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Voiceless stop aspiration in Yucatan Spanish: a sociolinguistic analysis

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Keywords: Sociolinguistics; Acoustic phonetics; Language contact

Abstract:

Previous research has indicated that in Yucatan Spanish, /ptk/ are aspirated a greater levels than in other varieties, a feature attributed to contact with Yucatec Maya, a language that has both aspirated and ejective voiceless stops. The current study presents the first quantitative, acoustic, variationist investigation of the linguistic and social factors that constrain aspiration (as measured by VOT) in Yucatan Spanish. Analyses, conducted using mixed-effects statistical models, indicate that VOT values are longer in stressed syllables and phrase initially, and also before non-low vowels. Regarding social factors, men consistently favor longer VOT, along with older speakers. While no significant result was obtained based on language background (Maya-Spanish bilinguals vs. Spanish monolinguals), there is evidence of the influence of language and dialect contact on the observed patterns. Further results and conclusions are discussed.

Voiceless stop aspiration in Yucatan Spanish: a sociolinguistic analysis.

1. Introduction

The Spanish spoken in the Mexican state of Yucatan stands out in the literature as a distinct dialect of the language. While scholars have debated the classification of Mexican varieties, in almost every study of Mexican dialects, Yucatan stands apart, due to a variety of features that distinguish it from surrounding forms of speech (Henríquez Ureña 1938; Lope Blanch 1970; Lipski 2004; among many others). Many of these forms have been attributed (rightly or wrongly) to the long-term situation of language contact in the peninsula, where Spanish has been in contact with Yucatec Maya over the last 500 years (Lipski 2004; Klee 2009; Klee & Lynch 2009). [1] Previous research has identified several of the phonetic/phonological differences that characterize Yucatan Spanish (YS), including the labialization of absolute final nasals (*pan* > [pam] 'bread')(Yager 1982, 1989; García Fajardo 1984; Pfeiler 1992; Lope Blanch 1987; Michnowicz 2006a, 2006b, 2007, 2008); the pronunciation of voiced stops /bdg/ in contexts that would condition approximate realizations in most dialects (*todo* > [to.do] instead of [to.ðo] 'all')(Mediz Bolio 1951; Alvar 1969; Yager 1982; García Fajardo 1984; Lope Blanch 1987; Rosado 2011; Michnowicz 2009, 2011, 2012); hiatus breaking via the insertion of a pre-vocalic /ʔ/, as in *cuatro años* > [kwa.tro.ʔa.ɲos] 'four years' (Barrera Vásquez 1937; Nykl 1938; Suárez 1979; Yager 1982; García Fajardo 1984; Lope Blanch 1987; Michnowicz 2006a, 2012); pre-nuclear peak alignment in declarative phrases (Michnowicz & Barnes in press), and the aspiration of the voiceless stops /ptk/ (*casa* > [k^{h}a.sa] 'house') (Nykl 1938; Mediz Bolio 1951; Alvar 1969; Coupal & Plante 1977; Suárez 1979; Yager 1982; García Fajardo 1984; Rosado

[1] Hereafter referred to simply as "Maya", since that is the term employed by speakers of that language.

2011; Michnowicz 2012), which is the focus of the present study. This investigation presents a quantitative, acoustic, variationist analysis of /ptk/ aspiration in 22 native-speakers of YS, using VOT as the measurement of aspiration. To our knowledge, this is the first study undertaken on this feature of YS to combine sociolinguistic methods and acoustic analysis, expanding on the preliminary acoustic work undertaken by Coupal & Plante (1977) by examining a much larger range of contexts and tokens. The rest of the article is organized as follows: Section 2 will review previous studies on VOT across Spanish dialects, and present a summary of research on aspirated /ptk/ in YS; Section 3 outlines the methodology, speaker backgrounds and the variables included in the statistical analysis; Section 4 presents the results, with discussion and conclusions following in Section 5.

2. VOT across Spanish dialects and in Yucatan Spanish

One common measure of aspiration in voiceless stops is voice onset time (VOT), which has been widely used in studies of Spanish, allowing for a point of comparison across dialects. VOT is defined as the time between the release of the occlusion and the onset of voicing (Lisker & Abramson 1964). It is known that VOT varies across languages and that each language assigns a general range for different categories of stops. These categories are: voicing lead (-30ms or more; also termed voiced stops), zero onset or short lag (0-30ms; also termed voiceless unaspirated stops), and long lag (+30ms; also termed voiceless aspirated stops) (Cho & Ladefoged 1999). Numerous studies have set out to examine VOT across Spanish dialects (Williams 1977; Borzone de Manrique 1980; Castañeda 1986; Roldán & Soto-Barba 1997; Rosner, López-Bascuas, García-Albea & Fahey 2000; Troya Déniz 2005). Spanish is generally considered a language with little aspiration present for /ptk/ (i.e. it presents short voice lag (Hualde 2005, 150)), in contrast with other languages, like English or Maya, that present long

voice lag for the voiceless stops (see Burnett-Deas 2009 for Maya). Lisker and Abramson (1964) were among the first to investigate VOT and establish distributions of the voiceless stops in Puerto Rican Spanish, finding average VOT values of 4ms for /p/, 9ms for /t/ and 29ms for /k/. Casteñada (1986) studied VOT for Castilian Spanish, and found mean values of 6.5ms, 10.4ms and 25.7ms for /ptk/ respectively. There are contradictory findings in the literature regarding the existence of the dialectal variation of VOT. Williams (1977) compared Lisker and Abramson's (1964) results from Puerto Rico with his own data from Guatemala, Venezuela and Peru, and determined that there was no variation in VOT across dialects. The limitations of the study were recognized, however, noting that there could be dialectal differences in alternate dialects or if stops were examined in other contexts such as running speech or word-medially (Williams 1977). More recently, Rosner et al. (2000) replicated the experiments of Williams (1977) and Castañeda (1986) in order to make a quantitative comparison of Castilian and Latin American Spanish. Significant differences between dialects were found and confirmed when submitted to statistical analysis (see Figure 1 in section 4 for a comparison).

Yucatan Spanish has been identified as a dialect that presents more aspiration than that found in many other varieties of Spanish (Nykl 1938; Suarez 1945; Mediz Bolio 1951; Alvar 1969; Coupal & Plante 1977; Garcia Fajardo 1984; Lope Blanch 1987; Yager 1982; Rosado 2011), and many attribute this feature to contact with Maya, a language with both aspirated and ejective voiceless stops (Nykl 1938; Mediz Bolio 1951; Alvar 1969; Coupal & Plante 1977; Yager 1982; see Burnett-Deas 2009 for Maya). Nykl (1938) employs the term "*consonantes heridas*" "wounded consonants" to refer to the aspirated or ejective stops that give YS an unmistakable sound. He notes that listening to YS is like "estar oyendo hablar en castellano a un comerciante alemán" "listening to a German merchant speaking Spanish" (p. 217). Suárez (1979:

78) lists the "*fuerza explosiva*" "explosive force" of /ptk/ as one of the characteristics of the dialect, and Mediz Bolio (1951) also attributes the distinctive sound of YS to Maya influence. Alvar (1969) notes that aspiration in YS reaches higher levels than Castilian Spanish, but is not as great as English. Using 10 speakers, he concludes that that there is no aspiration of /p/ and infrequent aspiration of /t/. He also describes the realization of aspirated [k^h] as sporadic and occurring in combination with unaspirated [k]. Finally, it is argued that aspirated [k^h] does not occur before back vowels. Yager (1982, 48-50) finds slight aspiration word initially and in emphatic speech and asserts that this variation is due to contact with Maya. He also reports aspiration to be most frequent with /k/, followed by /p/ and only rarely /t/. Garcia Fajardo (1984) explains that YS voiceless stops are sometimes voiced or realized as fricative or glottal stops, especially /k/. In terms of aspiration, she finds that middle classes aspirate less than lower and upper classes, and /k/ to be the most aspirated stop followed by /p/. In general, she reports that aspiration occurs before vowels, in word-initial position, and in tonic syllables. Also citing Maya influence, Coupal & Plante (1977: 73), in a limited acoustic analysis (99 total tokens of /k/), find YS aspiration for /k/ to be not as strong as some authors have suggested, but note that there is "*un esfuerzo expiratorio más importante que lo que normalmente se encuentra en las realizaciones "normativas" de la oclusiva linguovelar sorda del castellano peninsular…y [el] habla de la zona del Caribe*" "an explosive force greater than what is normally found in "normative" realizations of the voiceless velar stop in Peninsular Spanish…and the speech of the Caribbean zone." Lope Blanch (1987) finds that /p/ and /k/ are aspirated with more frequency than /t/; however, because of the wide variation he attributes these findings to the *polimorfismo yucateco* 'Yucatecan polymorphism", or the wide range of realizations normally found in this dialect. Rosado (2011) examined the binary distinction between aspirated and non-aspirated

/ptk/ (expressed in the study as [+/-tense]) in a corpus of 36 speakers from Merida. This author reports 12% [+tense] articulations, with significant differences based on syllable stress, position in the word, point of articulation of the stop, gender and education. Finally, Michnowicz (2012) reports a decreasing amount of aspiration across age groups in family case studies for both monolingual Spanish and bilingual Maya-speakers. This is reported to be part of a larger trend of standardization.

As noted above, Maya possesses seven voiceless stops, including the plain stops /ptk/, the ejective stops /p't'k'/, and the glottal /ʔ/ (Frazier 2009, 18). The difference between the plain stops and the ejectives is phonemic, and the plain stops are generally aspirated in pre-vocalic position (McQuown 1967). Burnett-Deas (2009) found VOT values of 25ms, 18ms and 64ms for the plain stops /ptk/ respectively, and values of 48ms, 40ms and 70ms for ejective /p't'k'/, respectively.

In order to quantify the existing observations of /ptk/ in the literature on YS, which are often vague and contradictory, this study will examine how linguistic and social factors constrain VOT production for speakers of YS. Based on the previous studies highlighted in this section, we set out to test a series of research questions and related hypotheses. Our two main research questions are as follows: Does VOT in YS differ from other dialects of Spanish? How do linguistic and social factors constrain VOT production for these speakers of YS? Based on the reports of previous studies, we hypothesize: 1) that VOT values will be longer in YS than in other varieties; 2) a large amount of individual variation is also expected, according to the *polimorfismo yucateco* "Yucatecan polymorphism" described by Lope Blanch (1987); 3) that there will be more 'standard' like VOT production among younger speakers, following the conclusions of Michnowicz (2012); and 4) given the attribution of longer VOT in YS to contact

with Maya, along with the pattern of aspirated/ejective stops in that language, we hypothesize that we will find evidence of Maya influence on YS /ptk/.

3. Methods

Participants in this study were selected from a corpus of sociolinguistic interviews conducted in and around Merida, Yucatan. The first author lived in the area and made contacts through friends and university faculty. Each interview lasted approximately 30 minutes and took place in the participants' home or place of work. Conversations were casual and often self-guided in an attempt to capture the most natural speech sample possible. Following Labovian interview methods, every effort was made to minimize the *observer's paradox* (Labov 1972). Speakers were selected based on age group (younger, ages 19-25, n=7; middle, ages 37-49, n=7; older, ages 54-76, n=8), language (Spanish, n=10; bilingual, n=12) and gender (male, n=11; female, n=11). Social class was not included explicitly in the statistical analysis because of the strong correlation between language and class. Participants who were bilingual speakers of Maya and Spanish in the Yucatan belong to a lower social class, with one exception, while the monolingual Spanish speakers represent the middle/higher classes. [2]

Each interview was transcribed, measured manually, and coded in Praat (Boersma & Weenink 2012). There were 100 tokens for each variable per speaker, resulting in 6600 total tokens. Each token was measured from the first burst following the occlusion to the start of periodic voicing. [3] Both authors measured VOTs, and all measurements were checked for consistency by the first author. Once measured and coded in Praat, the VOT measurements were

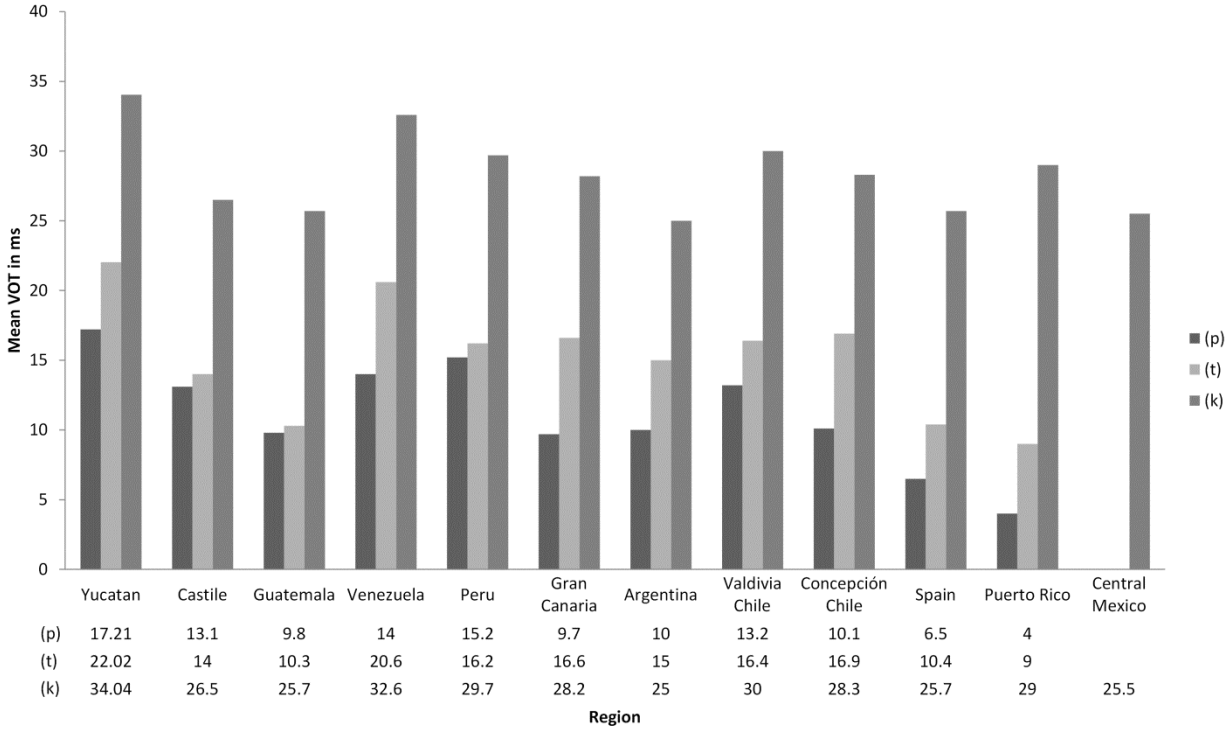
[2] The exception is MM44, a middle aged Maya-Spanish bilingual with a college education.
[3] As an anonymous reviewer points out, VOT measurements can sometimes be difficult in naturalistic speech. In reality, the only stop that presented occasional difficulty was /p/, where the burst was at times hard to identify. Any cases that could not be identified confidently were excluded from analysis.

extracted with a Praat script (Lennes 2002) and submitted to multivariate statistical analysis using R (R Core Team 2012) and Rbrul (Johnson 2012). Unlike traditional Varbrul analyses, these programs allow for mixed effects models, which take into account individual variation and continuous variables (Johnson 2009). According to Johnson (2009, p.365) a mixed effects model "can still capture external effects, but only when they are strong enough to rise above the inter-speaker variation." One-level mixed-effects models were fitted to the data in Rbrul. The dependent variable was VOT measured as a continuous variable. The independent variables were both linguistic and extra-linguistic in nature, and included following segment, position in the phrase, position in the word, syllable stress, gender, age group, and language background. Speaker was included as a random factor. Interactions among pertinent social and linguistic factors were also analyzed. Finally, one-level fixed-effects models were also run for all variables, to identify areas for future research with a larger subject pool. The results are presented graphically in the following section, with all analyses summarized in Table 1.

4. Results

The overall mean VOT length for the present data from YS is 17.2ms for /p/, 22ms for /t/, and 34ms for /k/. These values are substantially higher than those reported for Castilian Spanish: 12ms /p/, 14ms /t/ and 26.5ms /k/ (Rosner et al. 2000), as well as the value of 25.5ms reported for /k/ for female speakers from Central Mexico (Carpenter 2012). A comparison of YS mean VOTs and those reported in previous studies for other regions is found in Figure 1.

Figure 1. Mean VOTs across varieties. Castile: Rosner et al. 2000; Guatemala, Venezuela, Peru: Williams 1977; Gran Canaria: Troya Déniz 2005; Argentina: Borzone de Manrique 1980; Valdivia, Chile: Roldán & Soto-Barba 1997; Concepción, Chile: Soto-Barba & Valdivieso 1999; Spain: Castañeda 1986; Puerto Rico: Lisker & Abramson 1964; Central Mexico: Carpenter 2012.



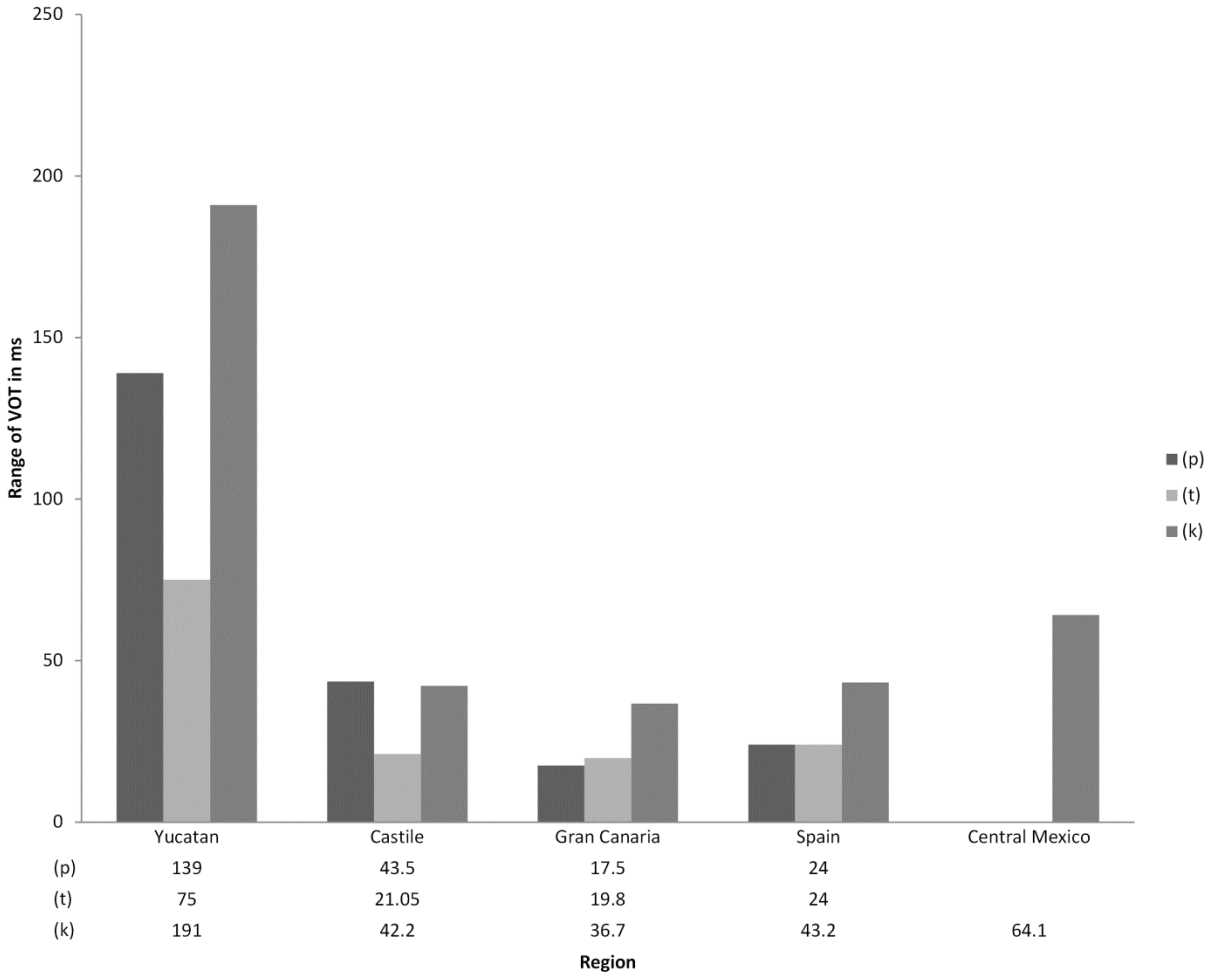
	Yucatan	Castile	Guatemala	Venezuela	Peru	Gran Canaria	Argentina	Valdivia Chile	Concepción Chile	Spain	Puerto Rico	Central Mexico
(p)	17.21	13.1	9.8	14	15.2	9.7	10	13.2	10.1	6.5	4	
(t)	22.02	14	10.3	20.6	16.2	16.6	15	16.4	16.9	10.4	9	
(k)	34.04	26.5	25.7	32.6	29.7	28.2	25	30	28.3	25.7	29	25.5

Although the values in Figure 1 are generally higher than those reported for other varieties, the difference is not always extreme (compare, for example, Williams' (1977) study on Venezuelan Spanish with YS), confirming the observation of Coupal & Plante (1977, 150) that aspiration in YS is greater than that found in Castile or the Caribbean, but is not as great as some previous literature has suggested. Another point to keep in mind is that the studies included in Figure 1 include a wide variety of methodologies, including laboratory and read speech, which may influence the amount of aspiration produced by speakers. Importantly, however, the /k/ value for Central Mexico (Carpenter 2012) was produced following the same methodology as the YS data, allowing for a clearer comparison.

A comparison of the range of VOT measurements across varieties, however, does show more striking differences. As seen in Figure 2, which includes range values for YS and for

previous studies that reported them, these YS speakers display a much wider range of aspiration than speakers of many other varieties.

Figure 2. VOT range in ms across varieties. Castile: Rosner et al. 2000; Gran Canaria: Troya Déniz 2005; Spain: Castañeda 1986; Central Mexico: Carpenter 2012.



The range values in Figure 2 include all tokens, and indicate a range of 139ms for /p/, 75ms for /t/, and 191ms for /k/, much larger than that reported for any other variety. This concurs with the findings of Lope Blanch (1987), who reports a large amount of individual variation regarding aspirated /ptk/, and based on a comparison of Figures 1 and 2, it is likely that this range of aspiration is what has been noticed by previous, impressionistic studies. It is important

to note that a majority of tokens show a much more restricted range of VOT length, as demonstrated by examining the interquartile range, with 50% of the tokens clustering between 9.17ms and 22.24ms for /p/; /14.27ms and 27.53ms for /t/; and 23.09ms and 41.12ms for /k/. Still, the large total range for each variable may give the impression of an extreme overall difference in mean VOT realization, suggested by some earlier studies but which is not borne out by the present data, as realizations closer to pan-Hispanic norms likely pass without notice. [4]

Figures 3, 4 and 5 present boxplots of the overall VOT measurements for each speaker. In each plot, the horizontal dotted line indicates the median value for YS (current study), and the horizontal dashed line indicates the median value reported for Castilian Spanish (Rosner et al. 2000). [5] The vertical solid lines separate the speakers into groups by gender and language background; within each group, age increases from left to right. In the boxes, the middle dark line represents the median value for that speaker, with the box limits representing the 1st and 3rd quartiles.

[4] Although a perception study is required to be certain regarding what level of aspiration is perceived by speakers.

[5] Median, rather than mean, values are discussed with reference to the boxplots in Figures 3, 4 and 5, based on the standard use of medians in boxplots of this type.

Figure 3. VOT across speakers: /p/

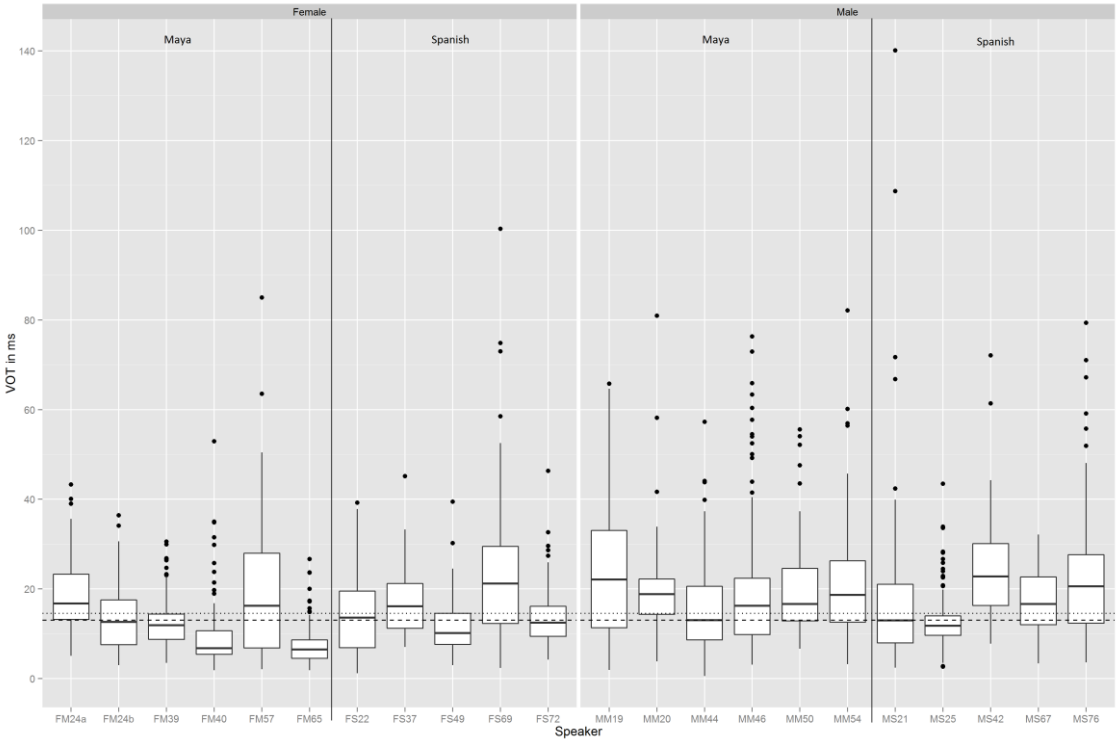


Figure 4. VOT across speakers: /t/

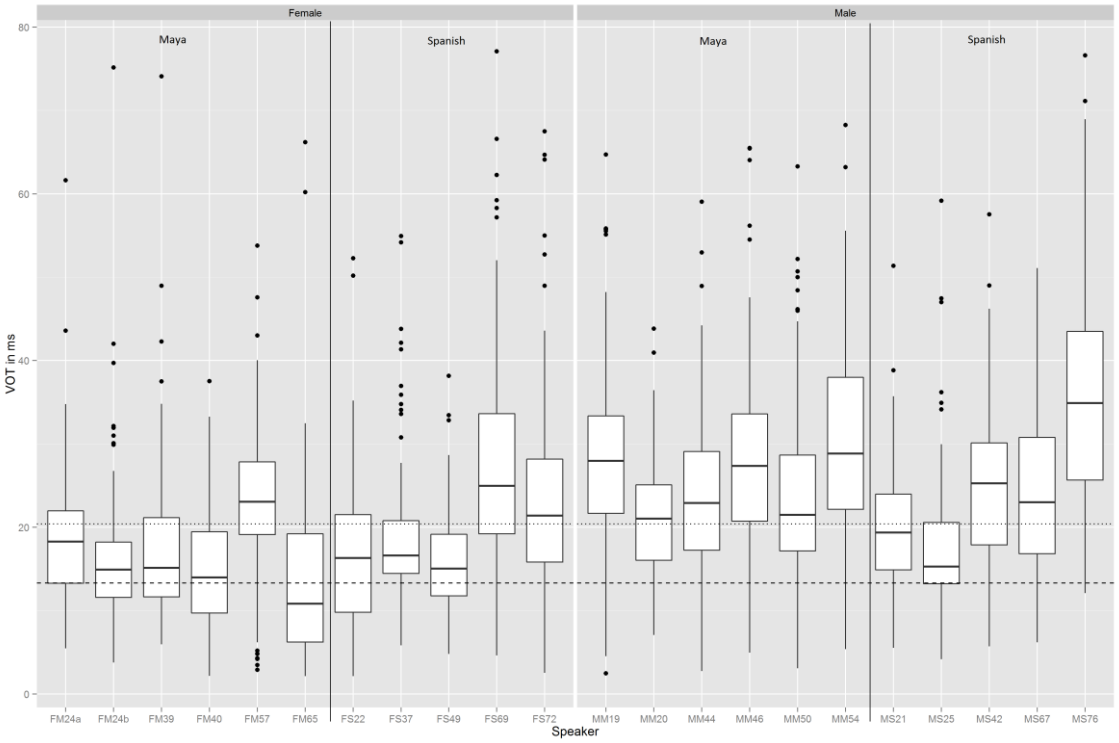
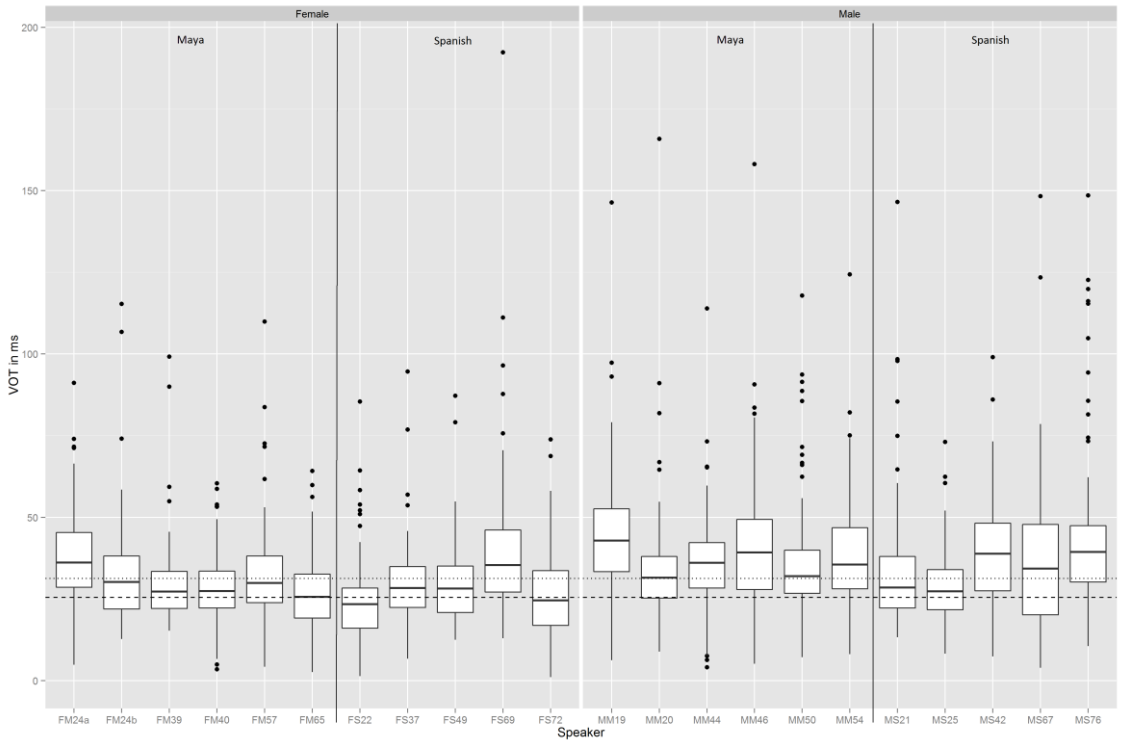


Figure 5. VOT across speakers: /k/



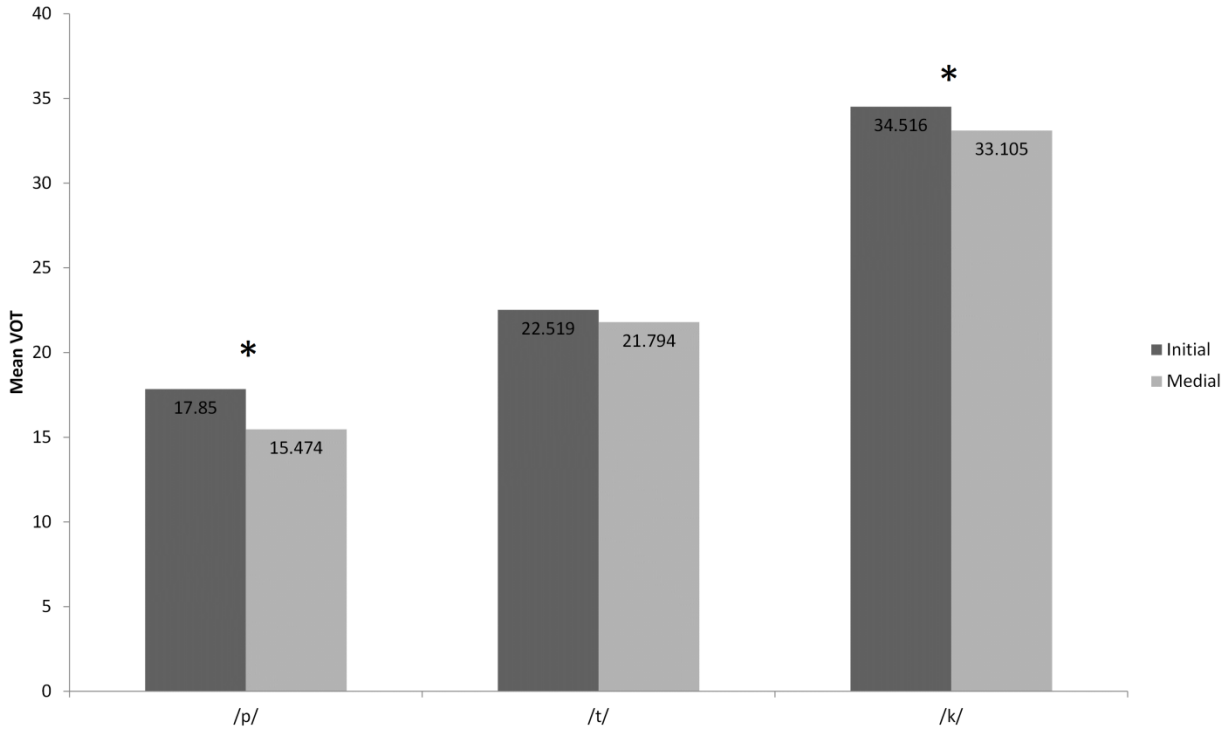
Some general trends can be observed across variables. First, for the most part, women produced median VOT values at or below the median value for Yucatan Spanish (dotted line), but generally at or above the median value for Castilian Spanish (dashed line - Rosner et al. 2000): median value for women of 12.57ms for /p/, 17.35ms for /t/ and 28.47ms for /k/. Men, on the other hand, demonstrate more of a tendency to cluster above the mean values for Yucatan Spanish for all three variables (16.63ms for /p/, 23.61ms for /t/ and 34.63ms for /k/). Regarding age and language group, no clear pattern is visible at all for /p/. For /t/, somewhat of a pattern is evident for all groups except female Maya speakers, with the clearest distinction across age for Spanish-speaking monolingual men and women, where older speakers in both groups produced higher VOT values. Finally, for /k/, the same pattern is most evident for Spanish-speaking men, with the three oldest speakers in that group producing higher than average VOT values. Also remarkable, as in Figure 2 above, is the large range of VOT values, with numerous 'outlier'

tokens visible for most speakers, but also large overall differences within speaker, as indicated by the 'whiskers' on each boxplot. It was not unusual for the same speaker to produce a very 'standard' token of /ptk/, followed closely by a highly aspirated token, often in the same context. [6]

We will begin by examining each of the linguistic and social factors in more detail. On each of the figures below, statistical significance in the mixed effects model at the .05 level will be indicated with an asterisk (*); significance in only the fixed effects model (without taking individual speaker variation into account - Johnson 2009; Tagliamonte 2012) is indicated with a plus (+). The complete Rbrul analyses in table form will be presented following the figures.

[6] Some previous research (Yager 1982) have noted that aspirated /ptk/ are more likely to arise in emphatic contexts. No attempt was made to code for 'emphatic' vs 'non-emphatic' in the present study, but a majority of the tokens did not stand out as contrastive or emphatic, and in fact included many forms, such as prepositions (*con* "with", *por* "by", etc.) that are unlikely to receive stress or emphasis of any kind in running speech. This does not, however, preclude a possible role for emphasis in increased VOT in Yucatan Spanish, and is something that should be studied further, possibly under controlled, laboratory conditions.

Figure 6. Mean VOT values for position in the word. Significance: /p/ - p = 0.00081; /t/ - p = 0.0589; /k/ - p = 0.0164.



All three variables show the same trend for word position: Mean VOT values are longer in word initial position than in word medial position, a result which is significant for /p/ (p = 0.00081) and /k/ (p = 0.0164), and marginally significant for /t/ (p = 0.0589). This result supports previous research that found more aspiration word-initially in YS (Yager 1982; García Fajardo 1984; Rosado 2011), and studies have found that word initial position favors longer VOT across a variety of languages (English, Cooper 1991; Korean, Jun 1995). Likewise, phrase initial (i.e. following a pause) vs. phrase internal position was analyzed for each variable.[7] Phrase initial position significantly favored longer VOT values for all stops (cf. Jun 1995). A similar trend for

[7] Position in the phrase was analyzed in a separate analysis, due to collinearity with other variables (particularly position in the word and syllable stress).

both position in the word and in the phrase was found for ‘strengthened’ occlusive /bdg/ in word initial position in YS (Michnowicz 2011)

Figure 7. Mean VOT values for position in the phrase. Significance: p = < 0.01 for all stops.

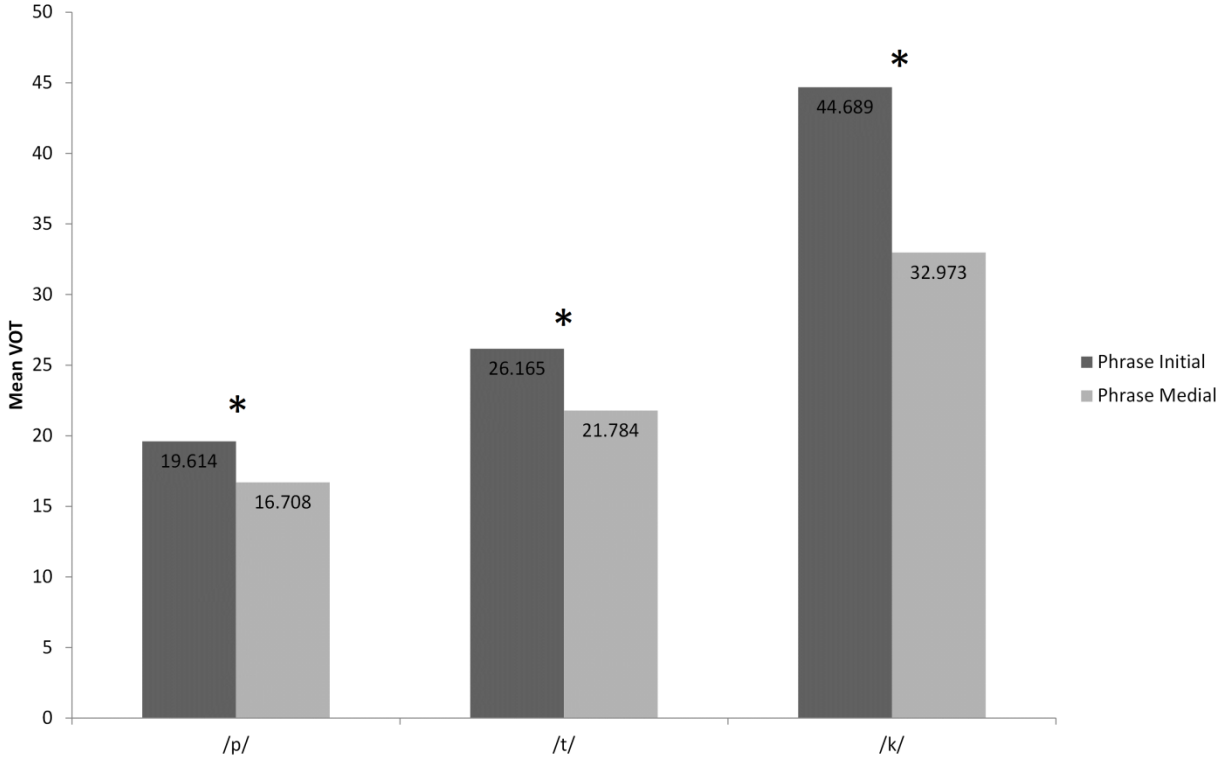
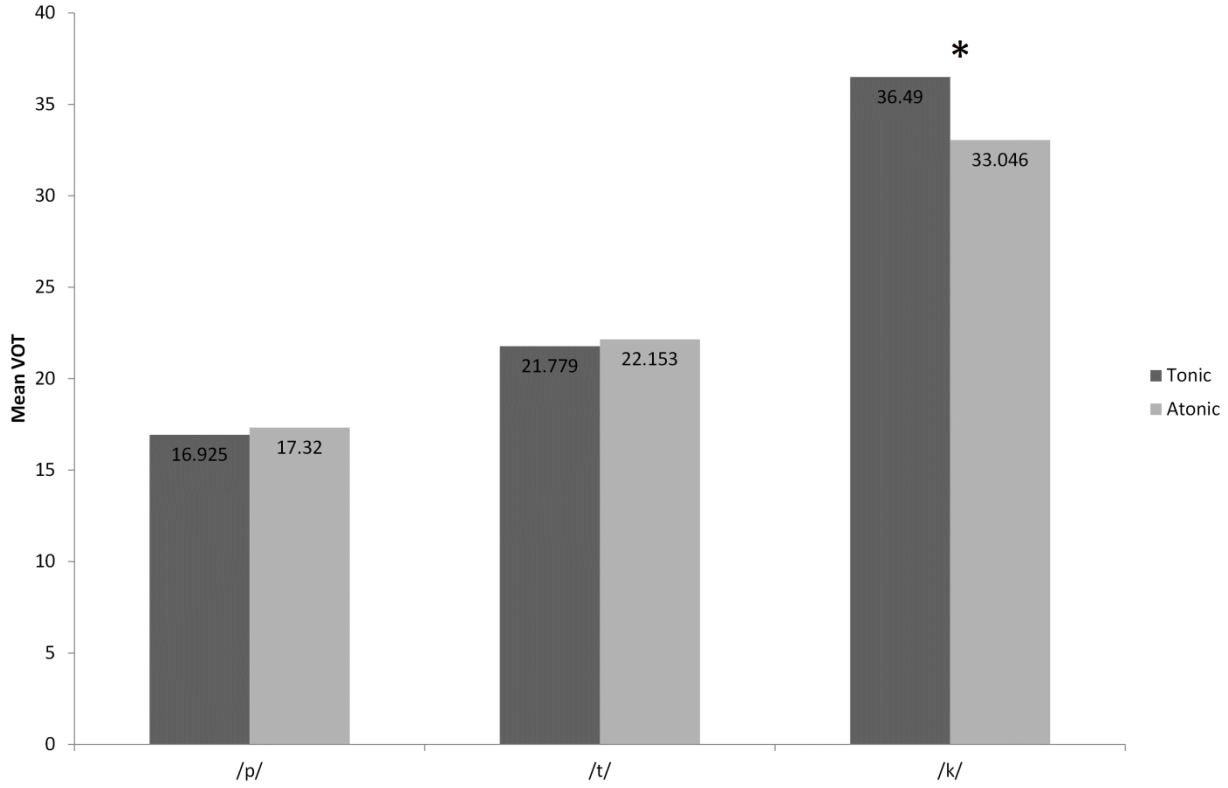


Figure 8. Mean VOT values for syllable stress. Significance: /k/ - p = < 0.001.



Regarding syllable stress, there is no significant difference between tonic and atonic syllables for either /p/ or /t/. For /k/, VOT values are significantly longer in stressed syllables (p = < 0.001). This result agrees with previous work on YS /ptk/ (García Fajardo 1984; Rosado 2011), as well as research that demonstrates consonant strengthening in tonic syllables for other variables in YS (see Michnowicz 2011 for occlusive /bdg/), in addition to the findings of VOT conditioning in other languages (such as English - Lisker & Abramson 1967). There was no significant interaction for position in the word:syllable stress for any of the three variables.

Figure 9. Mean VOT values for following segment - /p/ and /t/ Note that /tl/ is very limited in Spanish, and did not occur in the data. Significance: $p = < 0.001$ for both stops.

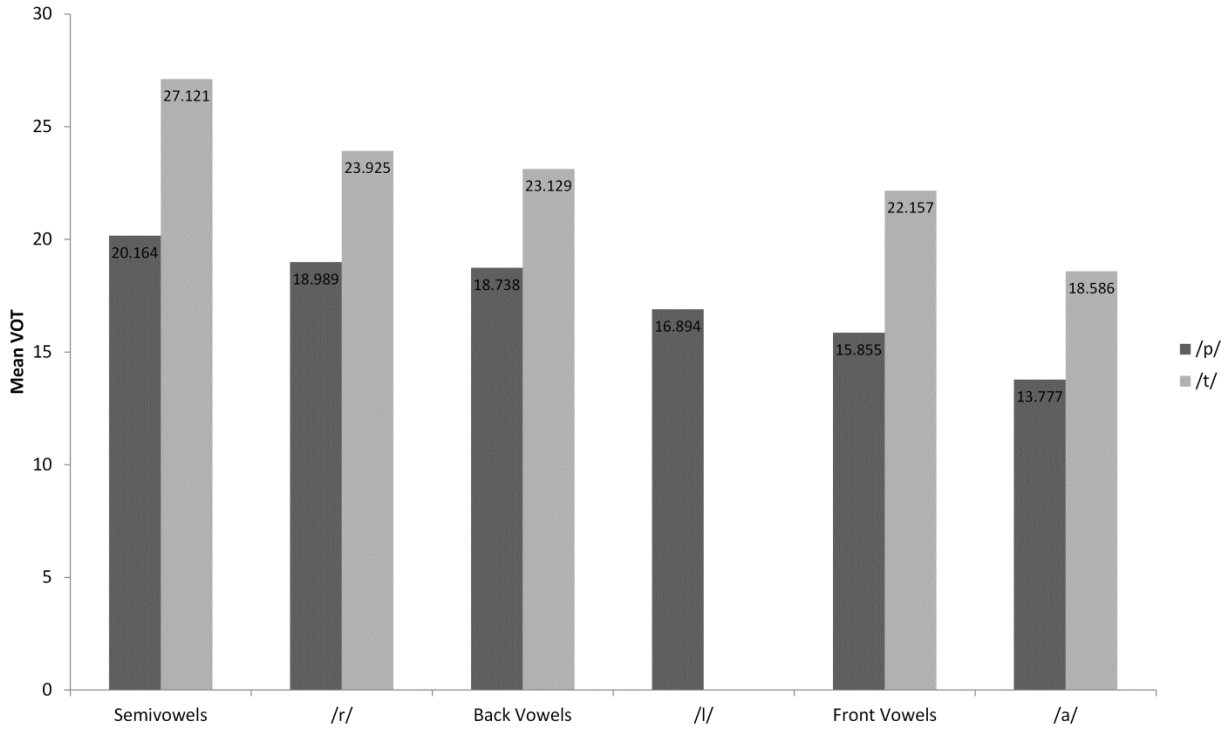
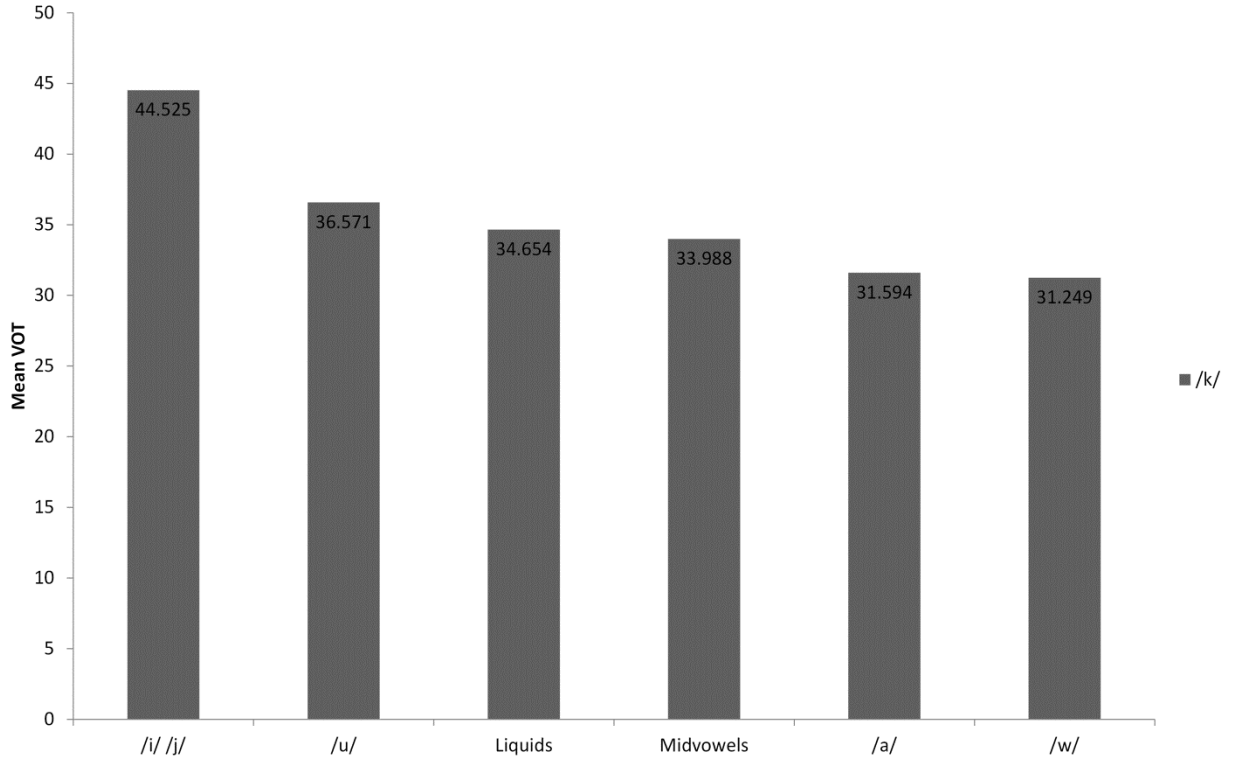


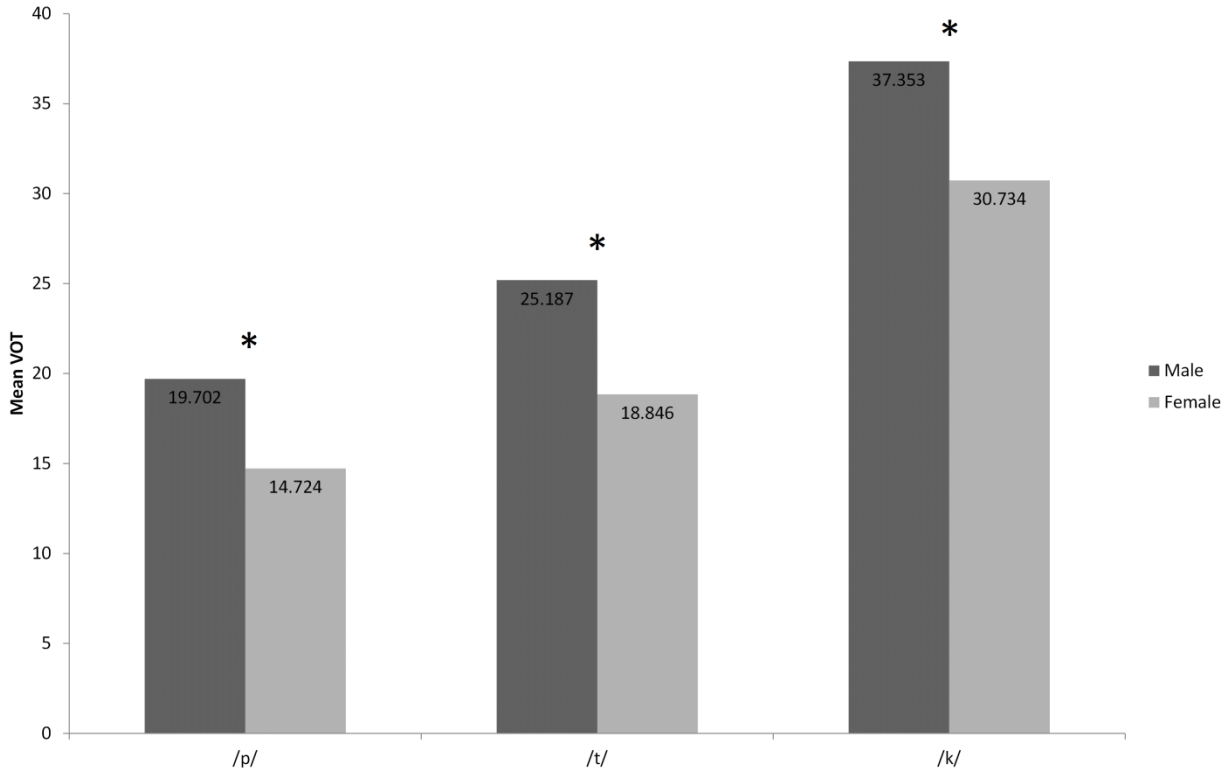
Figure 10. Mean VOT values for following segment - /k/. Significance: /k/ - p = < 0.001.



Initial analyses indicated that following segment suffered from multicollinearity with several factors, including syllable stress and tonicity. Due to this overlap, following segment was run as a separate mixed-effects analysis for all three variables, and was a highly significant factor for all three stops. Given the large number of possible following segments (for example, 9 different phonemes following /k/), many with small token counts, following segments were grouped according to linguistic class where appropriate and where combining factors (such as /l/ and /r/ into a group 'liquids') did not significantly change the model, as shown by the chi-square test to compare models available in Rbrul. Interestingly, according to this method, following segment seems to affect the labial/coronal vs. dorsal consonants in significantly different ways. As seen in Figure 9, /p/ and /t/ seem to respond primarily to consonant backness, with back vowels (along with semi-vowels and liquids) favoring longer VOT values, while front vowels and the central vowel /a/ conditioned shorter aspiration. VOT values for /k/, on the other hand,

seem to respond primarily to vowel height, with following high vowels (including the semivowel /j/) and liquids conditioning longer aspiration, and mid vowels and the low vowel /a/ (along with the semivowel /w/) favoring shorter VOTs. There are consistencies across the three variables regarding following context: first, /a/ consistently disfavors aspiration, while following liquids favor for all three stops. This finding is consistent with previous research in other languages, such as English (Klatt 1975), Mandarin Chinese (Chao & Chen 2008) and French (Fischer-Jørgensen 1972), that finds that VOT values are generally longer before high vowels than before low vowels, and in the present data, low /a/ conditions shorter VOT for all three stops.

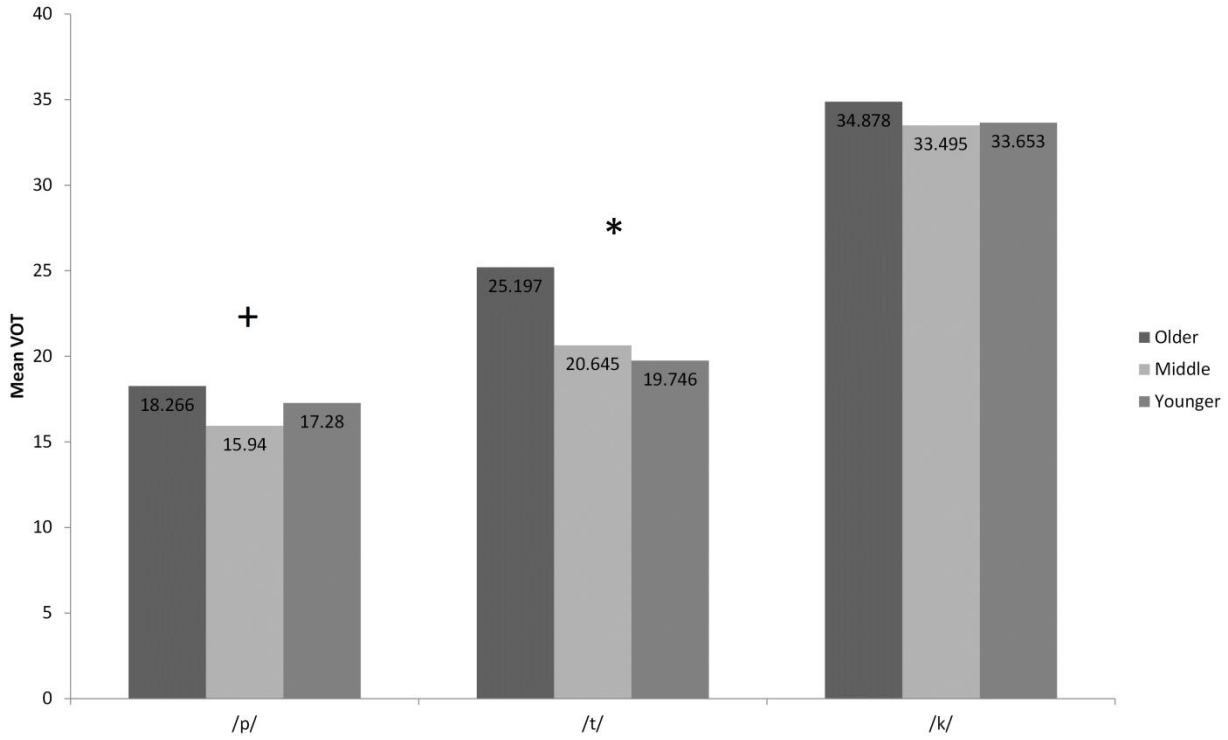
Figure 11. Mean VOT values for gender. Significance: p = < 0.01 for all stops.



Turning our attention to social factors, gender was a significant predictor of VOT values for each of the three variables, with men consistently producing longer aspiration than women. This agrees with the sociolinguistic principle that women tend to use more standard forms than

men, at least for stigmatized variables (Labov 2001). Regarding previous research on Yucatan Spanish, women have been found to use higher rates of some regional variants, such as final -m (Michnowicz 2008) and occlusive /bdg/ (Michnowicz 2011), a pattern which does not hold for the present data on VOT. Likewise, Rosado (2011) reports that women favor aspirated ([+tense]) variants significantly more than men, a result that is also contradicted by the present study. [8] Possible explanations for the observed gender patterns will be addressed in the discussion.

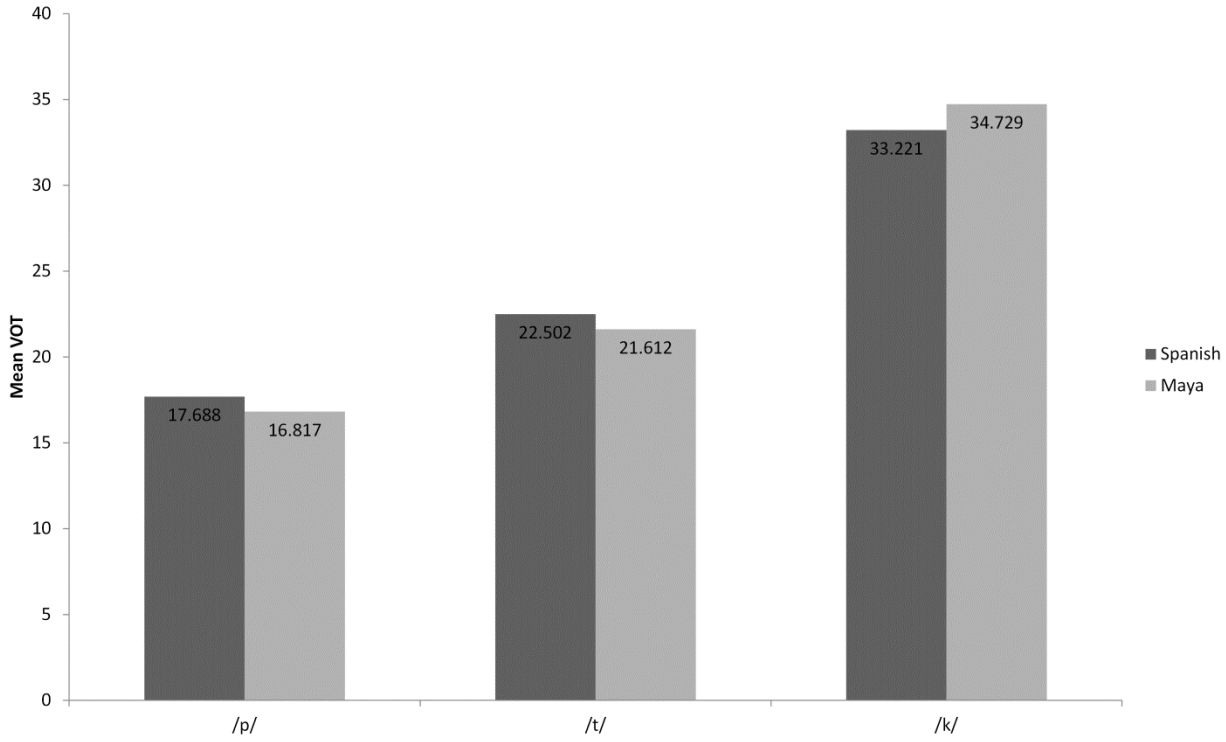
Figure 12. Mean VOT values for age group. Significance (mixed model): /t/ - p= 0.0247; Significance for /p/ (fixed effects model): p = 0.00496.



[8] Although in Rosado (2011) it is not clear from the study how the difference between [+/-tense] variants was determined. Further investigation is required to determine if the different results for gender are due to actual differences in the speaker pools (perhaps as some sort of interviewer effect?), or if instead they are due to methodology. Rosado does suggest that the fact that most of the women in her study worked outside of the home may be a factor (p. 159). Social network ties and access to the linguistic marketplace should be further explored in future research.

For age groups, all three variables show the same trend, with the oldest speakers producing higher mean VOT values than younger speakers. This pattern is significant in the mixed effects model for /t/, and achieves significance in the fixed effects model for /p/. Additional analysis indicates that the difference between middle age and younger speakers for /t/ is not significant ($p = 0.317$); likewise, the difference between older speakers and middle age speakers is also not significant ($p = 0.208$). The difference, then, is due to the increased VOT value among older speakers vis-à-vis the youngest speakers. This result is consistent with previous work on Yucatan Spanish that indicates that younger speakers are abandoning regional segmental forms in favor of a less marked, pan-Hispanic norm (Michnowicz 2012, 2011, 2009). In additional analyses, age was also run as a continuous variable, instead of being grouped as above. The results are essentially the same, with the same significant difference arising for /t/ in the mixed effects model (Age in years - continuous +1, coef = 0.154, $p = 0.00212$); age differences for /p/ are no longer significant in any model with age as a continuous measurement ($p = 0.122$). Given that the overall results are the same, the rest of the analysis will proceed with age groups.

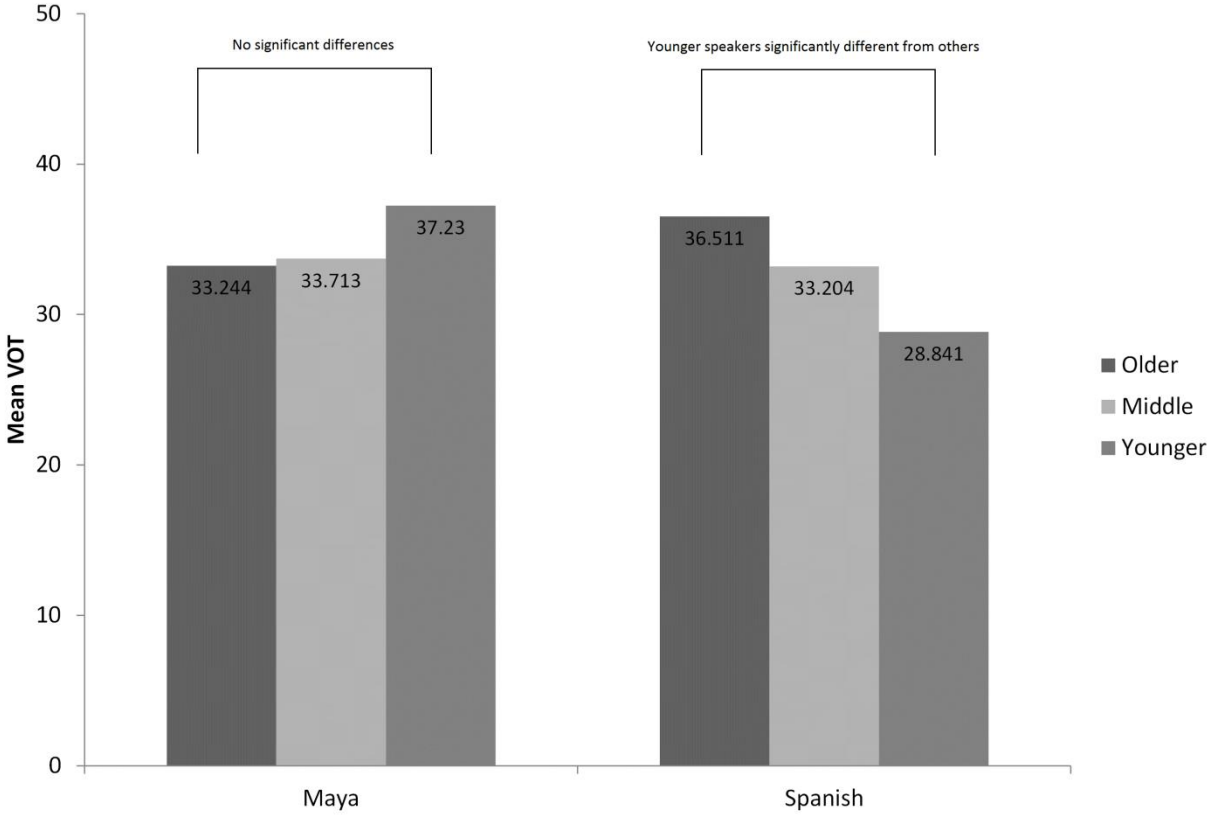
Figure 13. Mean VOT for language background. Not significant for any variable in the mixed effects or fixed effects models.



Language background was not a significant predictor for any of the variables in any of the mixed models or fixed models. These results agree with Rosado (2011), who found no significant differences based on language background. Still, the overall lack of significance, as well as the observed (non-significant) trend for Spanish monolinguals to produce longer VOT values for /p/ and /t/ is somewhat surprising, given the tendency in earlier studies to attribute Yucatan Spanish aspirated /ptk/ to direct Maya influence (Alvar 1969; Yager 1982). We will argue in the discussion, however, that this result does not preclude an indirect role for Maya, as what was originally a contact-induced feature may have been passed on to the monolingual population in prior generations (see Thomason & Kaufman 1988), thereby erasing the synchronic effect of language background.

Evidence of this possibility is found in a significant interaction found for /k/, seen in Figure 14.

Figure 14. Significant interaction in mixed effects model: /k/ Age:Language. Overall significance, p = 0.00694. Difference between Older/Middle vs. Younger Spanish speakers, p = 0.00129. No other differences significant.



First, in spite of the apparent differences between Older/Middle age and Younger Maya speakers, none of these significantly rise above the level of individual variation. Comparing Figure 14 to the boxplots in Figure 5, it is apparent that this observed increase in mean VOT for the youngest Maya speakers is essentially driven by the behavior of two speakers, MM19 (mean of 43.65ms), and to a lesser extent, FM24a (mean of 32.69ms). Both come from pueblos outside

of Merida, and work as domestic employees, but report different levels of proficiency in Maya. [9] Thus although there are not significant differences in the present data, VOT among Maya-bilinguals should be explored in further research.

The monolingual Spanish speakers, on the other hand, do exhibit significant differences across age groups. Younger Spanish speakers produced significantly shorter VOT values than did middle aged/older speakers. This trend matches that reported for other regional (possibly stigmatized) variables in Yucatan Spanish, such as occlusive /bdg/ (Michnowicz 2009, 2011, 2012) and /ʔ/ insertion (Michnowicz 2012), both of which show a decrease in use across age groups, with younger speakers more closely approximating 'standard' Spanish norms.

The full results for the multivariate analyses in Rbrul (mixed effects model) are found in Table 1. As demonstrated by the range (calculated as the total range of coefficient values for a given factor group), gender is by far the most important social factor, followed by age group (although only significant for /t/). Since following segment and position in phrase were both run as separate models due to collinearity with other factors, range was not computed. However, the very small p-values for those factors across all three variables attest to their importance in constraining VOT production.

[9] FM24a is a fluent Maya speaker, and notes that she did not learn Spanish until coming to Merida to work when she was a teenager. MM19 at first states that he does not speak Maya, but later in the interview notes that he speaks Maya when he is at home in his town, but adds that he speaks more Spanish than Maya. He does demonstrate some morpho-syntactic features consistent with L2 Spanish (e.g. lack of gender agreement - "*es muy bonito la leyenda*" "the legend (fem) is very pretty (masc)"; see Michnowicz 2012).

Table 1. Rbrul mixed effects model for all variables. *Following segment and Position in Phrase run as separate mixed effects models. P-values taken from main effects run. Significant interactions indicated.[10] [11]

Factor Group	/p/				/t/				/k/			
	Coef	Tokens	Mean	p-value	Coef	Tokens	Mean	p-value	Coef	Tokens	Mean	p-value
Following Segment: /p/, /t/*				3.48e-18				2.41e-23				
Semivowels	2.516	386	20.164		4.380	95	27.121					
/r/	1.304	251	18.989		0.394	370	23.925					
Back vowels	1.200	543	18.738		0.506	519	23.129					
/l/	0.175	82	16.894									
Front vowels	-1.722	402	15.855		-0.833	673	22.157					
/a/	-3.473	536	13.777		-4.448	543	18.586					
Following Segment: /k/*												1.75e-15
/i/, /j/									9.152	153	44.525	
/u/									1.013	60	36.571	
Liquids									0.180	80	34.654	
Mid vowels									-1.492	1223	33.988	
/a/									-3.703	509	31.594	
/w/									-5.150	175	31.249	
Position in Phrase*				0.00143				0.00116				4.09e-15
Phrase Initial	1.009	382	19.614		1.553	117	26.165		4.98	201	44.689	
Phrase Medial	-1.009	1818	16.708		-1.553	2083	21.784		-4.98	1999	32.973	
Gender				0.0063				0.000556				0.00207
Men	2.471	1100	19.702		3.341	1100	25.187		3.061	1100	37.353	
Women	-2.471	1100	14.724		-3.341	1100	18.846		-3.061	1100	30.734	
	Range = 4.942				Range = 6.682				Range = 6.122			
Age Group				0.761				0.0247				0.877
Older	1.286	800	18.267		3.328	800	25.212		1.161	800	34.894	
Middle Age	-0.969	700	15.940		-0.503	700	20.645		0.649	700	33.480	
Younger	-0.316	700	17.281		-2.825	700	19.737		-1.810	700	33.635	
	Range = 1.602				Range = 6.153				Range = 2.971			
Language Background				0.91				0.729				0.604
Spanish monolingual	0.675	1000	17.688		0.082	1000	22.502		-0.241	1000	33.221	
Maya-Spanish bilingual	-0.675	1200	16.817		-0.082	1200	21.612		0.241	1200	34.729	
	Range = 1.35				Range = 0.164				Range = .482			
Position in Word				0.00081				0.0589				0.0164
Initial	0.902	1610	17.850		0.477	676	22.519		0.619	1463	34.516	
Medial	-0.902	590	15.474		-0.477	1524	21.794		-0.619	737	33.105	
	Range = 1.804				Range = 0.954				Range = 1.238			
Syllable Stress				0.329				0.217				7.44e-07
Tonic	-0.055	595	16.925		-0.205	800	21.779		2.251	637	36.490	
Atonic	0.055	1605	17.320		0.205	1400	22.153		-2.251	1563	33.046	
	Range = .11				Range = 0.41				Range = 4.502			
Speaker [random]	Std. Dev. = 4.021				Std. Dev. = 3.99				Std. Dev. = 4.292			
Significant Interactions	None				Age: Position in Word; Gender: Stress; Age: Stress				Age: Language; Gender: Position in Word; Language: Position in Word			
	Deviance = 16839.75; df = 23; Grand Mean = 17.213				Deviance = 16394.94; df = 23; Grand Mean = 22.017				Deviance = 18696.62; df = 23; Grand Mean = 34.043			

5. Discussion and conclusions

The results presented above allow us to address our initial research questions and hypotheses. First, we asked if VOT values are longer for YS than for other varieties of Spanish, as suggested by previous work (Alvar 1969; Coupal & Plante 1977). The present results indicate that yes, generally speaking VOT values are longer in YS than in other varieties that have been

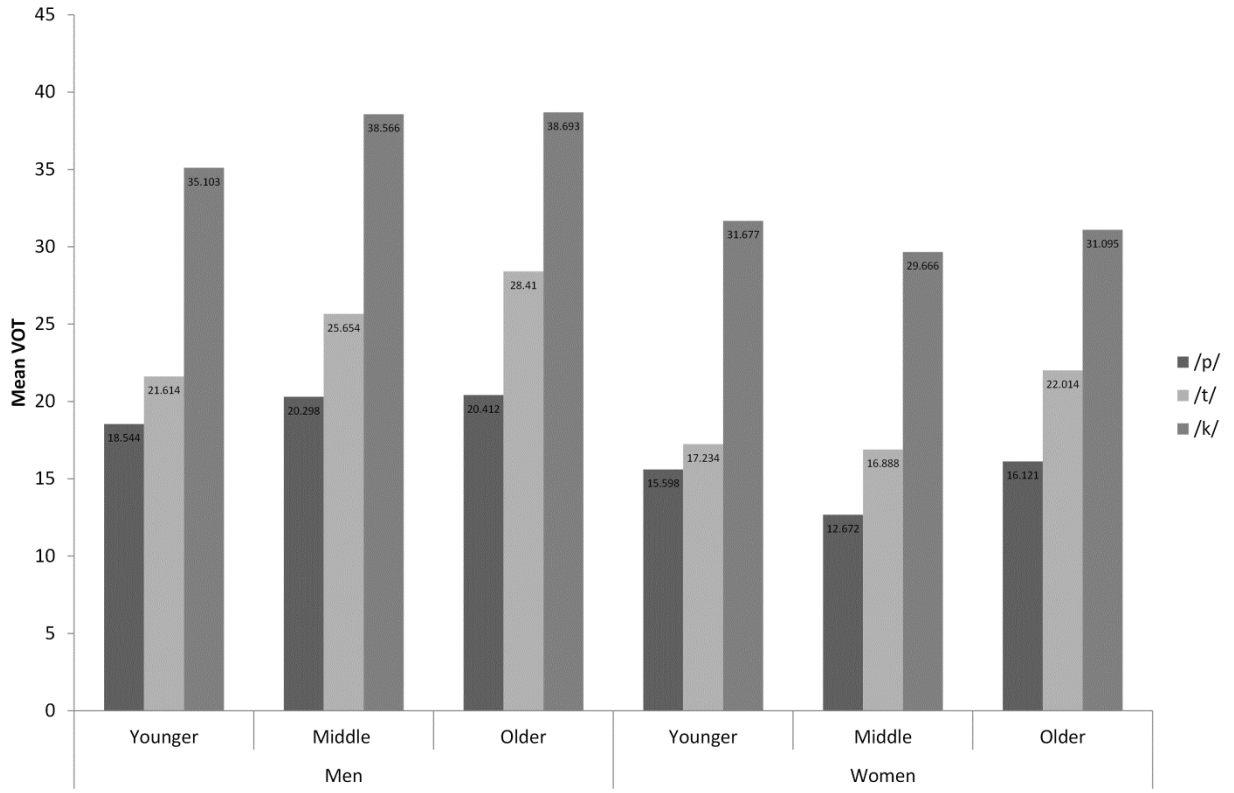
[10] Significant interactions were found between social factors and linguistic factors for /t/ and /k/. Since they do not add to the present discussion, they are not commented further here.

[11] The p-values in the chart are presented as given by Rbrul, which includes scientific E notation for very small values. For example, the p-value for Syllable Stress for /k/ is 7.44e-07, which is equivalent to 0.000000744 in decimal notation.

studied, but that the overall difference is not as great as has been suggested in some previous literature, backing up the findings of Coupal & Plante (1977). Hypothesis 1 is therefore confirmed, although not strongly. Likewise, the results suggest that the extremely large range of VOT values in YS may give the impression that overall aspiration rates are higher than what they actually are. Perception studies are required to provide a confident answer to this question. Related to overall range, the extreme individual variation seen in Figures 3, 4 and 5 confirms our second hypothesis and the claim of Lope Blanch (1987), and again may contribute to a sense that aspiration is stronger in YS than it actually is. Our second research question addressed the linguistic and social factors that constrain VOT production in YS. Following segment, position in the phrase and position in the word were all found to be significant predictors for all three stops, with more aspiration produced in 'stronger' positions (phrase and word initial). Syllable stress was significant only for /k/, with tonic syllables favoring longer VOT.

For social factors, gender was a significant predictor for all stops, with men producing longer VOTs than women. Previous work in variationist sociolinguistics has demonstrated that the ways in which language varies across genders is complex, and depends on a variety of factors, such as the relative prestige of the form in question (Labov 2001), as well as the intersection of gender with other social factors, such as age or social class (Cameron 2011). Combined, the observation that both women and younger speakers (commented further below) favor shorter, more 'standard-like' VOT values, suggests that heavily aspirated /ptk/ is a stigmatized feature in YS, and in this sense, women are conforming more to a 'standard', pan-Hispanic norm. The intersection of gender and age is seen clearly in Figure 15, which presents a crosstab of those factors for each variable.

Figure 15. Cross-tabulation of Gender and Age; all variables.



Women appear to be a minimum of a generation ahead of men in standardizing their VOT values, with younger and middle age women producing very similar values that distinguish them from older women. For men, however, it is the middle age and older speakers that pattern together, implying that the move toward shorter VOTs began among the youngest generation of men. Many of the middle age women are old enough to be the parents of the youngest speakers in the study, and these speakers appear to generally follow the model of language change outlined in Labov (2001, 308-309), in which women proceed in a linear fashion in adopting a new linguistic form, whereas men, proceeding in step-wise fashion, lag a generation behind with respect to the change.

When considered alone, age was only significant for /t/, but all three variables showed the same overall trend: younger speakers produced shorter VOTs than older speakers. Thus

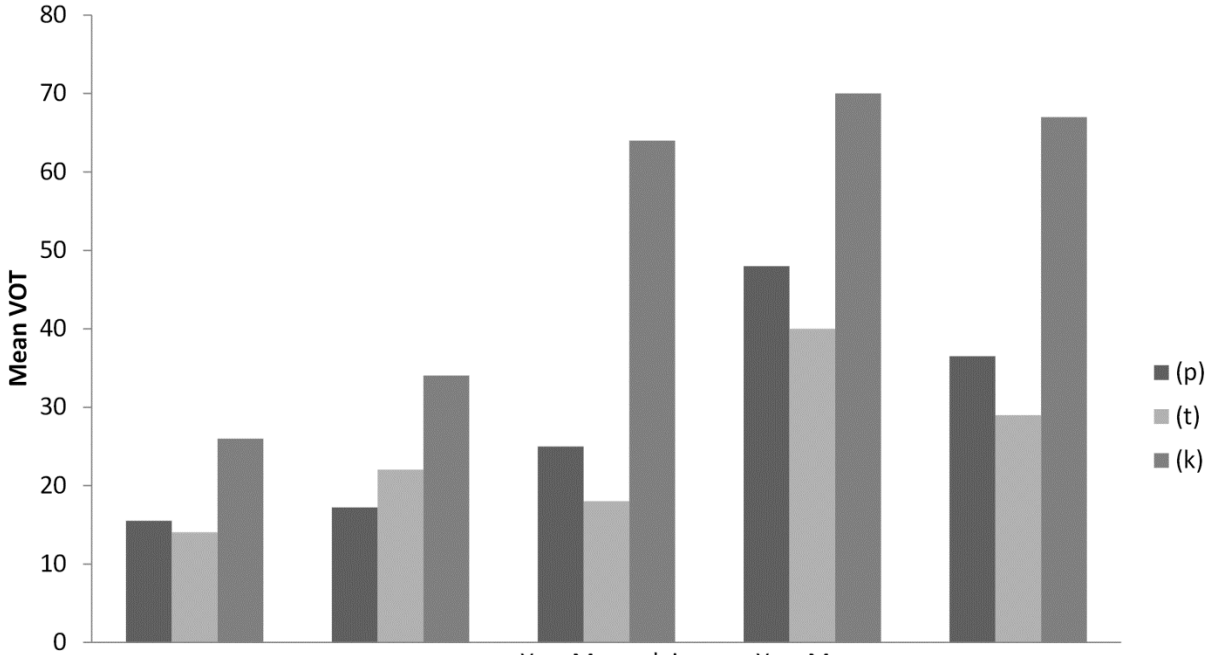
hypothesis 3 is confirmed, although as noted above, age intersects in complex ways with other social factors, such as gender. This result supports previous research by Michnowicz (2012) that showed a decrease in regional YS segmental features across age groups for two families in Izamal and Merida, Yucatan. As claimed in that article, younger speakers are quickly abandoning many regional forms of YS due to a variety of factors, such as increased education levels, access to more 'standard' varieties of Spanish, and a possible move away from what are perceived to be indigenous interlanguage forms (see also Klee 2009).

Hypothesis 4, that we would find evidence of influence from Maya on YS aspiration was not directly confirmed. Language group was not a significant factor for any of the three variables (cf. Rosado 2011), although language and age did significantly interact for /k/, with Spanish monolinguals showing a significant decrease in VOT values across age groups (see Figure 14). This result is surprising, considering the tendency for early studies to attribute YS [$p^h t^h k^h$] to direct Maya influence. We argue, however, that there is other, indirect evidence that supports a contact origin for these phones in YS.

First, some previous research on VOT realization in bilingual speech suggests that when the two languages spoken by the bilingual differ with regard to VOT, (late) bilinguals may produce intermediate "compromise" values that lie between the norms of the two languages (Flege 1991, 395). Likewise, intermediate VOT values among Spanish-English bilinguals have been explained as a combination of exposure to Spanish-accented input and incomplete phonetic realization rules for /ptk/ (Flege & Eefting 1988). Not all studies have found intermediate values, however, especially when considering early learners, who are generally capable of approximating monolingual norms (Williams 1977; Mack 1989; Flege 1991; Magliore & Greene 1999). While the debates surrounding the existence and realization of phonetic categories among

bilingual speakers fall outside the scope of this study, some of the findings from these studies can shed light on the possibility of indirect Maya-influence on /ptk/ in YS.

Figure 16: Mean VOT values for Castilian Spanish (Rosner et al. 2000), Yucatan Spanish (present study) and Yucatec Maya (Burnett-Deas 2009). Maya overall values are the average of Maya plain stops and Maya ejectives.



	Castile	Yuc. Span	Yuc. Maya plain stops	Yuc. Maya ejectives	Yuc. Maya overall
(p)	15.5	17.21	25	48	36.5
(t)	14.05	22.02	18	40	29
(k)	26	34.04	64	70	67

Figure 16 presents a comparison of mean VOT values for Castilian Spanish (Rosner et al. 2000), Yucatan Spanish (the present data) and Maya plain stops and ejective stops (Burnett-Deas 2009). While the difference between plain and ejectives stops is phonological in Maya (Frazier 2009), it is possible that shifting Maya speakers, as well as Spanish monolinguals exposed to Maya-influenced Spanish, would have interpreted both of these groups as simply ‘aspirated’ and conflated them into one category of Maya ‘strong’ stops (see Winford’s 2003, 54-55 discussion

of the loss of phonemic distinctions in cases of borrowing/shift; also Weinreich 1953). Therefore, values for 'overall' Maya aspiration were also calculated (the average VOT value between plain stops and ejectives). As can be seen, the YS values lie between the means for Castilian Spanish and Maya stops, although at no point nearing the levels reported for Maya ejectives. For /p/, the YS mean value lies closer to the Castilian Spanish value, and below the exact midpoint between Castilian and Maya plain stops (20.25ms). The YS mean value for /t/ actually exceeds the mean for Maya plain stops by 4ms, but almost exactly coincides with the intermediate value between Castilian /t/ and 'overall' Maya /t/ (21.525ms). Finally, YS /k/ VOT, while greater than Castilian /k/, falls far short of values for Maya stops. There is some evidence, then, for intermediate values between Castilian Spanish and Maya for YS /t/, but no clear conclusions can be drawn for /p/ or /k/.

Additionally, the wide range of individual variation found for YS /ptk/, as reported by Lope Blanch (1987) and confirmed in the present data (see Figures 3, 4 and 5), is expected in cases of language shift and koineization brought about by dialect contact (Kerswill 2002). In this case, demographic changes over the past century have led to increased contact between monolingual speakers of Spanish (the monolingual dialect), and speakers of an interlanguage, L2-influenced variety of Maya-influenced Spanish (the bilingual dialect) (see Klee 2009; Michnowicz 2012 for an overview of demographic shifts in Yucatan). Thomason (2001, 66-76; see also Thomason & Kaufman 1988, 38-42) outlines the outcomes of what she calls "imperfect learning", or the interlanguage that arises when a large group of speakers shift, via unbalanced bilingualism, to the target language. These speakers, having not acquired the monolingual target variety of the language to which they are shifting (in this case, Spanish), are likely to retain fossilized L2 features in their speech. Thomason (2001) notes that if this group (Maya-dominant

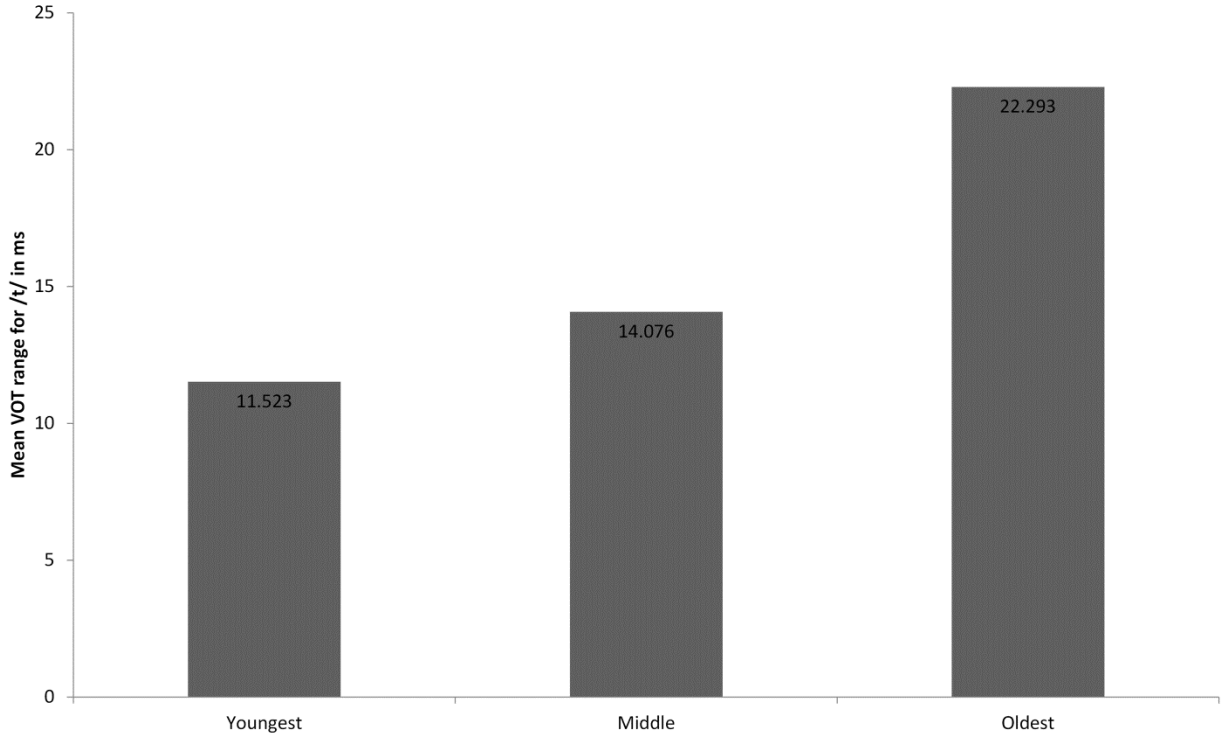
speakers) remains separate from the dominant society (and language) to which they are shifting (urban monolingual Spanish society), their interlanguage variety of (in this case) Spanish is not likely to affect the speech of the monolingual, Spanish-speaking population. If, however, the shifting population is later integrated into the community, mutual accommodation of regional dialects and the interlanguage of the shifting group can create a new variety of the target language (Spanish), which then may be passed on to monolingual speakers of Spanish. This process has been argued to be responsible for other features of YS that have been attributed to Maya influence, including aspirated /ptk/ (Michnowicz 2012), occlusive /bdg/ (Michnowicz 2009, 2011, 2012), phrase-final -/m/ (Michnowicz 2007, 2008) and /ʔ/ insertion (Michnowicz 2012) - see also Klee (2009) and Klee & Lynch (2009). As these processes of mutual accommodation between monolingual and bilingual (Maya-influenced) Spanish occur, individual variation is increased, as the first speakers born into the new variety exhibit extreme variability in their selection of variants (Trudgill 1998; summary in Kerswill 2002: 679). In Yucatan, although contact between Spanish and Maya has been possible for the past 500 years, it is only since the middle of the 20th century that large scale movement of Maya-speakers to urban areas, accompanied by language shift, has taken place (Klee 2009, 60; Michnowicz 2012; INEGI). Although the relatively small number of speakers in the present study precludes any definitive findings, some tentative evidence of this shift can be found in the speaker demographics.

Of the 12 Maya-speakers studied, 10 of them reported that their parents speak both Maya and Spanish, although they do not distinguish how much Spanish was spoken in their homes, and based on the grammatical L2-influenced errors in their Spanish (see footnote 9 and Michnowicz 2012 for examples), many of these speakers were raised in households where Maya was likely the dominant language. Additionally, two of the speakers classified their parents as monolingual

Maya-speakers. While the monolingual Spanish-speakers all reported that they were raised in monolingual households, many of them are also only a few generations removed from Maya-speaking ancestor, as it was common for these speakers to report a Maya-speaking grandparent or great grandparent. The older speakers, then, represent the first few generations of intense contact and koineization, with the Maya-bilinguals representing an earlier stage in the family histories of many of the Spanish-monolinguals. The younger generation, however, represents the latter stages of koineization, in which linguistic forms are increasingly focused and leveled (Trudgill 1998). In other words, based on theories of koineization, younger speakers, representing a later stage of dialect contact, should display reduced variation vis-à-vis older speakers, that represent an earlier, more chaotic stage of contact (Trudgill 1998, Kerswill 2002). This is what we find for /t/ in the present data, seen in Figure 17. The youngest speakers are much more focused in their VOT production, only showing half the range of the oldest speakers (11ms vs 22ms). Middle aged speakers produced a range of values between the two other age groups, although more in line with that of the younger speakers (14ms). [12]

Figure 17. Range of mean VOT values across age groups: /t/

[12] The same pattern holds for /p/ (Younger 10.29ms; Middle 15.08ms; Older 16.44ms), with more variation for /k/ (Younger (with one outlier removed 14.22ms -19.59ms with outlier included; Middle 10.59ms; Older 18.22ms).



Thus while language group per se did not significantly predict VOT realization in the present data, this is the expected result for late-stage koineization and language shift, as speaker differences are leveled in the newly formed variety. Interestingly, this idea, if correct, suggests that we may be observing the peak of variation with respect to VOT in YS, as monolingual Spanish-speakers in past generations prior to extensive Maya contact (i.e. the generations preceding the oldest generation studied here), likely would have produced VOT values similar to those of other, non-contact varieties of Spanish. VOT values, as part of the process of koineization outlined above, would have increased as intermediate generations began leveling the differences between /ptk/ in Spanish and Maya, while the youngest generation is now moving back to a more monolingual Spanish range of VOT production due to a variety of factors, including increased exposure to other forms of Spanish through education, media and personal contact (see Klee 2009; Michnowicz 2011, 2012 for a summary). Maya influence on YS /ptk/, then, is primarily the product of shifting speakers, a process which peaked in the past and is now

waning as younger speakers of both language backgrounds focus their linguistic output on more pan-Hispanic models. Further research with larger subject pools is needed to definitively confirm this possibility.

In sum, the results of this study have indicated that YS /ptk/ is constrained by a complex interplay of linguistic and social factors. As suggested in Michnowicz (2012), younger speakers are abandoning traditional, regional variants from YS in favor of more normative forms, and this pattern holds true for aspirated /ptk/. The role of Maya, posited here as the influence of an L2 interlanguage spoken by shifting Maya speakers as part of the process of dialect contact and koineization, is also an important factor, and deserves further research in areas outside of the urban capital where contact has been more recent, such as in rural areas or small *pueblos* throughout the YS dialect zone. As suggested above, this seems to be the ideal moment in the linguistic history of Yucatan to study questions of indigenous language influence and dialect standardization, and it is hoped that the future will bring increased scholarly attention on this important variety of Latin American Spanish.

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