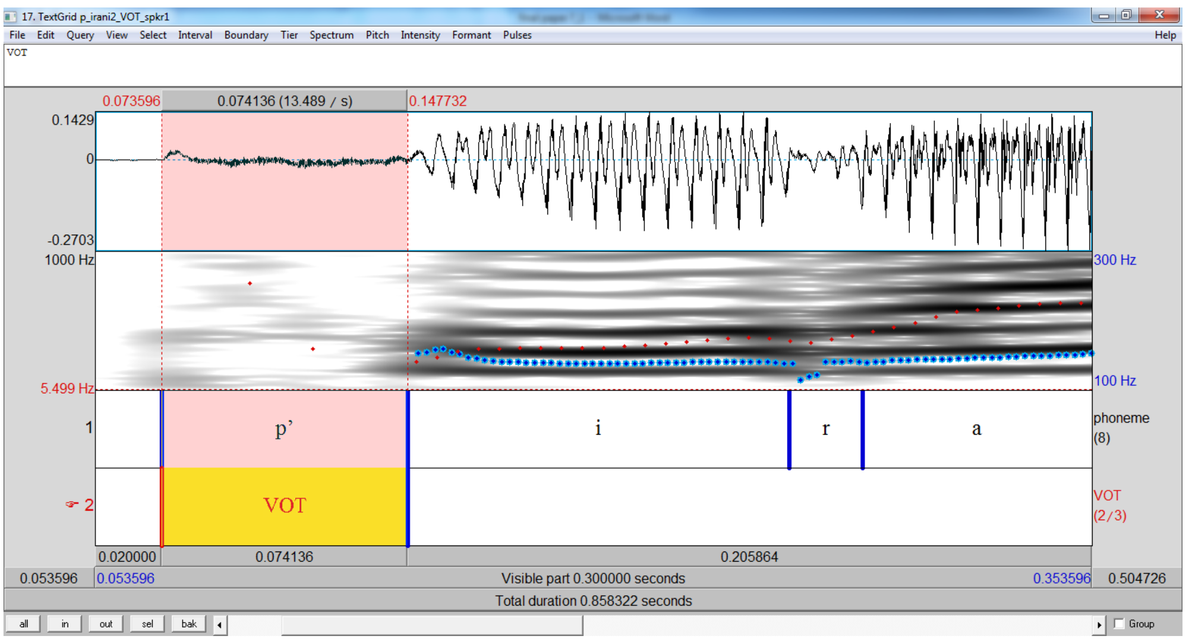

Figure 7: Speaker 1 "p'irani"

Effect of Fortis/lenis and Place on VOT for Speaker 2

For Speaker 2, fortis stops were found to have significantly longer VOT than lenis ($F\ [1,77] = 59.116$; $p<.0001$). A significant effect was also found for Place of articulation on VOT ($F\ [2,77] = 6.717$; $p=.00$). No reliable interaction effect was found. Results are shown in Figure 8.

Results further submitted to a Fisher's PLSD show that velar stops have significantly greater VOT than alveolar and bilabial stops (velar v. alveolar p = .0021, velar v. bilabial p = .0043). No significant difference was found between alveolar and bilabial stop VOT.

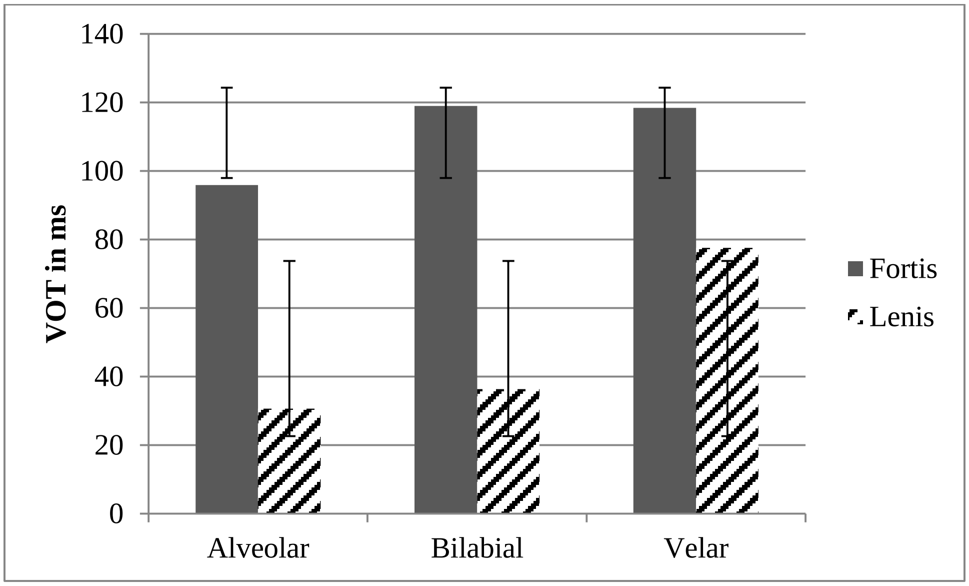

Figure 8: Speaker 2 VOT and Place of Articulation

Speaker 2 Variability

The following spectrograms illustrate the intraspeaker variability found for Speaker 2 for lenis alveolar and lenis bilabial tokens.

Lenis alveolar stops

Spectrograms displayed in Figures 9 and 10 illustrate the variability found for Speaker 2 within lenis alveolar tokens. Figure 9 depicts the relatively short VOT of "tumina" (9 ms.) and Figure 10 shows the longer VOT found in "tirhipuni" (38 ms.)

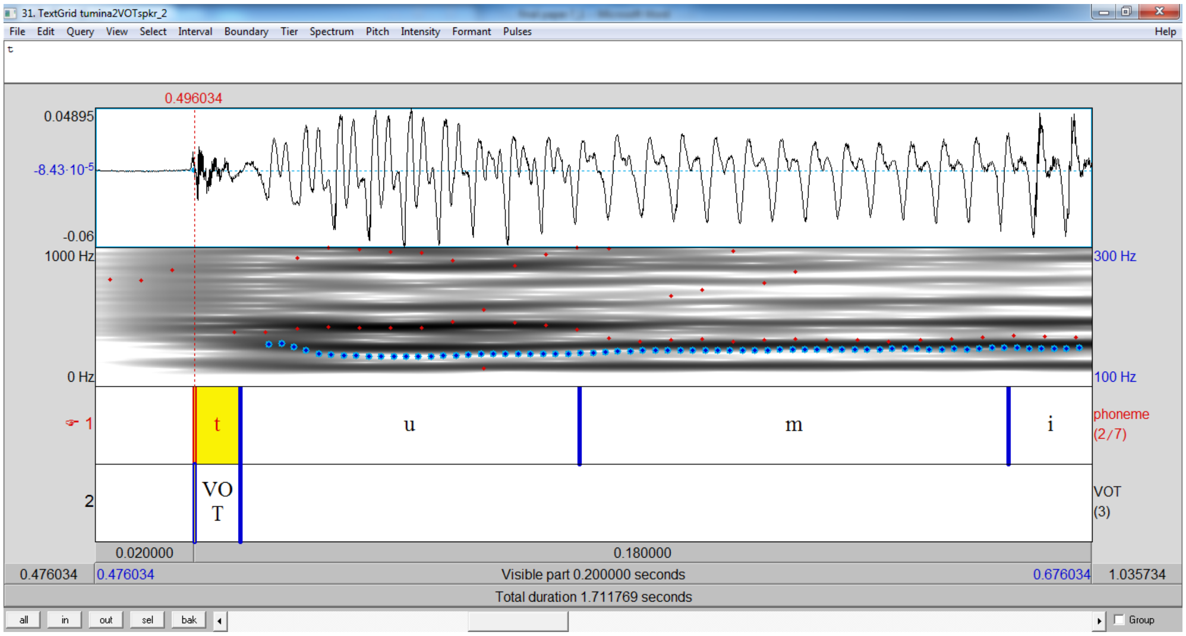

Figure 9: Speaker 2 "tumina"

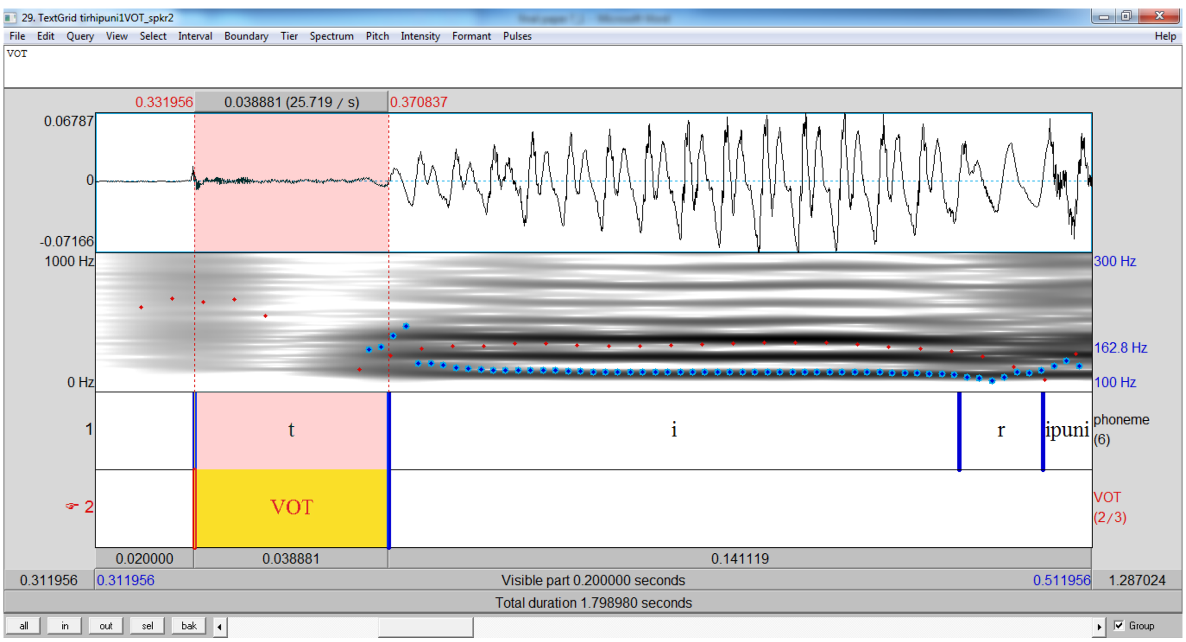

Figure 10: Speaker 2 "tirhipuni"

Lenis bilabial stops

Figures 11 and 12 compares the VOT found for Speaker 2 lenis bilabial tokens. Figure 11 depicts the relatively shorter VOT found in "pambini" (10 ms) compared to the longer VOT in "porhechi" (116 ms.).

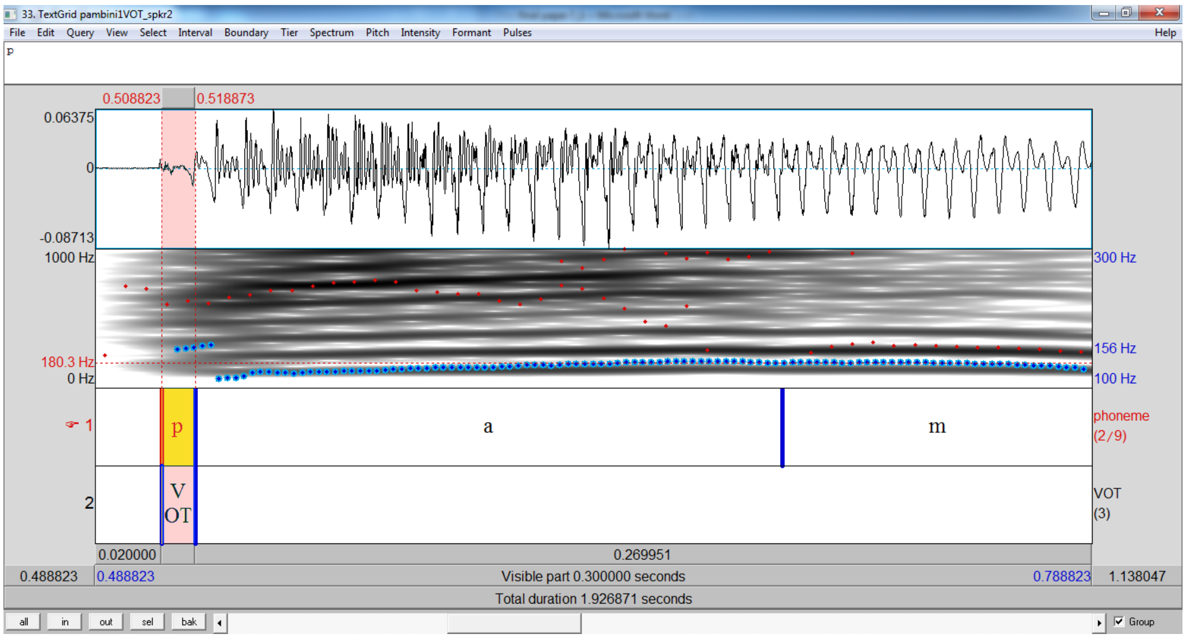

Figure 11: Speaker 2 "pambini"

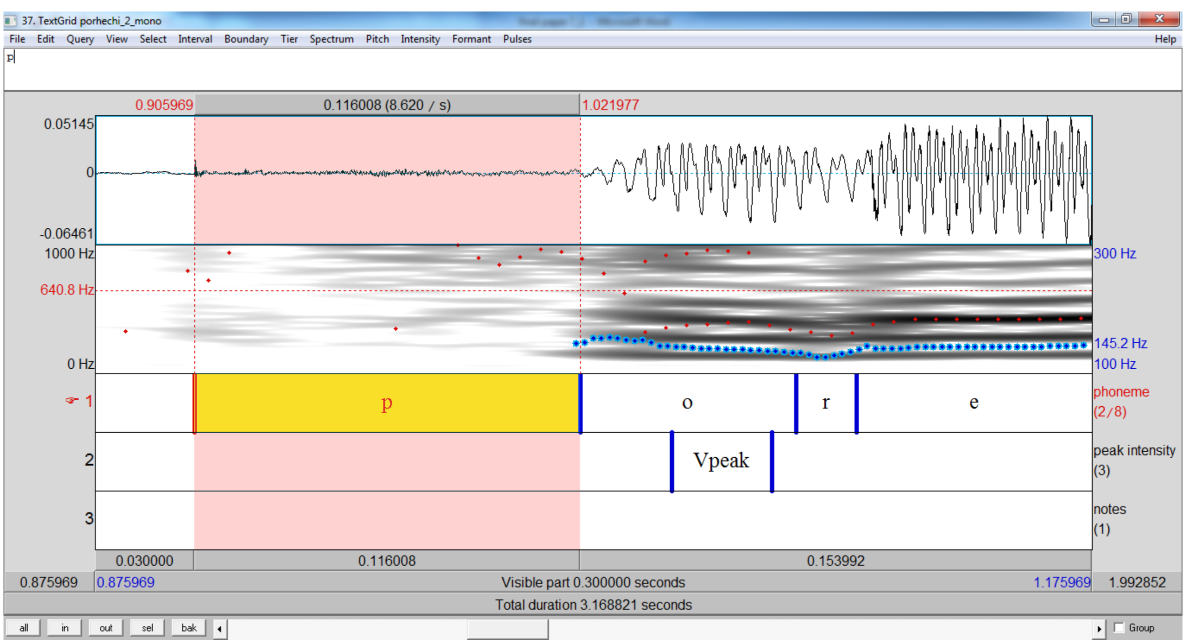

Figure 12: Speaker 2 "porhechi"

Effect of Fortis/lenis and Manner on VOT for Speaker 1

For Speaker 1 affricates had significantly longer ($F[1,134]=111.552$; $p<.0001$) VOT than stops. Fortis consonants had significantly longer ($F[1,134]= 20.575$; $p<.0001$) VOT than lenis consonants. No reliable interaction was found between Manner and Fortis/lenis. Results are shown in Figure 13.

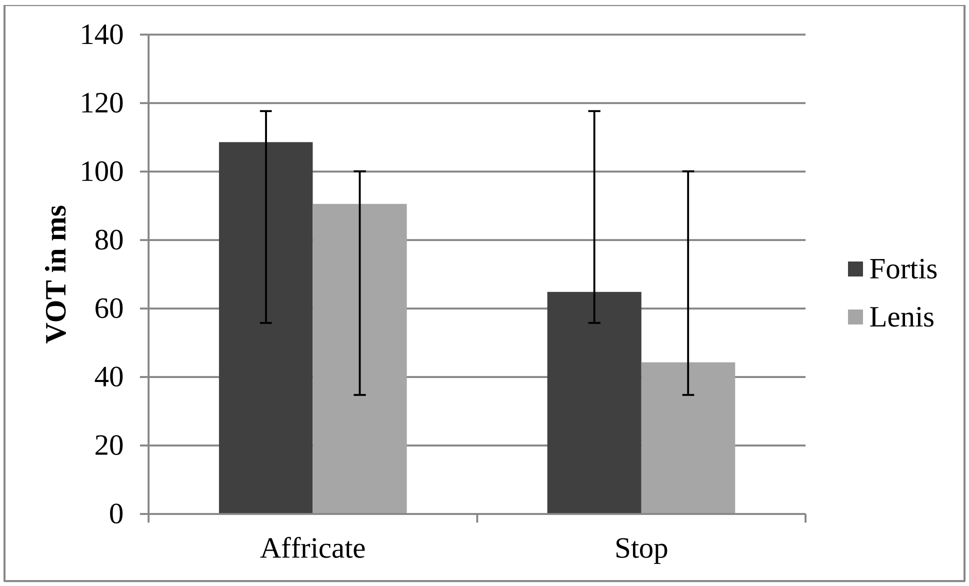

Figure 13: Speaker 1 VOT and Manner of Articulation

Speaker 1 Variability

The following spectrograms are included to illustrate the intraspeaker variability found for Speaker 1 VOT among fortis and lenis stops.

Fortis stops

Figures 14 and 15 illustrate the variability found for Speaker 1 among fortis stops and VOT. Figure 14 displays a relatively short VOT in “p’arini”” (27 ms.) compared to the VOT found in Figure 15 “k’uini” (102 ms.).

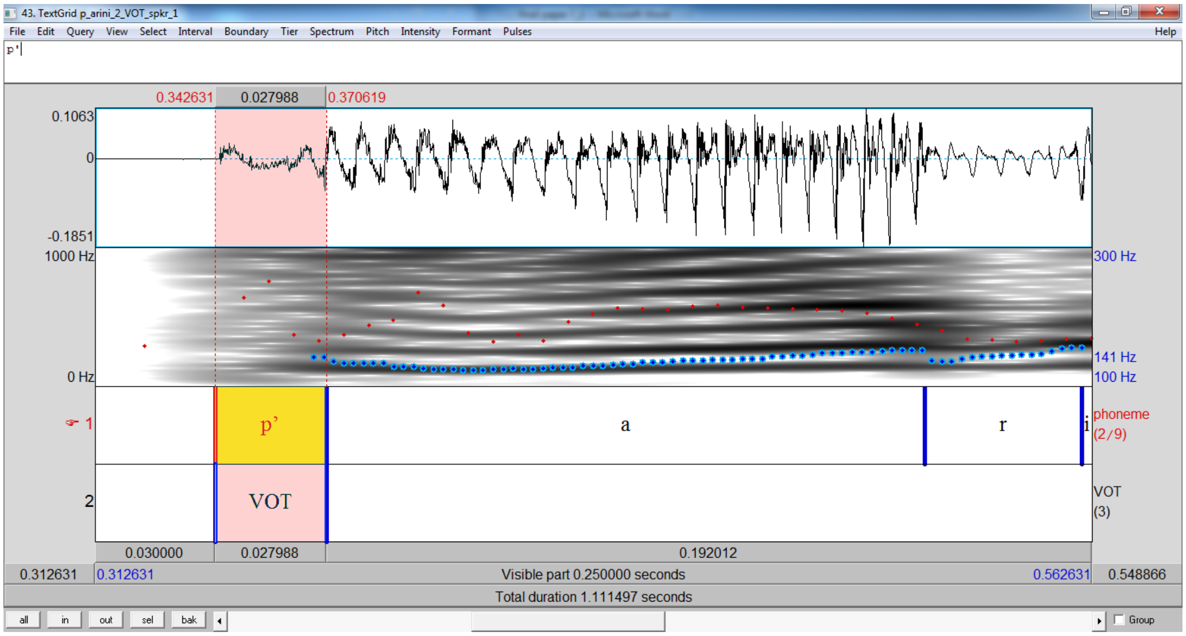

Figure 14: Speaker 1 "p'arini"

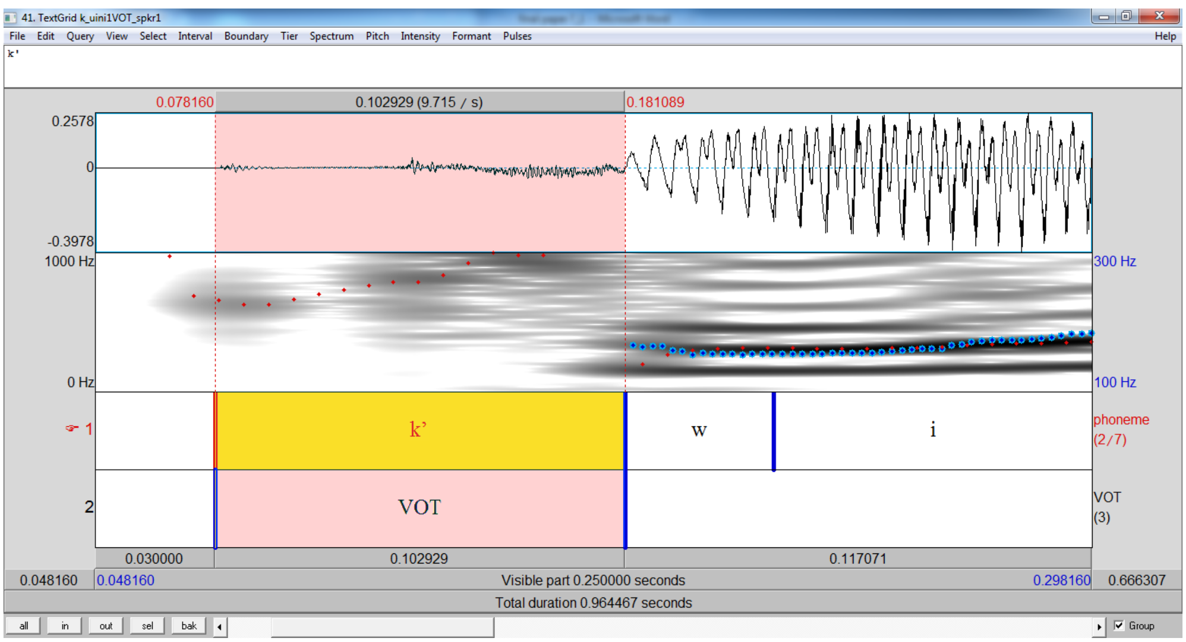

Figure 15: Speaker 1 "k'uini"

Lenis stops

Figures 16 and 17 depict the variability found for Speaker 1 among lnis stops. The spectrograms compare the relatively short VOT of "tumina" (11 ms.) and longer VOT of "kerenda" (80 ms.)

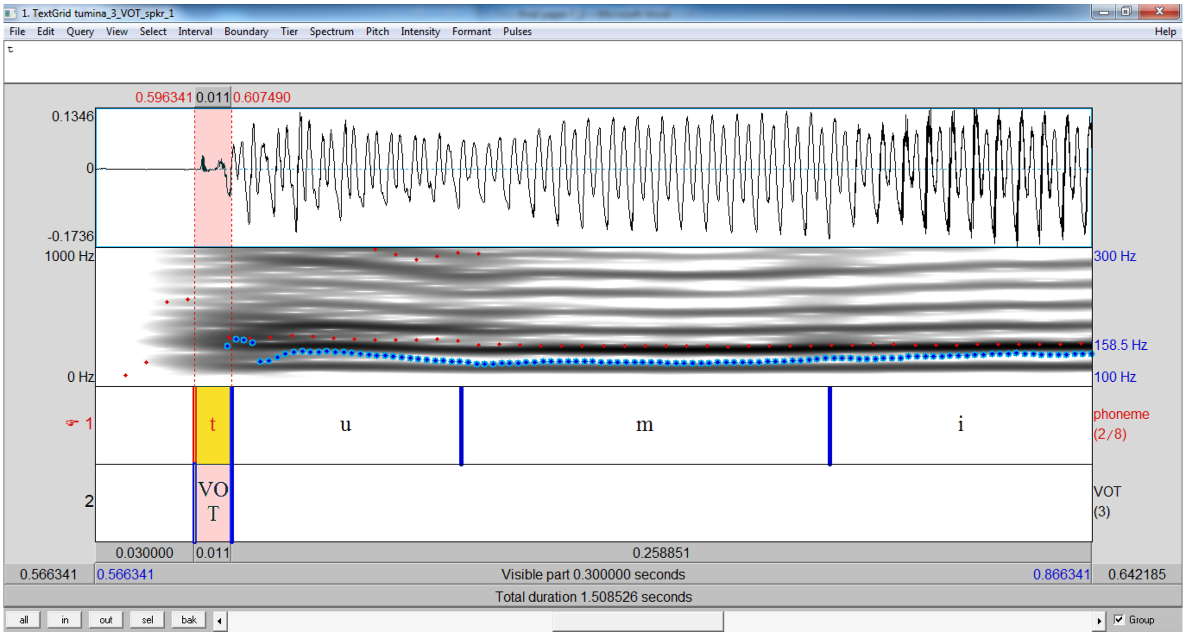

Figure 16: Speaker 1 "tumina"

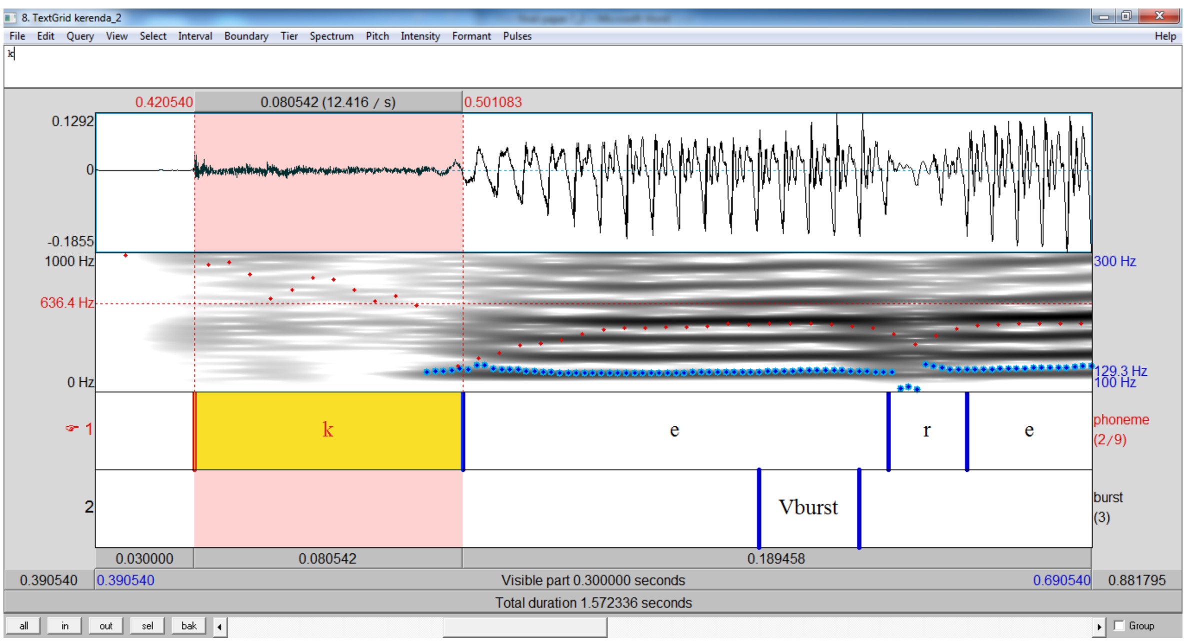

Figure 17: Speaker 1 "kerenda"

Effect of Fortis/lenis and Manner on VOT for Speaker 2

For Speaker 2, fortis consonants had significantly longer ($F[1,124] = 25.538$; $p<.0001$) VOT than stops. Affricates also had significantly longer ($F[1,124]= 8.224$; $p= .0049$) VOT than stops, but for this speaker there was a significant interaction between Manner and Fortis/lenis ($F[1,124]= 8.639$;

p= .0039). Most of the difference between fortis and lenis consonants can be attributed to the affricates rather than stops, as can be seen in Figure 18.

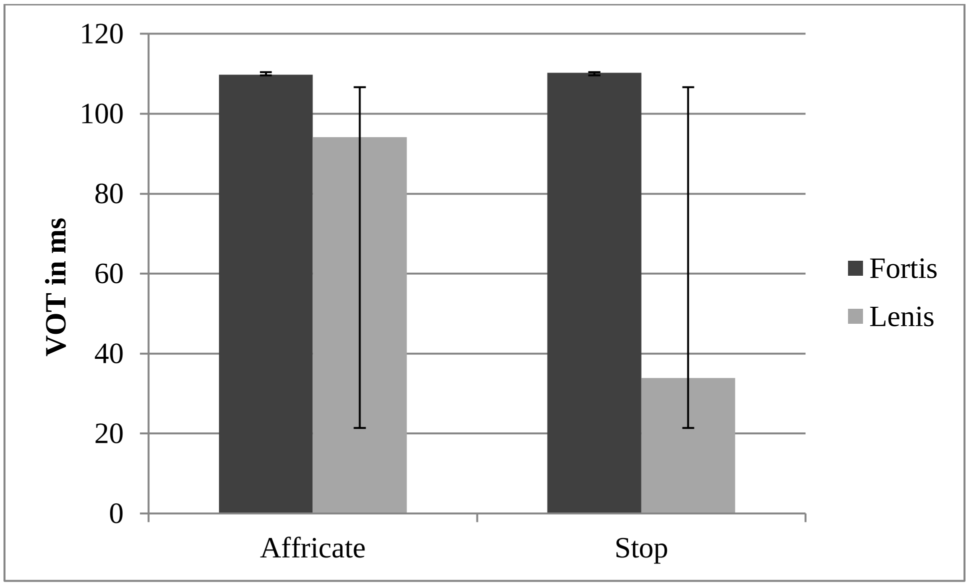

Figure 18: Speaker 2 VOT and Manner of Articulation

Speaker 2 Variability

The following spectrograms are included to illustrate the intraspeaker variability found for Speaker 2 VOT among lenis stops.

Lenis stops

Figures 19 and 20 illustrate the variability found for Speaker 2 among lenis stops. Figure 19 depicts the relatively short VOT of "tumina" (9 ms.) while Figure 20 shows the longer VOT of "kani" (128 ms.).

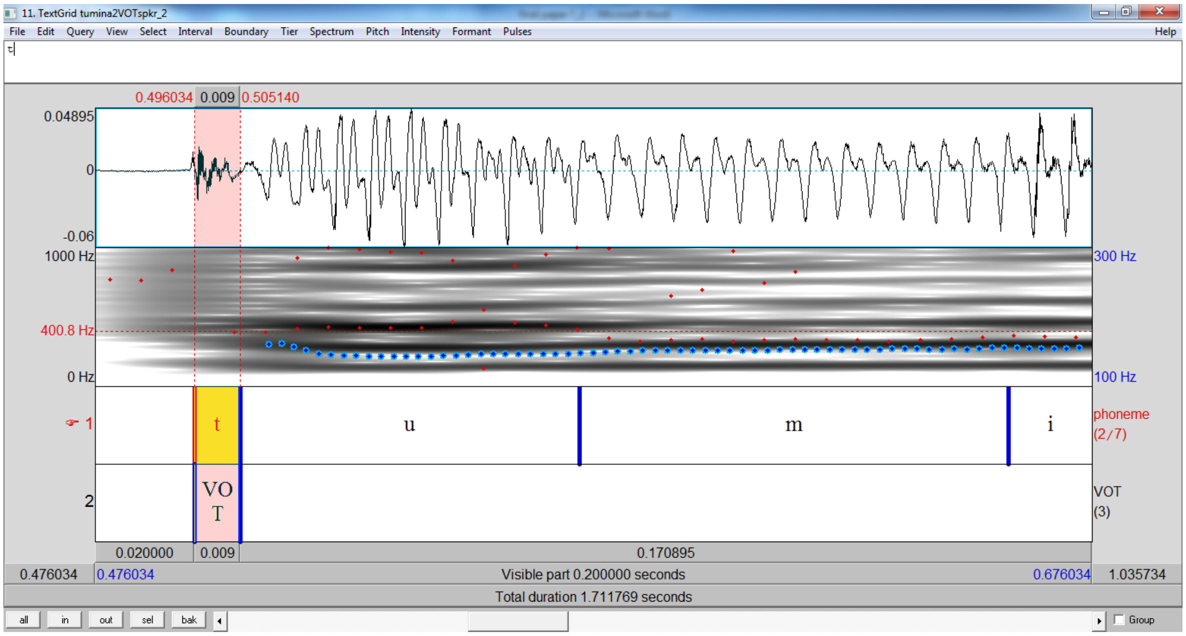

Figure 19: Speaker 2 "tumina"

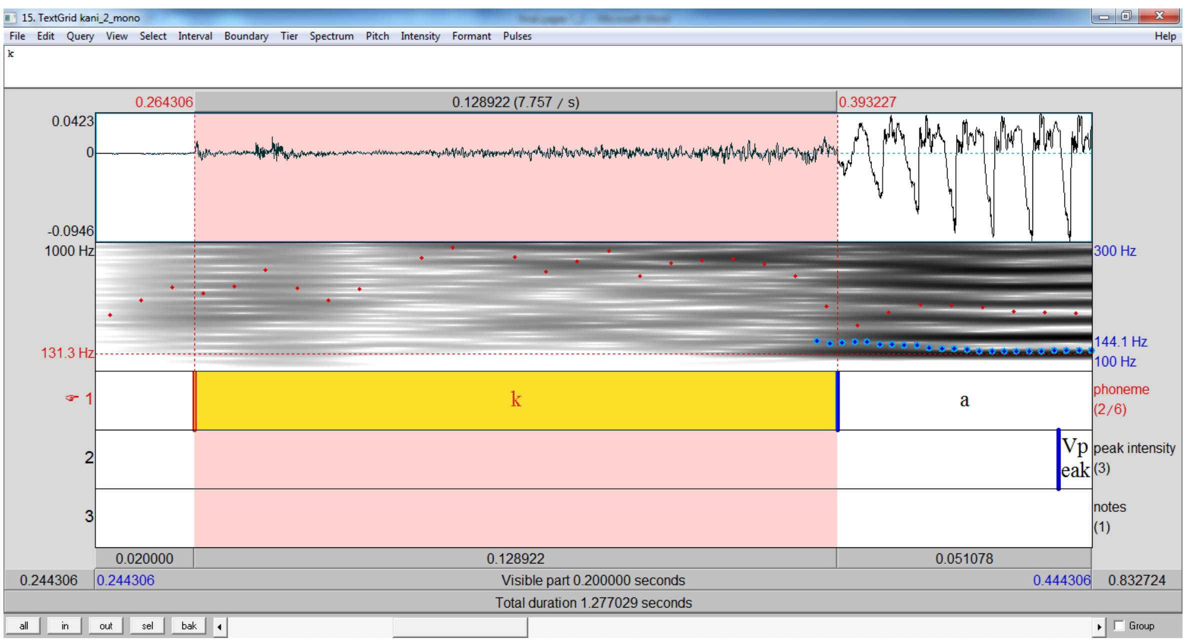

Figure 20: Speaker 2 "kani"

4.2 Normalized energy results

Effect of Fortis/lenis and Place on Normalized Energy for Speaker 1

For Speaker 1, fortis consonants were found to have a significantly greater Normalized energy than lenis consonants ($F[1,84] = 9.186$; $p = .0032$). A significant effect was also found for Place of articulation on Normalized energy ($F[2, 84] = 6.706$; $p = .0020$). No reliable interaction effect was found.

Results submitted to Fisher's PLSD found that velar stops have significantly greater Normalized energy than alveolar and bilabial stops (velar v. alveolar $p = .0010$, velar v. bilabial $p = .0059$). No significant difference was found for the Normalized energy of alveolar stops v. bilabial stops. Results are illustrated in Figure 21.

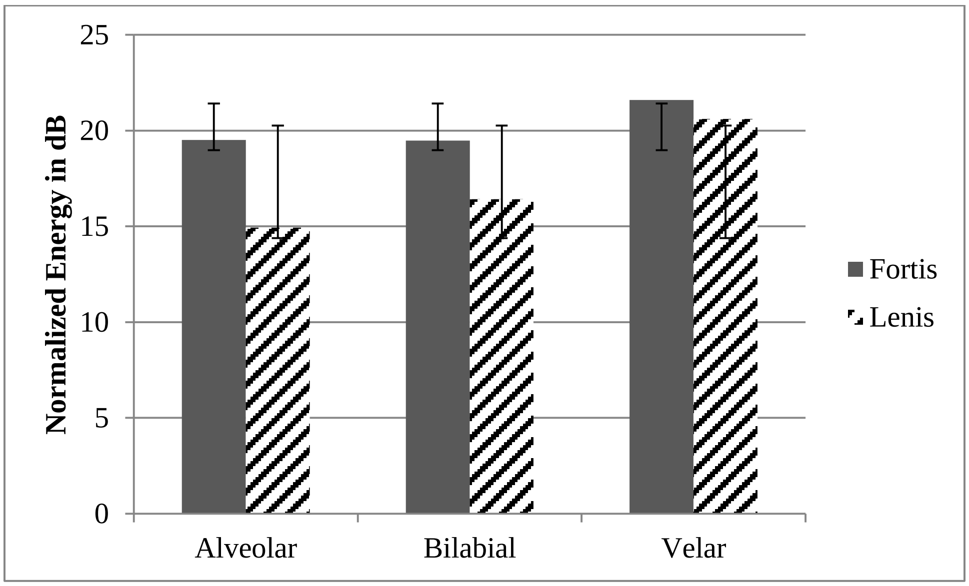

Figure 21: Speaker 1 Normalized Energy and Place of Articulation

Effect of Fortis/lenis and Place on Normalized Energy for Speaker 2

For Speaker 2, fortis consonants were not found to have a significantly greater Normalized energy than lenis consonants. No significant effect of Place of articulation on Normalized energy was found. No reliable interaction effect was found. Results are illustrated in Figure 22.

Results further submitted to Fisher's PLSD found that bilabial stops have significantly greater Normalized energy than alveolar ($p = .0370$). No significant difference was found between the Normalized energy of velar v. alveolar or velar v. bilabial.

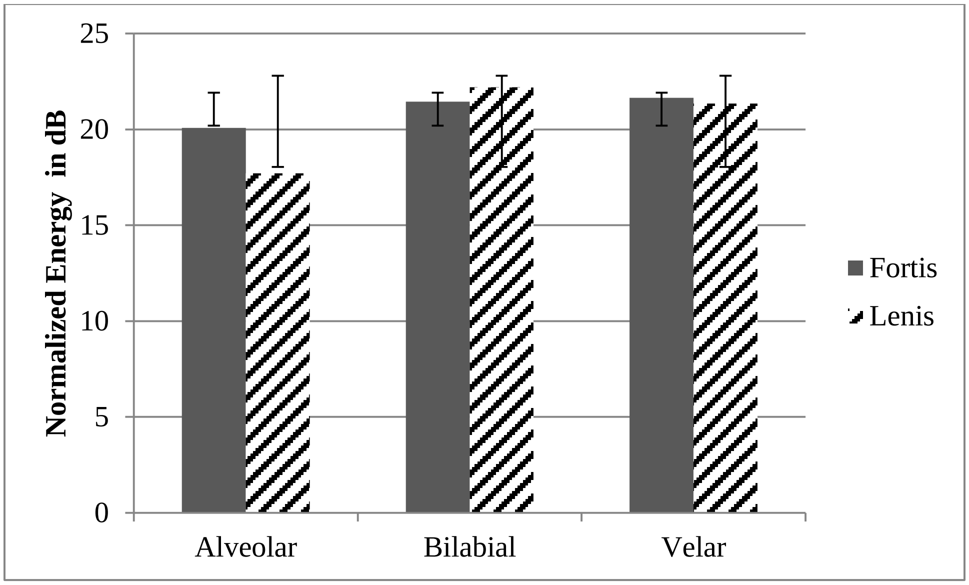

Figure 22: Speaker 2 Normalized Energy and Place of Articulation

Effect of Fortis/Lenis and Manner on Normalized Energy for Speaker 1

For Speaker 1 stops were found to have a significantly greater Normalized energy (F [1,137] 91.883; p<.0001) than affricates. No significant effect was found for Fortis/lenis on Manner. A reliable interaction effect of Manner and Fortis/lenis was found (F [1,137] 12.743; p =.0005). Results are displayed in Figure 23.

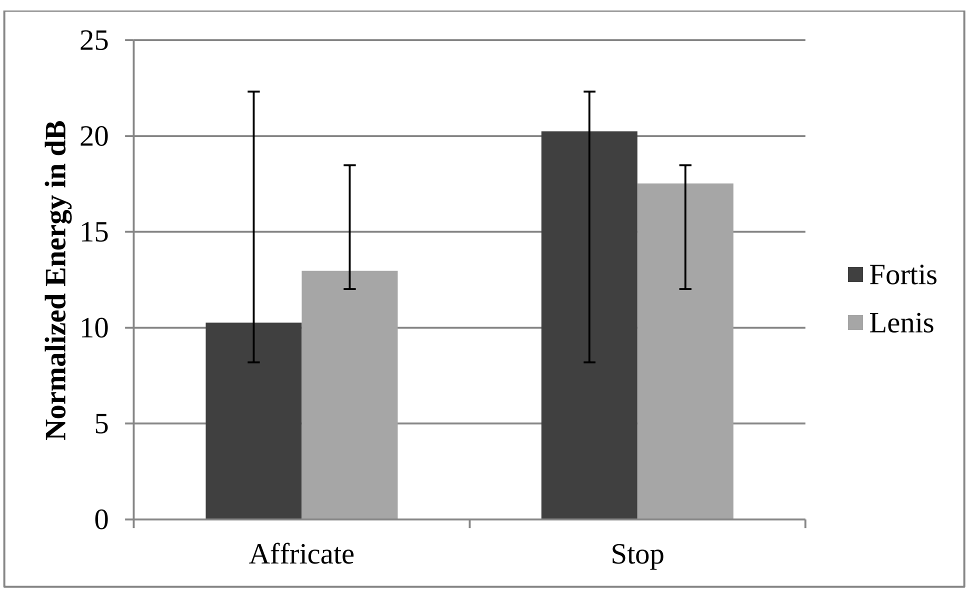

Figure 23: Speaker 1 Normalized Energy and Manner of Articulation

Speaker 1 Variability

Figures 24 and 25 demonstrate the variability found for Speaker 1 Normalized energy among fortis affricates. Burst amplitude was taken at the point of greatest intensity within the burst. Vowel peak amplitude was determined from the mean intensity of a 30 ms. window centered around the highest point of intensity within the vowel. This 30 ms. window is highlighted in the following spectrograms.

Fortis affricates

Figures 24 and 25 depict the variability found among fortis affricates for Speaker 1. Figure 24 illustrates the relatively low Normalized energy found in “ts’auapiti” with a Burst intensity of 72.694 dB, Vowel peak intensity of 68.379 dB and Normalized energy of 4.315 dB. Figure 25 shows a relatively high Normalized energy found in “ch’ech’eraxe” with a Burst intensity of 74.276 dB, Vowel peak intensity of 57.116 and Normalized energy of 17.159 dB.

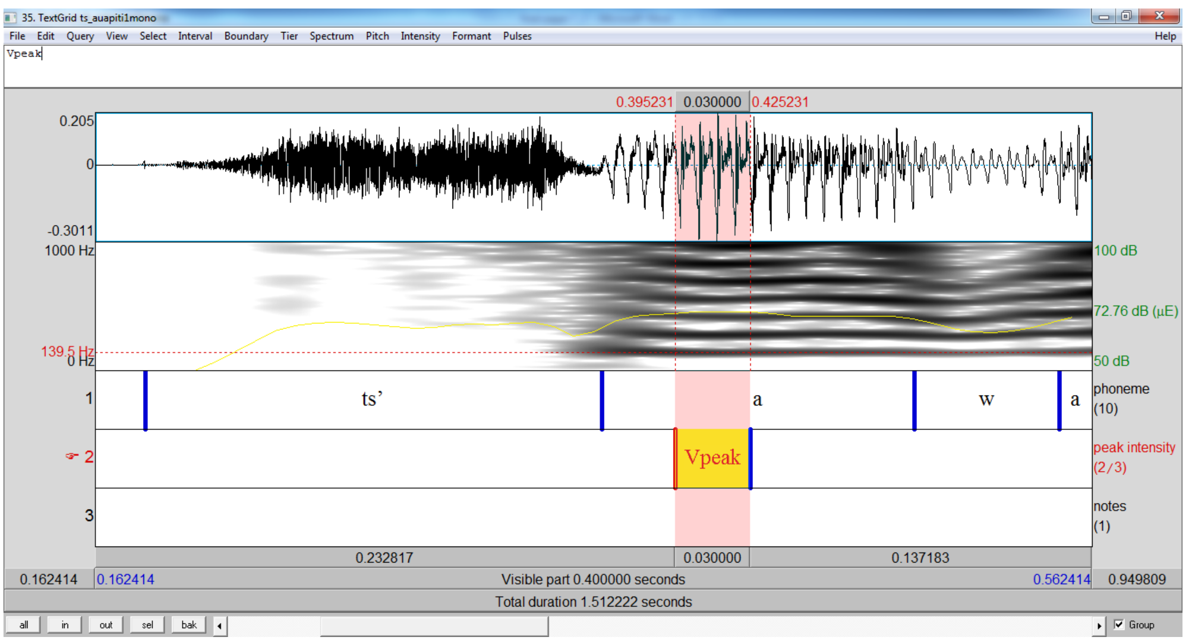

Figure 24: Speaker 1 “ts’auapiti”

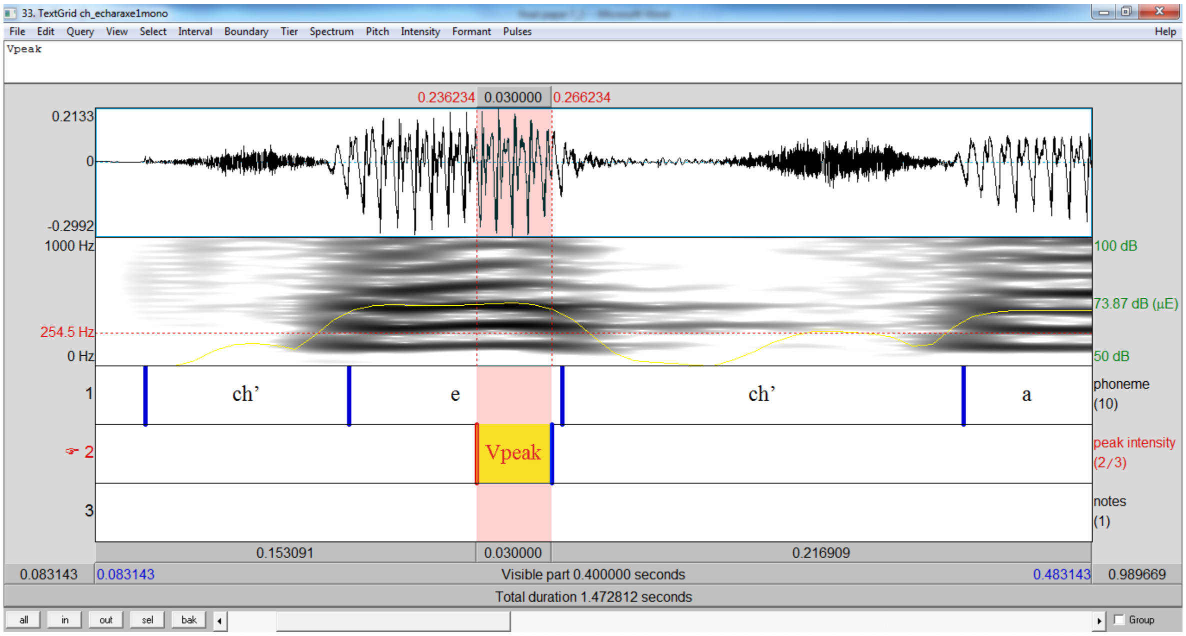

Figure 25: Speaker 1 “ch’ech’eraxe”

Effect of Fortis/Lenis and Manner on Normalized Energy for Speaker 2

For Speaker 2, stops were found to have a significantly greater Normalized energy (F[1,126] 30.235; p<.0001) than affricates. No significant effect was found for Fortis/lenis on Normalized energy. No reliable interaction of Manner and Fortis/lenis was found. Results are illustrated in Figure 26.

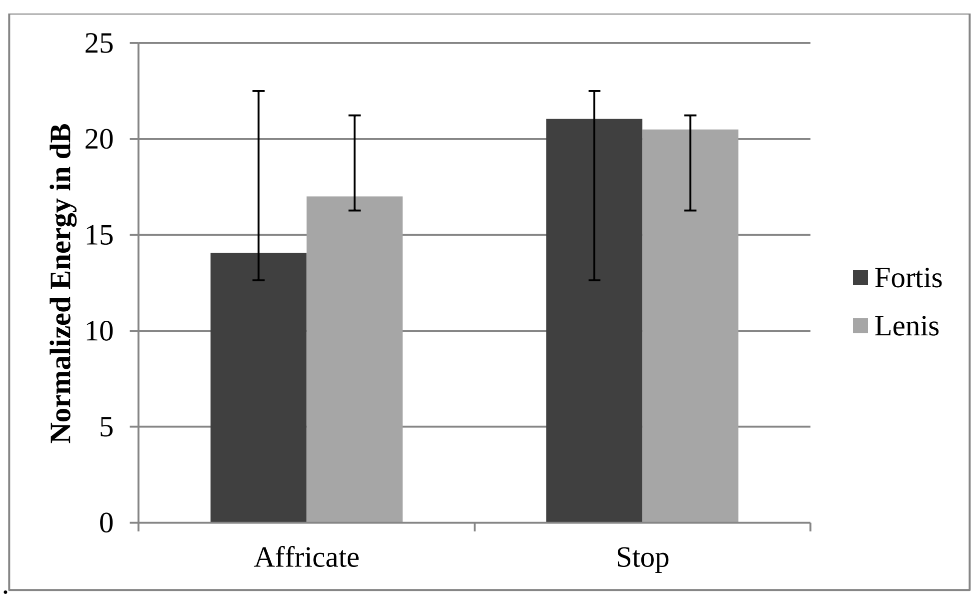

Figure 26: Speaker 2 Normalized Energy and Manner of Articulation

Speaker 2 Variability

Spectrograms presented in Figures 27 and 28 illustrate the variability found for Speaker 2 Normalized energy among fortis affricates. Burst intensity measures were taken at the point of highest intensity within the burst, while Vowel peak intensity was determined as the mean of a 30 ms. window centered around the point of highest intensity within the vowel, highlighted in the spectrograms below.

Fortis affricates

Figures 27 and 28 compare the variability found among fortis affricates for Speaker 2. Figure 27 illustrates the relatively low Normalized energy of “ch’anani” (5.372 dB) with a Burst intensity of 55.023 and Vowel peak intensity of 60.395. Figure 28 depicts the relatively high Normalized energy of “ts’emuni” (21.659 dB) arrived at from a Burst intensity of 45.704 dB. and a Vowel peak intensity of 67.363 dB.

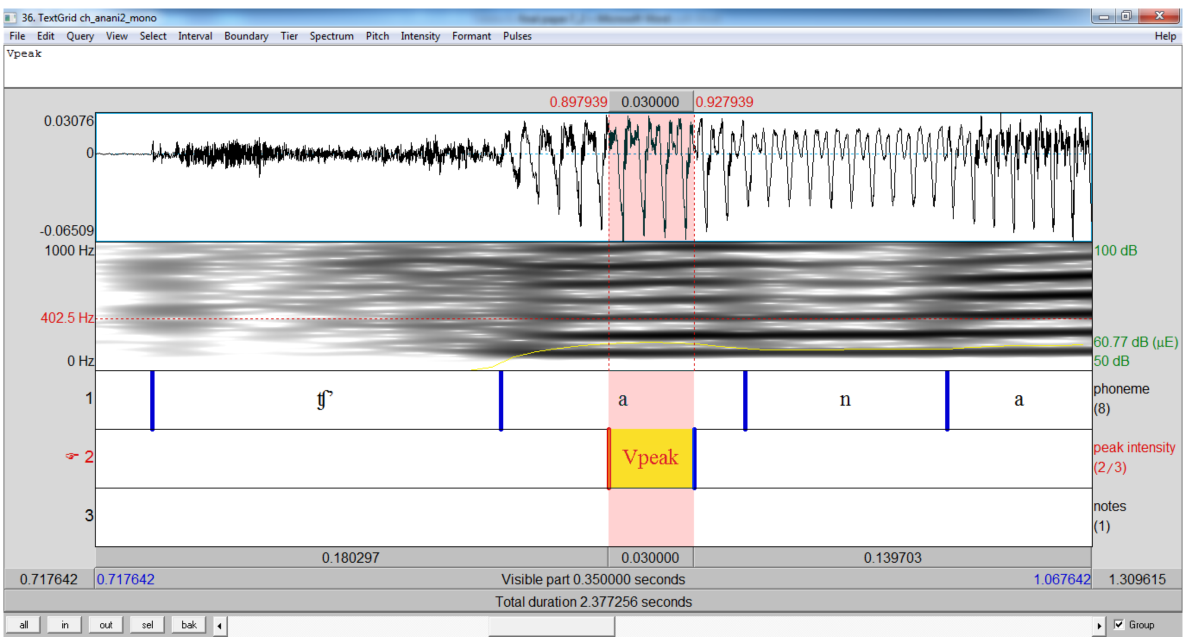

Figure 27: Speaker 2 “ch’anani”

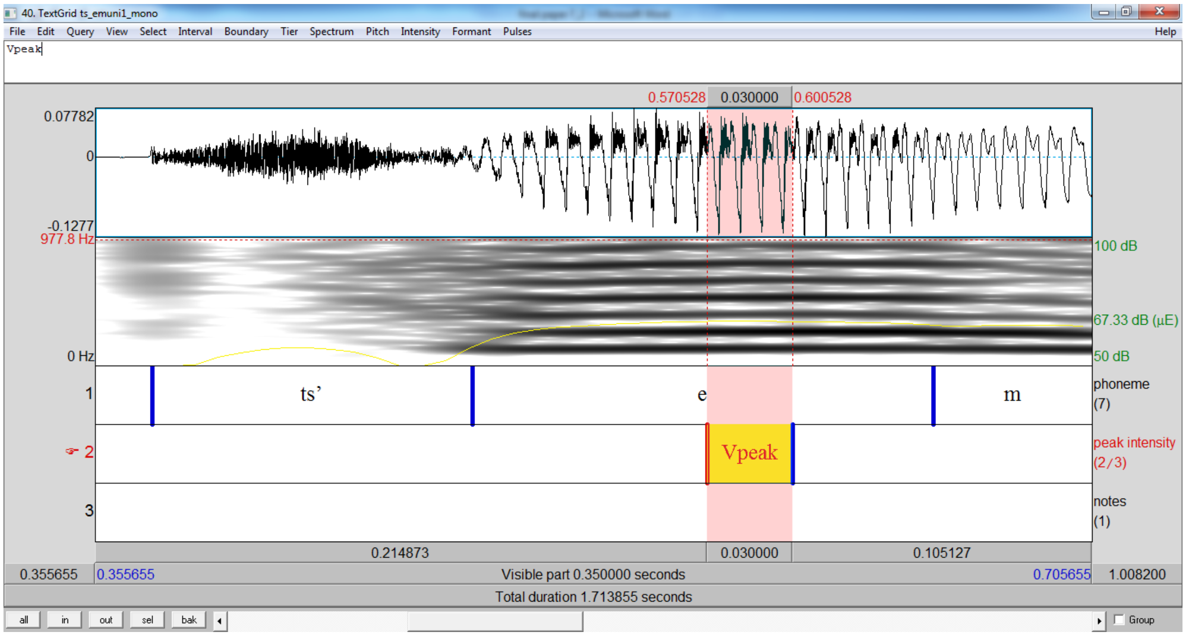

Figure 28: Speaker 2 "ts'emuni"

4.3 f0 results

Effect of Fortis/lenis and Place on Normalized f0 for Speaker 1

For Speaker 1, no significant effect of Fortis/lenis on Normalized f0 was found. No significant effect of Place of articulation on Normalized f0 was found. No reliable interaction was found. Results are displayed in Figure 29.

Results submitted to Fisher's PLSD did not find any significant difference in Normalized f0 between any Place of articulation.

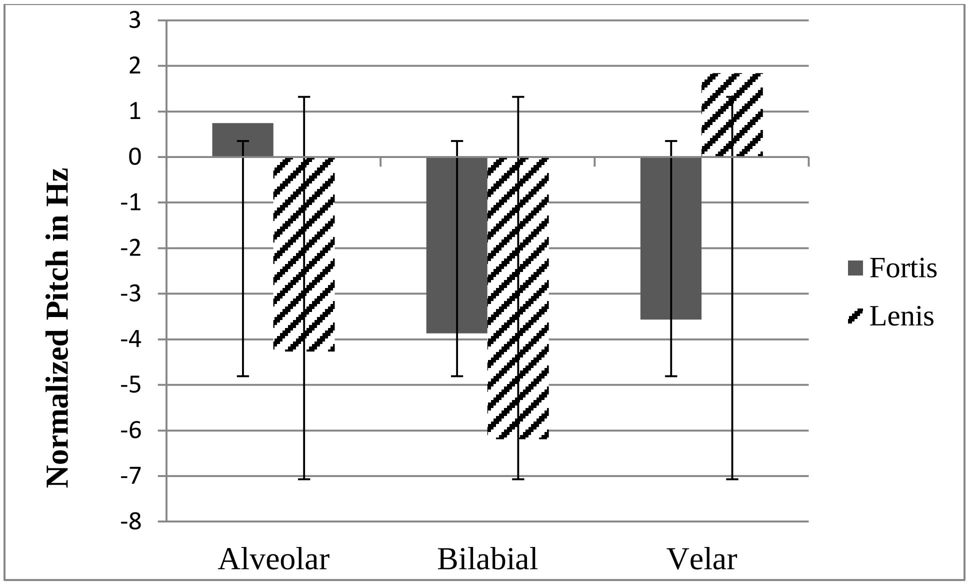

Figure 29: Speaker 1 Normalized f0 and Place of articulation

Speaker 1 Variability

Figures 30 – 37 presented below illustrate the variability fond for Speaker 1 Normalized f0 and Place of articulation at all places of articulation except for fortis bilabial and fortis velar. The spectrograms depict the 25 ms. window at vowel onset and 25 ms. window centered around the middle of the vowel from which mean pitch measurements were taken. Negative Normalized f0 measurements denote that the pitch decreased throughout production of the vowel, while positive Normalized f0 results show that pitch was raised throughout vowel production.

Fortis alveolar stops

Figures 30 and 31 depict the variability found for Speaker 1 Normalized pitch in fortis alveolar stops. Figure 30 shows “t’ungeni” with a Normalized f0 of -11.155 Hz based on the Vowel onset mean pitch of 138.142 Hz and a Vowel mid f0 of 126.986 Hz. Figure 31 shows a relatively high Normalized pitch of 12.672 Hz for “t’amk’u” arrived at from a Vowel onset mean pitch of 134.038 Hz. and a mean Vowel mid f0 of 146.711 Hz.

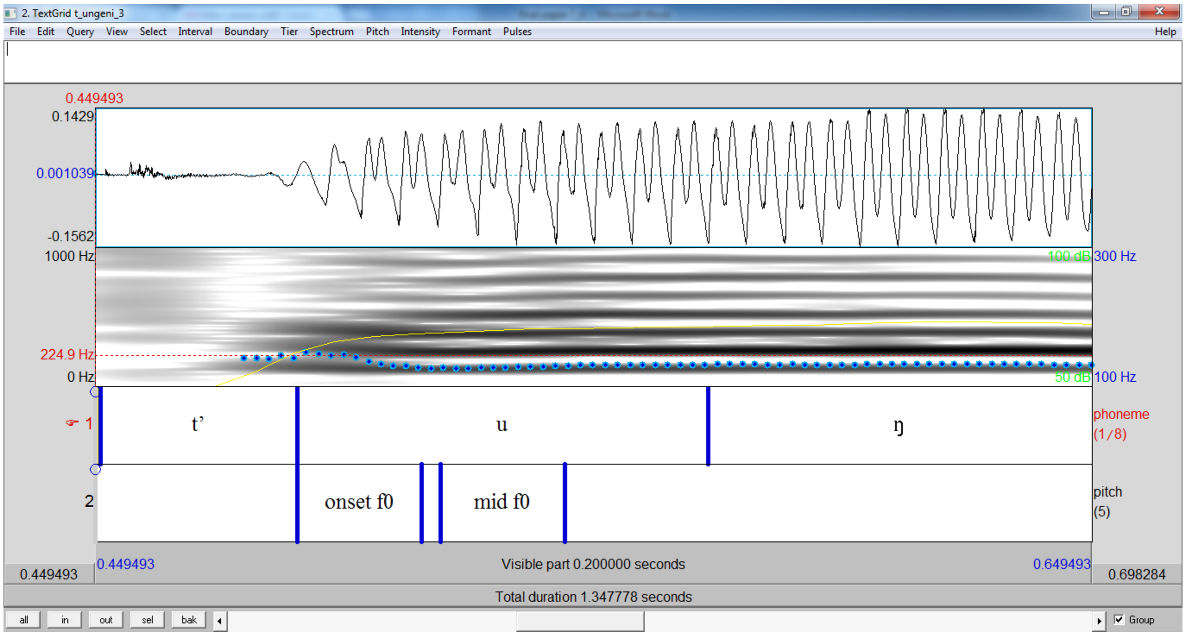

Figure 30: Speaker 1 “t’ungeni”

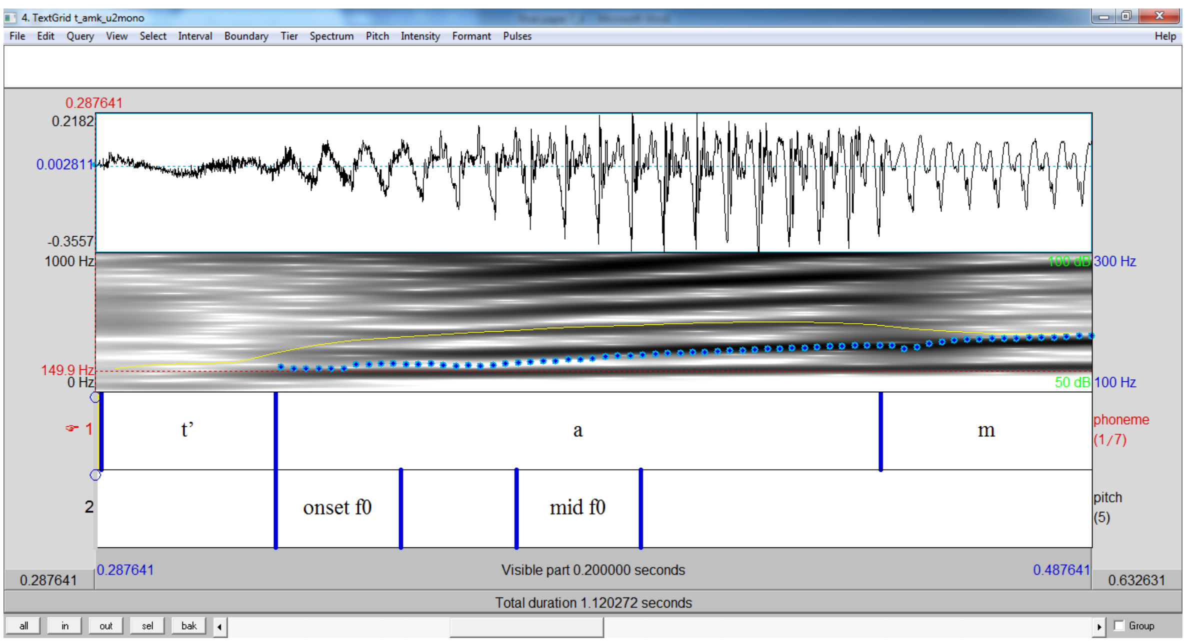

Figure 31: Speaker 1 “t’amk’u”

Lenis alveolar stops

The spectrograms presented in Figures 32 and 33 compare the variability in Normalized energy of lenis alveolar stops. Figure 32 illustrates the lower Normalized f0 found in “tupu” (-11.542 Hz) based on mean Vowel onset pitch of 149.936 and mean mid-Vowel pitch of 138.393 Hz. Figure 33 depicts the relatively high Normalized f0 of "tatsikua" (9.862 Hz) calculated from a mean Vowel onset pitch of 152.326 Hz and mean Vowel mid pitch of 162.189 Hz.

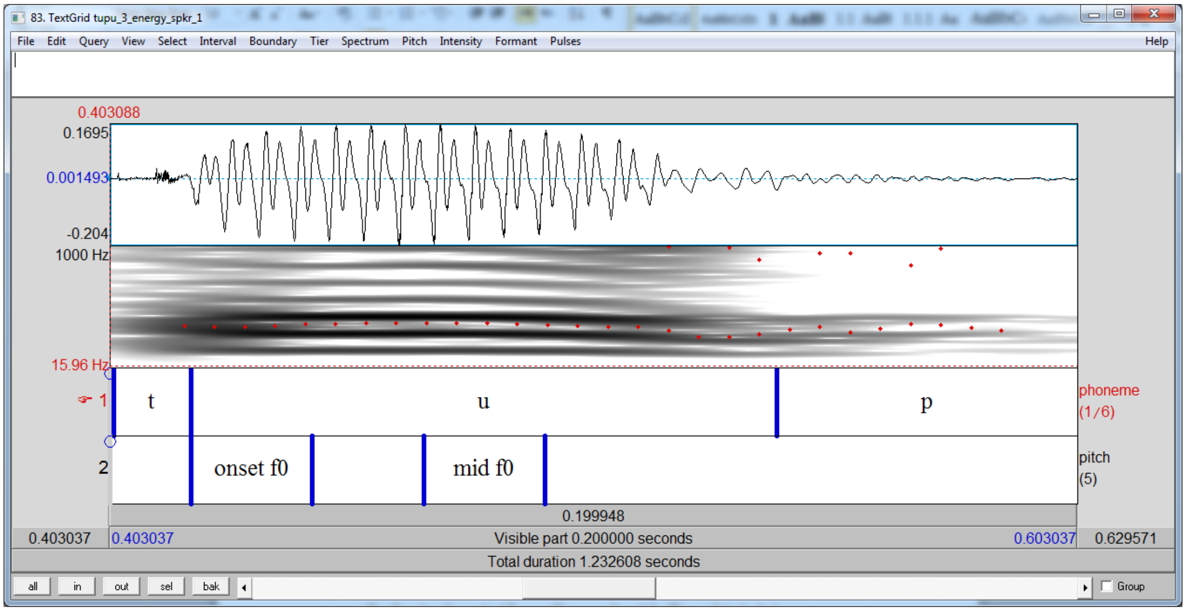

Figure 32: Speaker 1 "tupu"

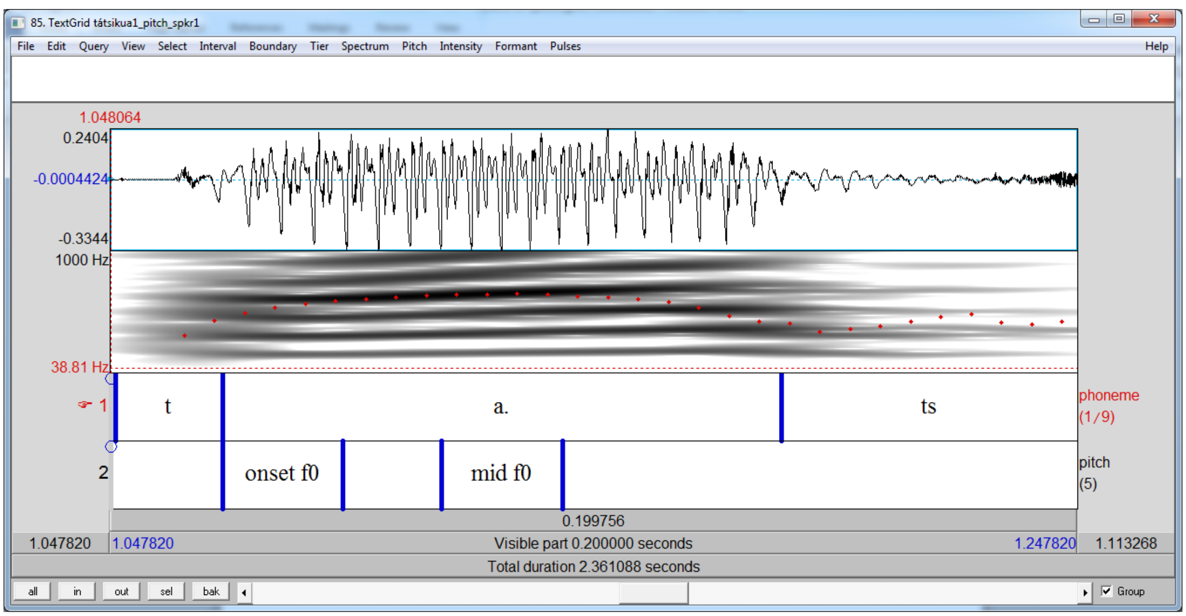

Figure 33: Speaker 1 "tatsikua"

Lenis bilabial stops

The following figures depict the variability found among Normalized f0 for Speaker 1 in lenis bilabial stops. Figure 34 shows the relatively low Normalized f0 of "pimu" (-15.338 Hz) based on the mean Vowel onset of 135.069 Hz and mid Vowel mean pitch of 119.731 Hz. Figure 35 illustrates the high Normalized f0 of “pambini” (10.516 Hz.) calculated from a mean Vowel onset pitch of 136.722 Hz and mid Vowel mean pitch of 147.238 Hz.

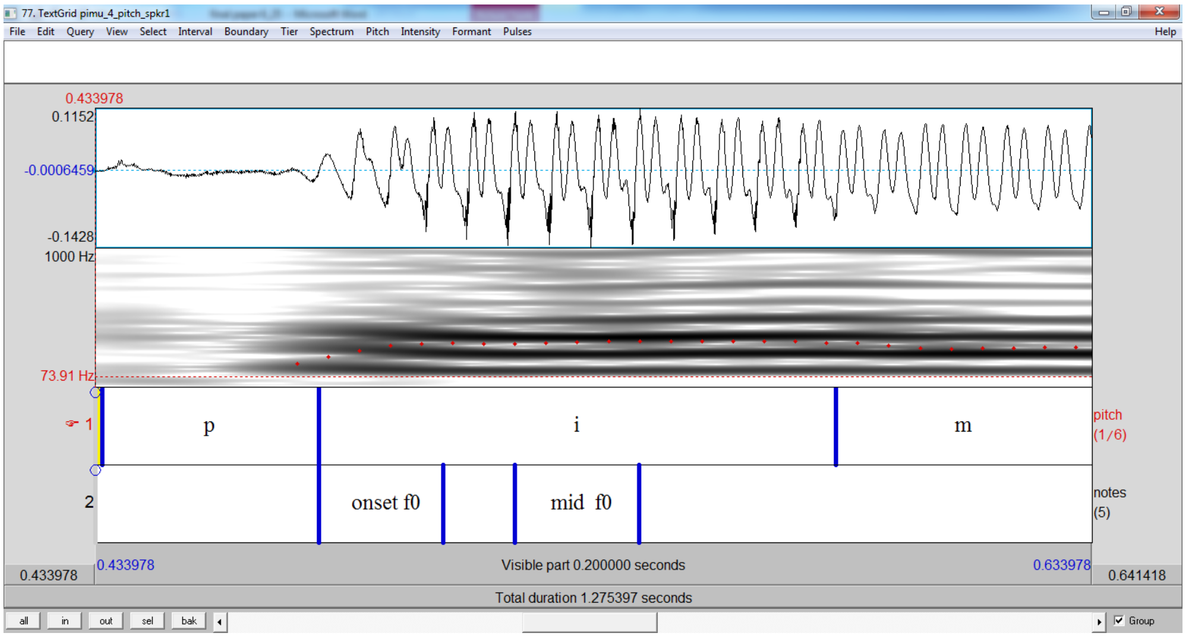

Figure 34: Speaker 1 “pimu”

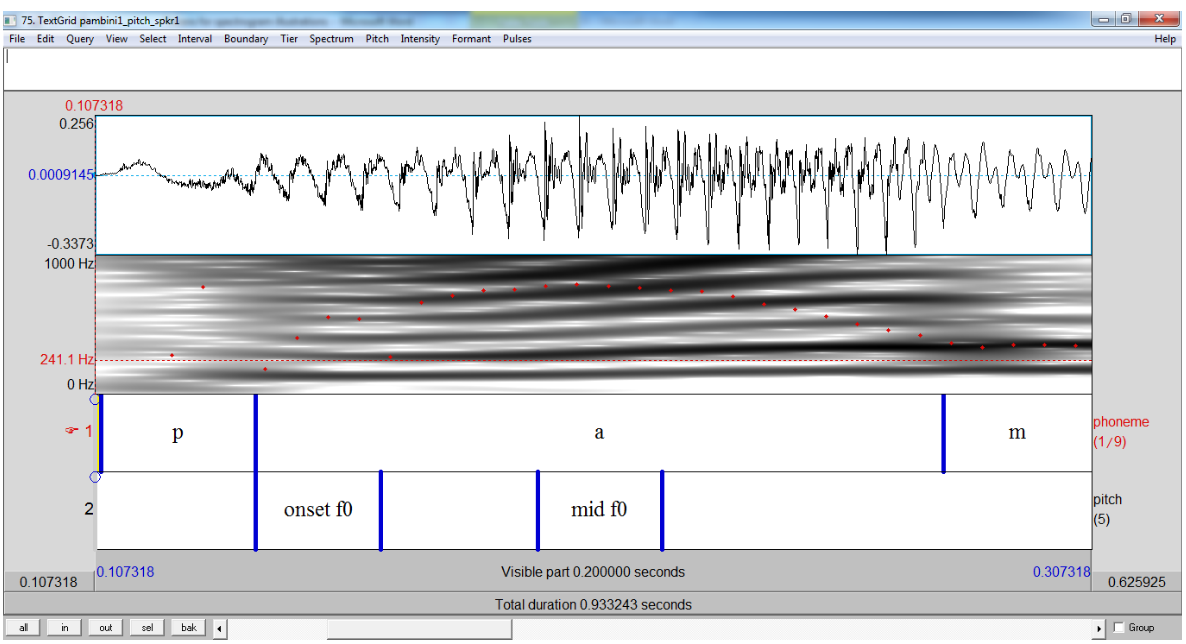

Figure 35: Speaker 1 “pambini”

Lenis velar stops

Figures 36 and 37 demonstrate the variability found among lenis velar stops and Normalized pitch for Speaker 1. Figure 36 displays the relatively low Normalized pitch of -17.415 Hz found for “karani” calculated from a mean Vowel onset pitch of 138.244 Hz and mid Vowel mean pitch of 120.829 Hz. Figure 37 depicts the relatively low Normalized f0 of 19.925 Hz found for “kani” based on a mean Vowel onset pitch of 137.488 Hz and mean mid Vowel pitch of 157.413 Hz.

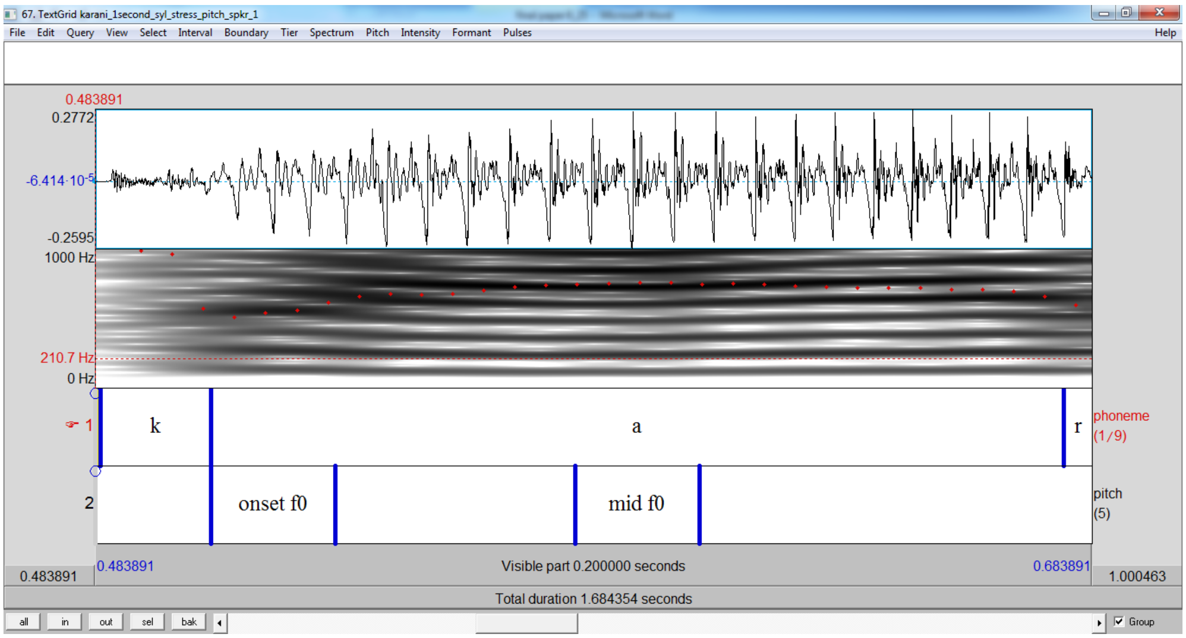

Figure 36: Speaker 1 “karani”

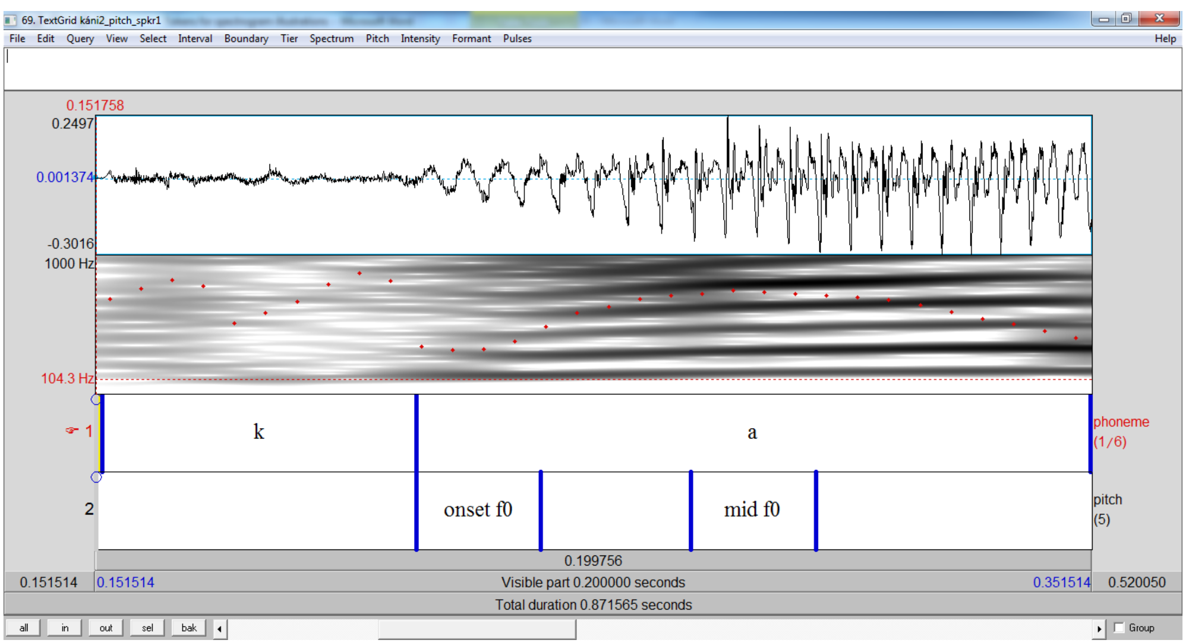

Figure 37: Speaker 1 “kani”

Effect of Fortis/lenis and Place on Normalized f0 for Speaker 2

For Speaker 2, no significant effect was found for Place of Articulation or Fortis/lenis on f0. No reliable interaction was found between Place of Articulation and Fortis/lenis. Results are shown in Figure 38.

Results submitted to a Fisher's PLSD did not find any significant difference between Normalized f0 at any Place of articulation.

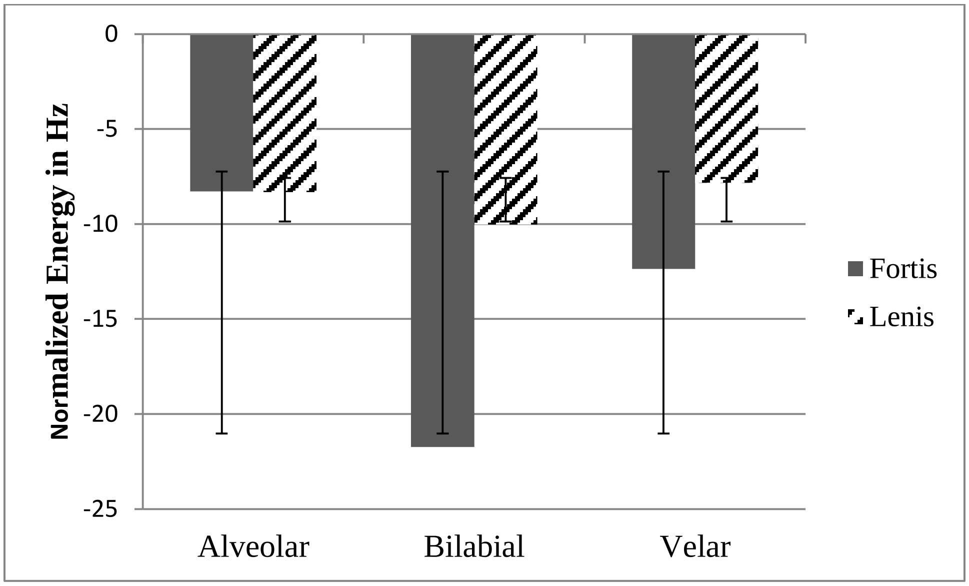

Figure 38: Speaker 2 Normalized f0 and Place of articulation

Speaker 2 Variability

Effect of Fortis/lenis and Manner on Normalized f0 for Speaker 1

For Speaker 1, no significant effect was found for Fortis/lenis on Normalized energy. Stops were found to have a significantly greater Normalized energy (F[1,113] 9.312; p = .0028) than affricates. No reliable interaction effect was found between Manner and Fortis/lenis. Results are displayed in Figure 45.

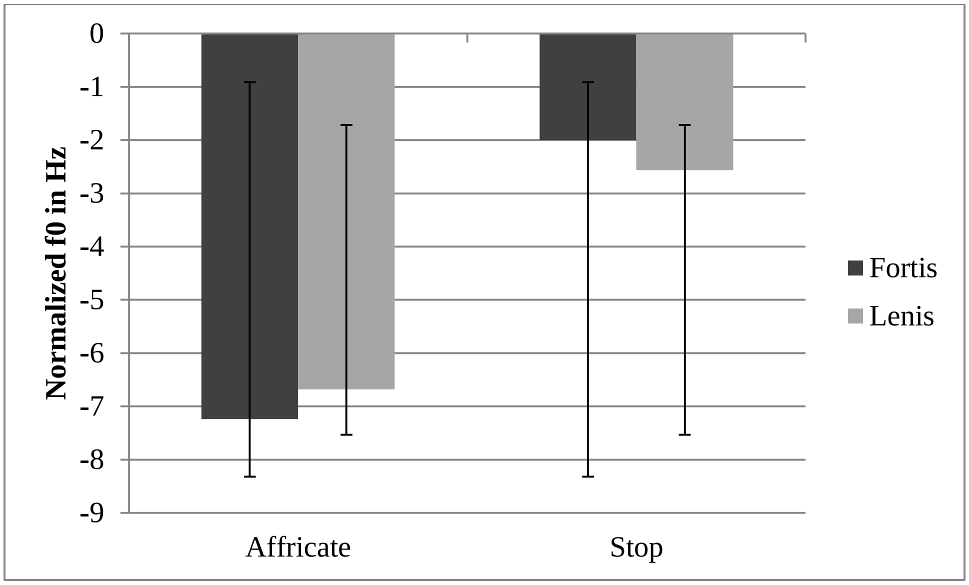

Figure 39: Speaker 1 Normalized f0 and Manner of Articulation

Speaker 1 Variability

Speaker 1variability for Normalized f0 and Manner of articulation is presented in Figures 46 – 49, which illustrate the variability found in both fortis and lenis stops. The 25 ms. windows used for calculating mean pitch at Vowel onset and mid Vowel are marked in the following figures.

Fortis stops

Figures 46 and 47 demonstrate the variability found among fortis stops and Normalized f0 for Speaker 1. Figure 46 shows the relatively low Normalized pitch of -11.155 Hz found for “t’ungeni” based on a mean Vowel onset f0 of 138.142 Hz and mid Vowel mean f0 of 126.986 Hz. Figure 47 illustrates the relatively high Normalized f0 of 12.672 Hz for “t’amk’u” calculated from a mean Vowel onset pitch of 134.038 Hz and mid Vowel mean pitch of 146.711 Hz.

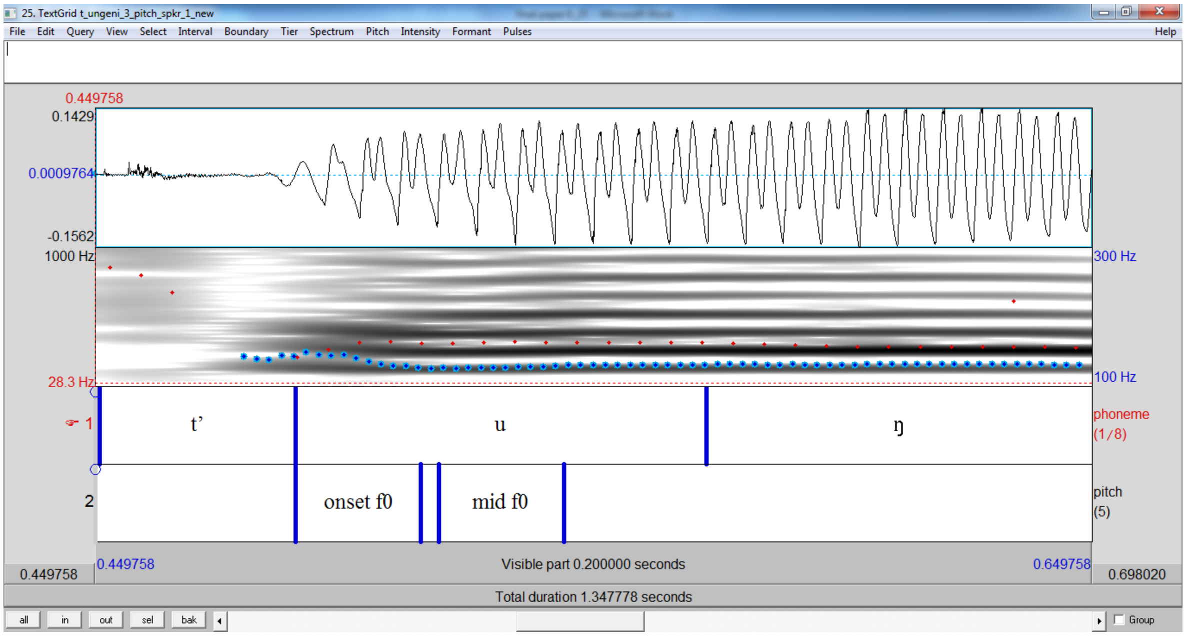

Figure 40: Speaker 1 “t’ungeni”

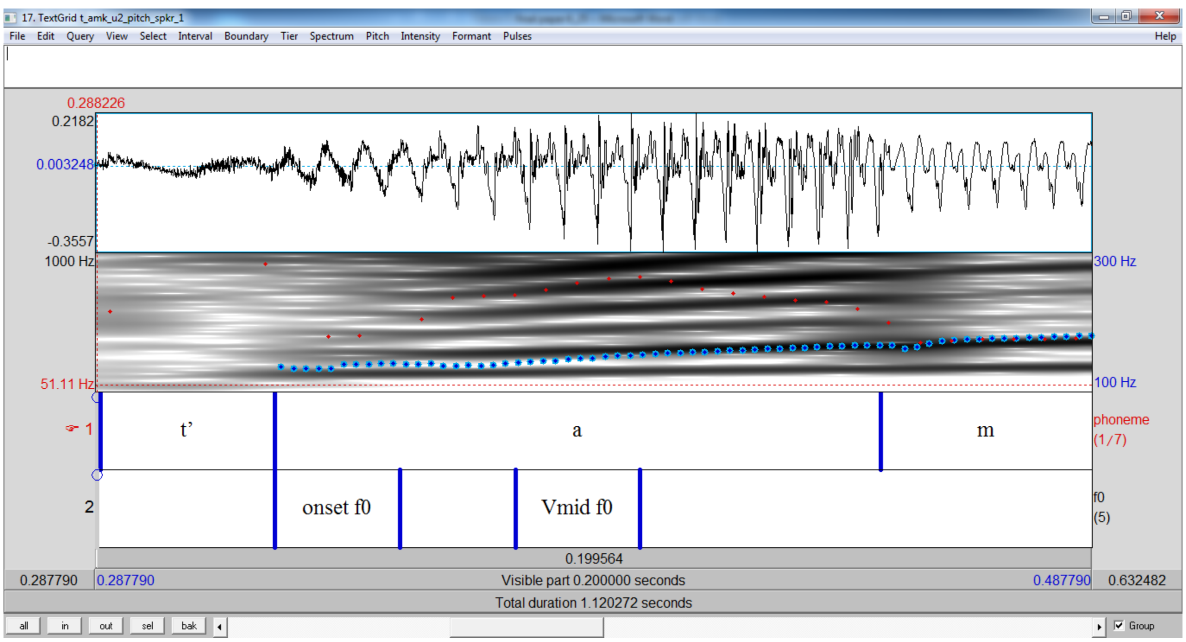

Figure 41: Speaker 1 “t’amk’u”

Lenis stops

Figures 48 and 49 demonstrate the variability found for Normalized f0 and lenis Stops for Speaker 1. Figure 48 shows the relatively low Normalized energy found for “pimu” (-15.338 Hz) based on a Vowel onset mean pitch of 135.069 Hz and mid Vowel mean f0 of 119.731 Hz. Figure 49 illustrates the higher Normalized f0 found for “kani” (19.925 Hz) calculated from a mean Vowel onset pitch of 137.488 Hz and mid Vowel mean pitch of 157.413 Hz.

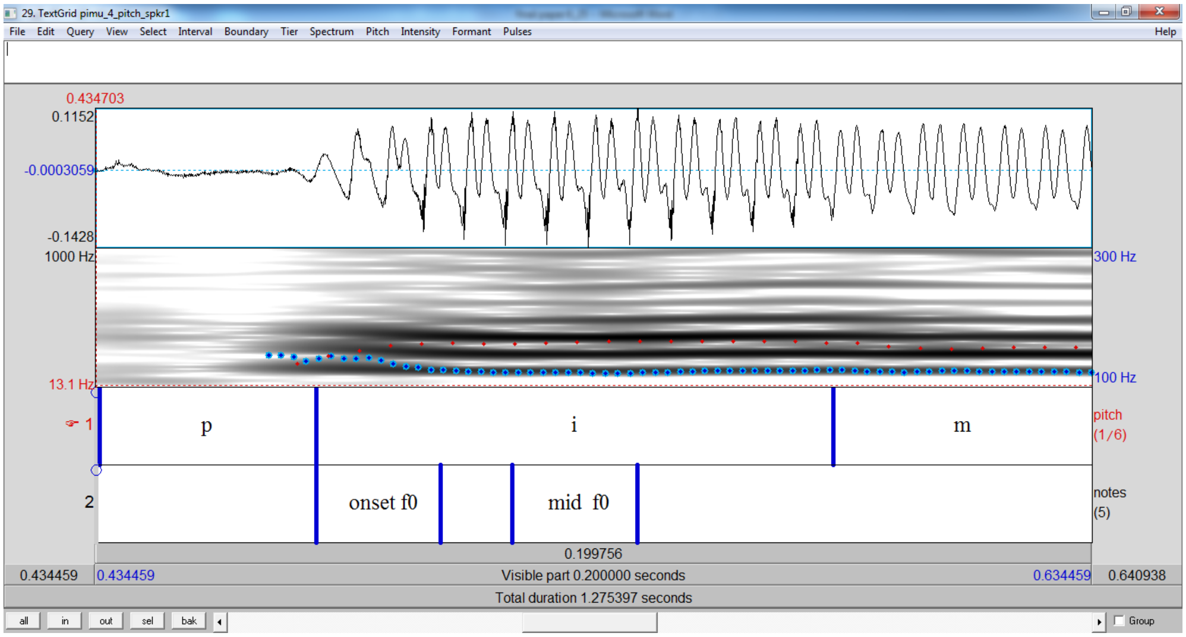

Figure 42: Speaker 1 “pimu”

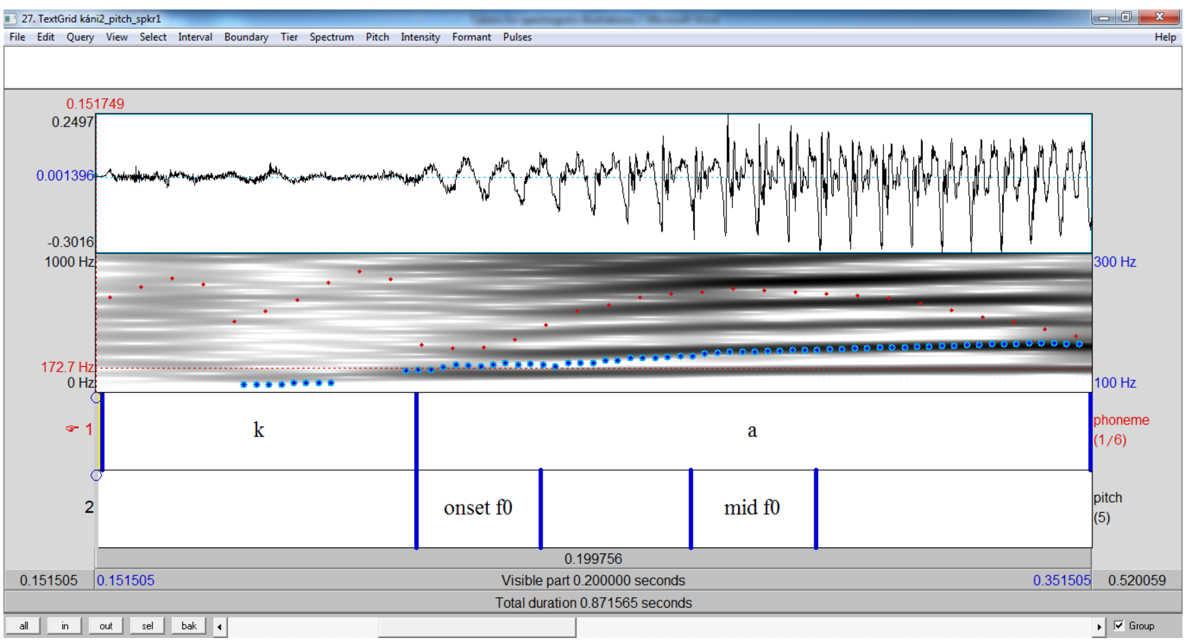

Figure 43: Speaker 1 “kani”

Effect of Fortis/lenis and Manner on Normalized f0 for Speaker 2

For Speaker 2, no significant effect of Manner on Normalized Energy was found. No significant effect was found for Fortis/lenis on Normalized energy. No reliable interaction between Manner and Fortis/lenis was found. Results are illustrated in Figure 50.

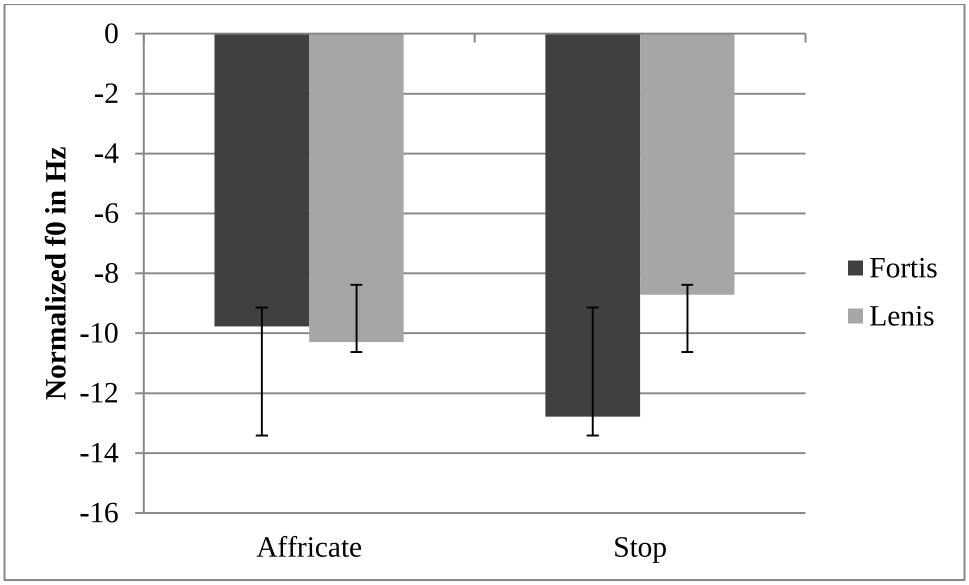

Figure 44: Speaker 2 Normalized f0 and Manner of articulation

5 Conclusion

This study has shown that the Fortis/lenis distinction in P'urépecha is realized as a difference in VOT. Normalized energy was not found conclusively for both speakers to be a distinguishing factor of the Fortis/lenis contrast in P'urépecha. Normalized f0 was not found to have a significant effect.

The proposed hypothesis for Research Question 1 that VOT will be longer in fortis phonemes than for lenis phonemes in P'urépecha has been statistically confirmed with the data analyzed in this research endeavor. In regards to the effect of Place of articulation stated in H1, this study has shown that VOT in P'urépecha is affected by place of articulation as expected, except in the case of alveolar stops. The analysis of Speaker 1 VOT and Place of articulation had the unexpected result of bilabial stop VOT being significantly longer than alveolar; Speaker 2 did not have a significant difference between alveolar and bilabial tokens. Although both speakers showed similar interactions of VOT and alveolar place of articulation, a larger study is necessary to account for the unexpected nature of these phonemes. Except for these aberrant results all other Places of articulation for both Speakers show a gradient increase in the voicing lag as the location of occlusion moves towards the larynx. Velar stop VOT was found to be significantly longer than alveolar and bilabial stops. The analysis of the effect of Manner of articulation on Fortis/lenis for both Speakers resulted in significantly longer VOT among affricates when compared to stops.

Regarding the question of the contribution of Burst/vowel amplitude to the Fortis/lenis distinction, this study has not confirmed the hypothesis for Research Question 2. The results of Normalized energy for Speaker 1 showed significantly higher Normalized energy among fortis tokens than lenis as predicted in H2. However, Speaker 2 did not display a significantly greater Normalized energy among fortis tokens. Additionally, this study found Speaker 1 to have a significant effect of Place of articulation on Normalized energy, which was not found for Speaker 2. Both speakers show that stops have a significantly higher Normalized energy than affricates and a reliable interaction between stops and affricates was found for Speaker 1. The correlation between Normalized energy and stops v. affricates may be related to the Manner of articulation of these phonemes and cannot be decidedly correlated with Fortis/lenis. Based on these results, Manner of articulation distinguishes Normalized energy, but because both speakers did not show that Fortis/lenis distinction affects Normalized energy, this study cannot conclusively state that Burst amplitude/vowel amplitude contributes to the distinction. The data collected from Speaker 1 which demonstrates an effect of Fortis/lenis on Normalized energy suggests that further research should be conducted with additional speakers to determine if Normalized energy contributes to the Fortis/lenis distinction in P'urépecha.

The hypothesis proposed for Research Question 3, which sought to determine if f0 contributes to the distinction between Fortis/lenis, was not supported. At the outset of this research, it was anticipated that f0 in lenis phonemes would rise from a low fundamental frequency to a high fundamental frequency in the first 50-100 ms of the vowel following the target consonant and fortis consonants would display the reverse pattern. This pattern was not found to be significant for either Speaker 1 or 2. For both Speakers no significant effect of Fortis/lenis or Place of articulation was found on Normalized f0. Furthermore, as noted in Section *4.3,* Speaker 1 data had high variability among all Places of articulation, Fortis/lenis and Normalized f0. This suggests that pitch does not contribute to the Fortis/lenis distinction in P'urépecha. Regarding Manner of articulation and Normalized f0, neither speaker displayed an effect for Fortis/lenis on Normalized f0.

In attempting to disambiguate the Fortis/lenis classification of P'urépecha obstruents, this study has considered the interaction of VOT, Fundamental frequency and Normalized energy in the production of the phonemes. Through examining the possible contribution of these features in the production of the obstruents in P'urépecha, it is hoped to better understand the nature of the Fortis/lenis distinction in P'urépecha as well as other languages. This study has found VOT to significantly distinguish "fortis" and "lenis" in P'urépecha, while development of the Fundamental frequency and Normalized energy were not found to have an effect. Therefore, this research shows that the obstruents in P'urépecha are best described as having long or short VOT . Using these terms in lieu of the ambiguous "fortis" and "lenis" will benefit further research regarding P'urépecha by providing universally understood and accurate descriptions of the phonemes.

In order to conclusively sustain the interaction of VOT (and possible contribution of Normalized energy) in the production of fortis/lenis phonemes, a more comprehensive study of P'urépecha is required as the limited data gleaned from two speakers is noted to be susceptible to incorrect results. In addition to examining VOT and Normalized energy in data collected from further speakers, this study recommends examining burst spectral shape (mean, skew, and kurtosis), closure and frication duration, and formant transitions of fortis and lenis phonemes. Through investigating these acoustical clues, additional indicators of Fortis/lenis in P'urépecha may be understood.

6 References

Árnason, K. 2011. *The Phonology of Icelandic and Faroese.* Oxford: Oxford University Press.

Boersma, P. and Weenink, D. 2012. Praat. Praat: doing phonetics by computer [Computer program]. Version 5.3, retrieved 12/2/2012 from http://www.praat.org/.

Cervantes, C. and Tata F. 2009. *Diccionario de la Lengua Michhuaque.* Michoacán, México: Morevallado Editores.

Chamoreau, C. 2002. Le systeme phonologique du Purepecha. *Travaux du SELF, 9*, 133- 161.

Cho, T. and Ladefoged, P. 1999. Variation and universals in VOT: Evidence from 18 languages. *Journal of Phonetics, 27*, 207-229.

DiCanio, C.T. 2012. The phonetics of fortis and lenis consonants in Itunyoso Trique. *International Journal of American Linguistics*, *78*(2):239-272.

Foster, M.L. 1969. *The Tarascan Language.* Berkeley: University of California Press.

Friedrich, P. 1969. On the meaning of the Tarascan suffixes of space. *International Journal of American Linguistics*, *35*(4),5-48.

Friedrich, P. 1970. Shape in grammar. *Language*,*46*(2), 379-407.

Friedrich, P. 1975. *The Phonology of Tarascan.* Chicago: The University of Chicago, The Department of Anthropology.

Friedrich, P. 1984. Tarascan: From Meaning to Sound. In Munro Edmonson (ed.), *Supplement to the Handbook of Middle American Indians*. Austin: University of Texas Press.

Garza, A. 2011. Locative and orientation descriptions in Tarascan: Topological relations and frames of reference. *Language Sciences*, *33*, 1006-1024.

Gilberti, M. 1559. *Diccionario de la Lengua Tarasca*. Morelia, Mexico: Balsal Editores, S.A.

Han, M. and Weitzman, R. 1970. Acoustic Features of Korean /P, T,K/, /p, t, k/, and /ph, th, kh/. *Phonetica 22*, 112-128.

Hardcastle, W. 1973. Some observations on the *tense-lax* distinction in initial stops in Korean. *Journal of Phonetics 1*, 263-272.

Hargus, S. 2011. Effects of morpheme type on Deg Xinag ejectives. Poster presented at ASA, Seattle, WA, 24 May 2011.

Jaeger, J.J. 1983. The fortis/lenis question: Evidence from Zapotec and Jawoñ. *Journal of Phonetics, 11,*177-189.

Kemper, R. V. & Adkins, J. 2006. From the "Modern Tarascan Area" to the" Patria Purépecha: Changing Concepts of Ethnic and Regional Identity." Retrieved from http://faculty.smu.edu/rkemper/anth_3311/anth_3311_kemper-adkins_Purepecha_Region_article.htm

Kim, C. 1965. On the autonomy of the tensity feature in stop classification (with special reference to Korean stops). *Word 21,*339-359.

Kim, C. 1970. A Theory of Aspiration. *Phonetica 21*,107-116.

Laxthrop, M. 2007. *Vocabulario del Idioma Purépecha*. Instituto Lingüistico de Verano A.C., Retrieved from: http://www.sil.org/mexico/tarasca/G026-VocabularioPurepecha- tsz.pdf.

Leander, A. J. 1998. *Acoustic Correlates of Fortis/Lenis in San Francisco Ozolotepec Zapotec*. (Dissertation). University of North Dakota. Retrieved from: http://arts-sciences.und.edu/ summer-institute-of-linguistics/theses/_files/docs/2008-leander- anita-j.pdf

Lewis, M. P. (ed.), 2009. Ethnologue: Languages of the World, Sixteenth edition. Dallas, Tex.: SIL International. Online version: http://www.ethnologue.com/**.**

Lisker, L. & Abramson, A. 1964. A cross-language study of voicing in initial stops: Acoustical measurements. *Word, 20*(3),527-565.

Mendoza, M. 2007. Derivational resources in Purhepecha: Morphological and verb formation. *Linguistica Hungarica*, 54(2), 157-172.

Ohde, R.N. 1983. Fundamental frequency as an acoustic correlate of stop consonant voicing. *Journal of the Acoustic Society of America*, *75* (1), 224-230.

Ragone, A. & Marr, P. 2006. Language maintenance in the Meseta Purépecha region of Michoacán, Mexico. *Anthropological Linguistics*, 48(2),109-131.

Vicenik, C. 2010. An acoustic study of Georgian stop consonants. *Journal of the International Phonetic Association, 40*, 59-92.

Whalen,D.H., Abramson, A.S., Lisker, L. and Mody, Maria. 1992.*F*0 gives voicing information even in ambiguous voice onset times. *Journal of the Acoustic Society of America, 93*(4), 2152-2159.

Zavala, A.J. 2010. *La utopia de la lengua p'urhépecha*. Michoácan, México: El Colegio de Michoácan.

7 Appendix

7.1 Speaker 1 Wordlist

Complete wordlist as read by Speaker 1: starred items represent words that are analyzed in this study, items with strike-through were not recognized by the speaker and not recorded.

P’urepécha	Español	English
1. naandi	madre	mother
2. siturhi	estómago	stomach
*3. t^{h}úngeni	a usted	to you (sing.)
*4. pámpiri	compañero	friend
*5. pímu	palma	palm
*6. túpu	ombligo	navel
*7. k^{h}úparhani	inflamada de la espalda	inflammation of the back
*8. p^{h}íchpiri	amigo	friend
*9. tsikáta	gallina	chicken
*10. t^{h}ukúpu	mosquito	mosquito
*11. ch’éti	cola	tail
*12. porhéchi	olla	pot
*13. chekákua	canoa	canoe
*14. t^{h}upúri	polvo	dust
*15. tsakápu	piedra	stone
*16. tumína	dinero	money
*17. ch’akári	leña/madera	wood
*18. ch’ipíri	fuego	fire
*19. tsánda	Sol	sun
20. uékperakua	amor	love
*21. chéta	susto, miedo	fear
*22. kerénda	peña	shame
*23. k^{h}éni	crecer	to grow
*24. k^{h}uaníkuni	tirar	to throw
*25. t^{h}ireni	comer	to eat
*26. ch’anáni	jugar	to play
*27. karáni	escribir	to write

*28. tirhimuni	colgar	to hang up
*29. cháuani	abrir	to open
*30. p^{h}orhémbini	visitor	to visit
*31. kuanítani	prestar	to lend/to borrow
*32. charáni	tronar, reventar	to thunder/burst
*33. p^{h}árini	tocar	to touch
*34. ch’ukuanderani	mentir	to lie
*35. tsípeni	sonreír	to smile
36. uandani	hablar	to talk
37. xanharani	andar	to walk
*38. k^{h}uíni	dormir	to sleep
*39. tepéni	tejer	to weave
*40. pámbini	acompañar	to accompany
*41. kárani	volar	to fly
*42. chiníni	arrugarse	to wrinkle
*43. piréni	cantar	to sing
*44. k^{h}aráni	engañar	to deceive
*45. p^{h}iráni	recibir, tomar	to receive, to take
*46. ts^{h}émuni	probar (el sabor)	to taste
*47. kójti	ancho	wide
*48. t^{h}ámu	cuatro	four
*49. ch’ách’arancha	rasposo	rough
*50. ts^{h}iráni	frío	cold
*51. k^{h}eresi	sucio	dirty
*52. ts^{h}auapiti	delgado	thin
*53. ts^{h}án ts^{h}auasi	muy delgado	very skinny
*54. ch’erapiti	áspero	rough
*55. tátsikua	después	later
*56. tskándini	resbaloso	slippery
*57. káni	?cuándo?	when?
*58. t^{h}am k^{h}u	solo cuatro	only four
59. iasi pirexaka	estoy cantando	I am singing
60. kokani tsípeni	apuráte a sonreír	smile quickly

61. kokani ch’anani	apuráte a jugar	play quickly
62. iasi ch’anaxaka	estoy jugando	I am playing
63. iasi kuanitaxaka	estoy prestándolo	I am lending it
64. kokani p^{h}irani	apuráte a tomar	take it quickly
65. kokani t^{h}ireni	apuráte acomer	eat quickly
66. iasi karaxaka	estoy escribiendo	I am writing
67. kokani charani	apuráte a reventar	burst quickly
68. iasi ts^{h}emuxaka	estoy probándolo	I am tasting it
69. iasi kuanikuxaka	estoy tirando	I am throwing
70. kokani pireni	apuráte a cantar	sing quickly
71. iasi p^{h}iraxaka	estoy tomándolo	I am taking it
72. iasi tirhimuxaka	estoy colgándolo	I am hanging it
73. kokani ts^{h}emuni	apuráte a probar	taste it quickly
74. kokani karani	apuráte a escribir	write quickly
75. iasi tepexaka	estoy tejendo	I am weaving
76. kokani uandani	apuráte a hablar	talk quickly
77. kokan xanharani	apuráte a andar	walk quickly
78. iasi p^{h}orhembixaka	estoy visitando	I am visiting
79. kokani kuanitani	apuráte a prestar	lend it quickly
80. iasi tsípexaka	estoy sonreíndo	I am smiling
81. iasi k^{h}exaka	estoy creciendo	I am growing
82. iasi t^{h}irexaka	estoy comiendo	I am eating
83. kokani k^{h}uankuni	apuráte a tirar	throw quickly
84. iasi chauaxaka	estoy abriéndolo	I am opening it
85. kokani tirhimuni	apuráte a colgar	hang up quickly
86. kokani k^{h}eni	apuráte a crecer	grow now
87. iasi niántaxaka	estoy llegando	I am arriving
88. kokani niántani	apuráte a llegar	arrive quickly

7.2 Speaker 2 Wordlist

Complete wordlist as read by Speaker 2: starred items represent words that are analyzed in this study, items with strike-through were not recognized by the speaker and not recorded.

P'urépecha	Español	English
*1. chpíri	lumber	fire
2. pirenchi	hermana	sister
3. uékperakua	amor	love
4. aríp^{h}eni	decirle a algunas personas	to tell several people
*5. káni	la milpa	field/garden
6. kokani tirhipia	apuráte a colgar	hang up quickly
7. kokani karhaia	apuráte a escribir	to write quickly
*8. p^{h}orhémbini	visitar	to visit
*9. t^{h}amk^{h}u	solo cuatro	only four
10. charhaku	bebé	baby
11. k^{h}uinchikua	fiesta	party
12. tsíri	maíz	corn
13. paini	comprar	to buy
~~14. karáp^{h}eni~~	~~hincharse~~	~~to swell~~
15. chakákua	canoa	canoe
16. tsakapindo	pedregal	stony area
*17. pímu	palma	palm
18. chátani	clavar clavos	to hammer nails
*19. ch^{h}erapiti	áspero	rough
20. pirékwareni	cantar para ti mismo	to sing alone
~~21. exek^{h}amani~~	~~verlo de repente~~	~~to see it suddenly~~
22. k^{h}amékua	amargo en el centro	to be bitter in the center
23. keréndа	peña, tristeza	shame
24. ch^{h}ukurhini	picar	to bite
25. kuanhasi	rana	frog
26. mikani	cerrar	to close
27. kauaru	barranca	gully
28. tsikát^{h}akwa	muslo	thigh

29. kuakáts^{h}ini	mojarse la cabeza	to wet one’s head
*30. t^{h}úngeni	a usted	to you (sing.)
*31. ch^{h}ipíri	fuego	fire
32. axákw’areni	enviar a alguien a hacer un mandado	send someone on an errand
33. iasi kuanitaxaka	estoy prestándolo	I am lending it
34. xanharani	caminar	to walk
35. charhapiti	rojo	red
36. axuni	venado	deer
37. iot^{h}ati	alto	tall
38. jurhiata	rayo del sol	sun ray
39.iasi t^{h}irexaka	estoy comiéndolo	I am eating
40. kokani xanharani	apuráte a caminar	walk quickly
41. ambakerani	limpiar	to clean
*42. t^{h}ireni	comer	to eat
43. axákwareni	enviarse a si mismo	to send oneself another
44. nák^{h}ini	puesto que	it seems that
*45. porhéhi	olla	pot
46. kokani niántani	apuráte a llegar	arrive quickly
47. iasi niántaxaka	estoy llegando	I am arriving
48. ketamba	lengua	tongue/language
49. eroksi	comal	plate for tortilla
50. irekani	vivir	to live
51. túmba	pestana	eyelash
52. iasi p^{h}iraxaka	estoy tomándolo	I am taking it
*53. kuanítani	prestart	to lend/to borrow
~~54. ch^{h}anátseni~~	~~jugar por el suelo~~	~~to play on the ground~~
*55. t^{h}ámu	cuatro	four
56. kachuch^{h}ani	cortar la trenza de alguien	to cut off one’s braid
*57. chéta	susto, miedo	fear
*58. tsípeni	estar contento/vida	to smile
59. xani tsípeni	mucha alegría	much happiness
60. iasi chántaxaka	ahora lo estoy cortando	I am cutting it now
61. k^{h}eresi	sucio/rasposo	dirty

62. tsitsiki	flor	flower
63. purhu	calabeza	squash
64. sési	bien, bueno	good
65. mintsita	corazón	heart
66. kokani ts^{h}emuia	apuráte a probarlo	taste quickly
*67. tsikáta	gallina	chicken
68. pákani	Yo lo llevo	I take it
69. uandani	hablar	to talk
70. p^{h}améch^{h}ani	dolor del cuello	to have pain in the neck
*71. tepéni	tejer	to weave
72. tarátani	guardarlo/levantarlo	to raise it
73. kokani k^{h}eia	apuráte a crecer	grow quickly
*74. ch^{h}akári	leña/madera	wood
75. pauani	mañana	tomorrow
76. suruki	hormiga	ant
77. jakajkuni	creer	believe
78. anhatapu	árbol	tree
*79. p^{h}íchpiri	amigo	friend
~~80. k^{h}aráni~~	~~engañar~~	~~to deceive~~
81. iasi tepexaka	estoy tejendo	I am weaving
*82. piréni	cantar	to sing
83. nandi	madre	mother
*84. ts^{h}iráni	frío	cold
*85. ts^{h}ánts^{h}auasi	muy delgado	very skinny
86. p^{h}améch^{h}uni	dolor de las nalgas	have pain in the buttocks
87. tembuchakua	boda	wedding
88. iasi k^{h}exaka	estoy creciendo	I am growing
89. kurucha	pescado	fish
90. parakata	mariposa	butterfly
~~91. ichuki~~	plano	~~flat~~
92. misitu	gato	cat
93. iasi p^{h}orhembixaka	estoy vistando	I am visiting
94. iasi pirexaka	estoy cantando	I am singing

95. kokani k^{h}uanikia	apuráte a tirarlo	throw quickly
96. xani kuantaxaka	estoy prestándolo	I am loaning it
*97. karáni	escribir	to write
98.kuátsita	excremento	excrement
*99. k^{h}uaníkuni	tirar	to throw
*100. k^{h}uíni	dormir	to sleep
101. iasi tsípexaka	estoy contento	I am happy
*102. tsánda	Sol	sun
~~103. tserhuku~~	~~frente~~	~~front~~
104.tamapu	viejo	old
*105. k^{h}uiripu	persona, gente	person
106. erandini	amanecer	dawn
*107. k^{h}éni	crecer	to grow
*108. tátsikua	después	later
109. kokani p^{h}irani	apuráte a tomar	take quickly
~~110. chiníni~~	~~arrugarse~~	~~to wrinkle~~
*111. ts^{h}auápeni	ser delgado	to be thin
112. p^{h}améchani	dolor de la garganta	to have pain in the throat
*113. ch^{h}éti	cola	tail
114. p^{h}amékurini	dolor	to have pain
115. xuturhi	estómago	stomach
116. xani charani	tronando mucho	thundering a lot
117. iasi kuanikuxaka	estoy tirándolo	I am throwing it
118. ichuskuta	tortilla	tortilla
~~119. pándi~~	~~sordo~~	~~deaf~~
120. jucha	nosotros	us
121. mítakua	algo que abrir	something that opens
*122. ts^{h}auapiti	delgado	thin
*123. ch^{h}ách^{h}arasi	rasposo	rough
124. t^{h}irutani	abrir mazorcas	open corncobs
*125. tsakápu	piedra	stone
*126. t^{h}upúri	polvo	dust
*127. tsípeni	estar alegre	to be happy

128. iasi ts^{h}emuxaka	estoy probándolo	I am tasting it
129. kokani uandaia	apuráte a hablar	talk quickly
*130. tirhipuni	colgar	to hang up
131. kokani pireni	apuráte a cantar	sing quickly
132. k^{h}út^{h}u	tortuga	tortoise
133. kútsi	mes	month
134. choperi	duro, macizo	hard, solid
135. ausi	ajo	garlic
136. éjpu	cabeza	head
*137. tumína	dinero	money
138. iasi tirhipaxaka	estoy colgando	I am hanging it up
139.t^{h}irék^{h}wareni	comer para ti mismo	to eat by yourself
140. kokani ch^{h}anaia	apuráte a jugar	quickly play
*141. kárani	volar	to fly
142. pirék^{h}wareni	cantar para ti mismo	to sing to yourself
*143. ch^{h}anáni	jugar	to play
*144. charáni	tronar, reventar	to thunder/burst
*145. tskánda	resbaloso	slippery
146. jupáts^{h}ini	lavarse la cabeza	to wash one's head
~~147. p^{h}árini~~	~~tocar~~	~~to touch~~
148. k^{h}arhiri	seco	dry
149. nombe	nada	nothing
150. sapichu	chico	young person
151. ixu	aquí	here
*152. t^{h}ukúpu	mosquito	mosquito
*153. pámpiri	compañero	friend
*154. kójti	ancho	wide
*155. ch^{h}ukuanderani	mentir	to lie
*156. p^{h}iráni	recibir, tomar	to receive, to take
*157. ts^{h}émuni	probar (el sabor)	to taste
158. xani t^{h}ireni	comer mucho	to eat a lot
159. kamátsita	sesos	brain
160. iasi karaxaka	estoy escribiendo	I am writing

*161. pámbini	acompañar	to accompany
*162. k^{h}úparhani	inflamada de la espalda	inflammation of the back
163. iasi ch^{h}anaxaka	estoy jugando	I am playing
*164. túpu	ombligo	navel
165. chakamukua	espina	spine
166. auani	conejo	rabbit