L2 Spanish /l/: The Roles of F2 and Segmental Duration in Foreign Accent Perception

Megan Solon

1. Introduction

The phoneme /l/ has two variants in American English: a *light* variant [l] and a *dark*, or velarized, variant [ɫ]. The realization and distribution of these variants depends on the regional dialect, but it is generally said that, in U.S. English, [l] occurs in syllable-initial or prevocalic positions, whereas [ɫ] occurs in syllable- and word-final as well as preconsonantal contexts (Bronstein, 1960, p. 125; Olive, Greenwood, & Coleman, 1993, p. 204). Spanish, in contrast, has only a light variant, which is used in all contexts. The influence, or interference, of the English dark [ɫ] in the second language (L2) Spanish of native English speakers is often cited as a major contributor to the percept of a foreign accent (e.g., Schwegler, Kempff, & Ameal-Guerra, 2010; Whitley, 2002). The aim of the present study is to investigate two acoustic cues present in the lateral segment in L2 Spanish—namely, the second formant (F2) and segmental duration—that may contribute to the degree of perceived foreign accent.

2. Background

2.1. /l/ in English and Spanish

English /l/ is generally described as a voiced alveolar lateral approximant that has two variants in most American varieties: a *light* or *clear* variant and a *dark*, or velarized, variant (Bronstein, 1960; Olive et al., 1993). Light [l] is generally articulated with the tip of the tongue touching the alveolar ridge, whereas dark [ɫ] is produced via a primary articulation involving the tip of the tongue against the alveolar ridge and a secondary articulation of the dorsum of the tongue arching upward toward the velum accompanied by a predorsal lowering (Ladefoged, 2006; Recasens, 2004; Whitley, 2002). It is this secondary articulation of the tongue dorsum that results in the phenomenon referred to as velarization (Ladefoged, 2006), the main acoustic correlate of which is a lowering of the F2 (as well as a raising of the first formant [F1]; Recasens, 2004). Recasens (2012) purports that, crosslinguistically, light /l/s demonstrate relatively high mean F2 values (i.e., in the range of 1500-2000 Hz), whereas darker variants range from 800-1200 Hz.[2,3]

The /l/ in Spanish is characterized as a lateral approximant whose standard allophone is apico-alveolar. Unlike English's light and dark variants, in Spanish, the /l/ is pronounced as light in all

[*]Megan Solon, Indiana University, msolon@indiana.edu. I would like to thank Erik Willis for his encouragement on this project, Beate Henschel and Stephanie Dickinson from the Indiana Statistical Consulting Center for their assistance with the statistical analyses, and three anonymous reviewers for their helpful feedback and suggestions, which greatly improved this article. All remaining errors are my own.

[2] Proctor (2009) offers similar F2 mean values for light and dark variants of /l/, but lists 1200 Hz as the cutoff point between the two variants.

[3] Although English contains both light and dark variants, both variants tend to be characterized by lower F2 values relative to /l/s in languages that have light variants. According to Lehiste (1964), English coda /l/s tend to have F2 values in the range of 655-890 Hz, whereas those of onset /l/s tend to demonstrate F2 values in a higher but still relatively "dark" range of 825-1185 Hz.

 Selected Proceedings of the 6th Conference on Laboratory Approaches to Romance Phonology, ed. Erik W. Willis et al., 83-94. Somerville, MA: Cascadilla Proceedings Project.

environments (Hualde, 2005). Nonetheless, Spanish does contain several allophones of /l/ that arise in specific syllable-final contexts, typically as a result of assimilation of the place of articulation of /l/ to that of the following consonant. These include a dental allophone [l̪] as in falda [fál̪.da] "skirt," the standard alveolar allophone [l] as in salsa [sál.sa] "sauce," and a palatalized allophone [l̠] as in *colchón* [kol̠.tʃón] "mattress" (Hualde, 2005; Quilis, 1993). Some dialects of Spanish also contain an interdental allophone [l̪] as in *dulce* [dúl̪.θe] "sweet, candy" (Quilis, 1993).

The realization of /l/ is thought to be relatively constant and invariable across the dialects of Spanish, except for a few documented phenomena affecting /l/ in coda position including liquid neutralization (Alonso & Lida, 1945; Lipski, 1994); rhotacism of final laterals (D'Introno, Rojas, & Sosa, 1979; Quilis, 1993; Quilis-Sanz, 1998), vocalization (especially in the Cibao region of the Dominican Republic, Alba, 1988; Alonso & Lida, 1945; Zamora Munné & Guitart, 1982); elision (Alonso & Lida, 1945; Quilis, 1993); and even nasalization in Cuba and the Dominican Republic (Quilis, 1993; for an overview of phonological processes involving laterals, see Quilis, 1993).

2.2. The /l/ in L2 Spanish

The contribution of /l/ velarization to foreign accent in the L2 Spanish of native English speakers has been recognized in introductory Spanish phonetics and phonology text books (e.g., Schwegler et al., 2010; Whitley, 2002). Nevertheless, little empirical research has investigated the phonetic realization of /l/ in L2 Spanish or the impact of /l/ velarization on the degree of perceived foreign accent. Díaz Campos (2004) constitutes one of the only studies to empirically examine the development of the lateral segment in the L2 Spanish of native English speakers. In this study, the author tracked the development of four segments (one of them being /l/) in the Spanish of two groups of native English learners over a 10-week period. The two groups represented learners studying in distinct contexts of learning during the 10 weeks in question: One group was learning Spanish during a 10-week study abroad experience in Alicante, Spain, whereas the other group was studying Spanish in the classroom setting at their home institution in the United States. The participants' productions of various segments were recorded and analyzed at the beginning and end of the 10-week study period. With regard to word-final laterals, which were coded impressionistically as velarized or not, Díaz-Campos found that both the at-home and study abroad groups improved in their production of alveolar (i.e., nonvelarized) laterals over the 10 weeks. Surprisingly, the at-home group's accuracy rate[4] increased more (from 16% word-final [l] to 45%) than the study abroad group's accuracy rate (from 21% alveolar productions to 31%) in 10 weeks. Díaz-Campos hypothesized that this may have been due to the greater average number of years that the at-home group had studied Spanish as compared to the study abroad group. Nonetheless, relevant for the present study is the fact that these results demonstrate that, overall, learners are able to adjust their pronunciation of /l/ over time to sound more nativelike.

Incorporating phonetic analysis, Willis, Solon, and Geeslin (2012) provided preliminary acoustic production data for 10 intermediate-level English-speaking learners of Spanish and four native Spanish speakers. All participants were audio recorded during an oral word list reading task that elicited /l/s in a variety of contexts; these productions were then analyzed according to degree of velarization (as measured by the F2) and segmental duration. Results showed that the learners produced word-final laterals with an F2 range of 1093-1477 Hz, whereas the native speakers' word-final /l/ F2s ranged from 1574-1871 Hz. The authors also noted that the duration of the learners' word-final lateral productions varied greatly (i.e., from 37-154 ms) and, on average, were much longer in duration than the native speakers' word-final /l/s, which ranged from 72-107 ms. These results suggest that acquisition of nativelike production of Spanish /l/ may involve adjusting not just tongue position (i.e., as indexed by F2) but also segmental duration. The present study investigates whether both cues are also at play in the percept of a foreign accent through /l/.

[4] Accuracy was defined as producing an alveolar lateral.

2.3. Foreign Accent

Extensive research in L2 acquisition and speech perception has focused on the perception of the degree of nativeness, or *global foreign accent* (e.g., Magen, 1998; Major, 2007; Munro & Derwing, 1995; Riney & Flege, 1998). Foreign accent is influenced by and comprised of various factors including those pertaining to specific segments, prosody, speaking rate, and fluency (e.g., Magen, 1998; Major, 2007; Munro & Derwing, 1998). It is also correlated with several extralinguistic factors including age of exposure to L2 (e.g., Flege, Munro, & MacKay, 1995; Piske, MacKay, & Flege, 2001), length of residence in the target language community (e.g., Flege & Fletcher, 1992), and first language (e.g., Purcell & Suter, 1980). Although a strong foreign accent does not necessarily reduce the comprehensibility or intelligibility of L2 speech, it is correlated both with perceived comprehensibility as well as with intelligibility (Munro & Derwing, 1995) and is, thus, important in the L2 acquisition process. Following research on the contribution of specific segments and phonetic and phonological processes in foreign-accentedness, the present study explores the effect of /l/ production on foreign accent perception. Specifically, it examines the roles of /l/ velarization (as measured via F2) and /l/ segmental duration in the L2 Spanish of native English speakers on the degree of perceived foreign accent as rated by native Spanish listeners.

3. Research Questions

The present study is guided by two research questions:

1. What are the roles of (a) tongue position (i.e., F2) and (b) duration of the lateral segment on the degree of perceived foreign accent in L2 Spanish?
2. Do these cues interact to affect the degree of perceived foreign accent?

4. Method

4.1. Participants

The participants were 38 native speakers of Spanish from Mexico from various states, including Mexico (n = 29), Puebla (n = 4), Jalisco (n = 1), Chihuahua (n = 1), Oaxaca (n = 1), Hidalgo (n = 1), Guerrero (n = 1), and Querétaro (n =1).[5] The participants ranged in age from 19 to 60 years (M = 28). Twenty-two participants indicated that they had some knowledge of English, and nine indicated at least some knowledge of an additional language (e.g., Russian, French, Italian, German, Nahuatl, Purépecha). All participants were born in Mexico and all but one (who lived in the United States) were still living in Mexico at the time of participation in this study.[6] Participants were contacted via the assistance of collaborators in Mexico[7], and all participants completed the task electronically.

4.2. Task

Participants completely a foreign accent rating task using the online software Qualtrics (Version 37103). One-hundred and twenty tokens (60 target stimuli and 60 distractors; described in more detail

[5] Given that little regional or dialectal variation in the realization of Spanish /l/ has been attested in previous literature, aside from the phenomena described in the Background section (e.g., rhotacism, vocalization) affecting /l/ in coda position mostly in Caribbean varieties (e.g., Alba, 1988; Quilis, 1993; Zamora Munné & Guitart, 1982), speakers of Mexican Spanish were considered appropriate raters as their speech was not known to exhibit any special characteristics related to /l/.

[6] Participants were not asked about their familiarity or experience with English-accented Spanish or about their level of proficiency in languages other than Spanish; as such, this information and its possible effects on the results cannot be reported. This is a limitation of the current study.

[7] I would like to thank Elizabeth Juárez-Cummings, Cristóbal Garza, Edgar Madrid, Heriberto Sierra, Alysa Schroff, and Eduardo Velázquez for their assistance in locating native Mexican Spanish speakers in Mexico to participate in this study.

in the next subsection) were presented to participants one-by-one in pseudorandomized order with no same-voice tokens occurring consecutively. Participants were instructed to listen to each sound file (i.e., word) and to rate the pronunciation of the word on a 9-point scale, *1* being very native sounding and *9* being very foreign sounding (Major, 2007; Munro & Derwing, 1995; Riney & Flege, 1998; Schoonmaker-Gates, 2012). The participants were given two sample questions to familiarize them with the task and were instructed to listen to each sound file no more than twice. Figure 1 is a screen shot of the task as it appeared in Qualtrics.

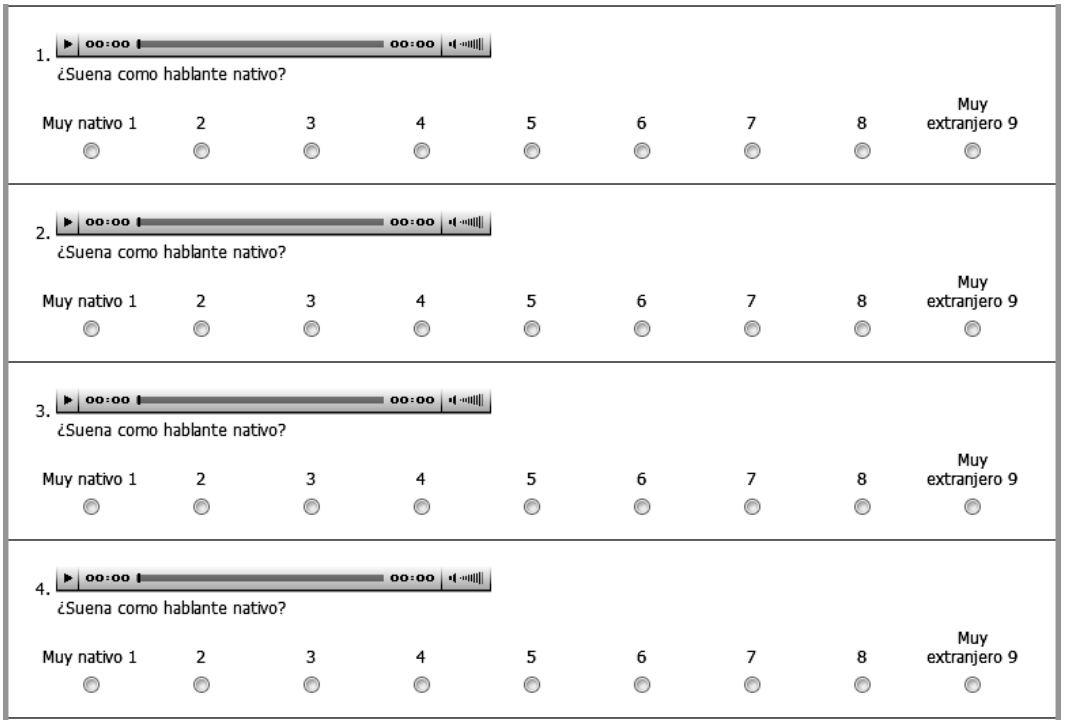

Figure 1. Screen shot of computerized foreign accent perception instrument

4.3. Stimuli

The stimuli used in the present perception of foreign accentedness study came from word list production data collected for a study on the production of /l/ in the L2 Spanish of native English speakers (Willis et al., 2012). The tokens were taken from a corpus of isolated words produced by 20 native English-speaking third-year university learners of Spanish and four native speakers of Spanish (two from Mexico, two from Spain); the native speakers' productions were used only as distractors to help ensure that the tokens heard by the listeners covered the range from native sounding to very accented. To diminish the impact of formant differences based on physical or physiological differences, such as variation in vocal tract size, the F2 of all coda /l/s was measured and normalized using a vowel centroid ratio (VCR) that was derived from Watt and Fabricius's (2002) vowel S-centroid normalization procedure. Unlike the S-centroid method, which normalizes vowels along both height (F1) and frontness-backness (F2) dimensions, the VCR utilizes measurements of the speakers' front vowel /i/ and back vowel /u/ to determine a centroid value along only the F2 dimension. A similar procedure has been adopted by Simonet (2010) and Davidson (2012); however, the VCR also incorporates a half-spread measure to account for differences in vocal tract spaces that could be lost by the one-dimensional centroid measure. F2 values that are VCR normalized are reported along a continuum from -1 to +1 with the speakers' centroid always at 0. A value closer to +1 indicates a

higher F2 and, thus, a more fronted tongue position; a value closer to -1 indicates a lower F2 and, thus, a darker production or a realization produced in a more backed position. The F2 values for coda /l/s for the four native Spanish speakers ranged from 1450-2000 Hz (-.11 to .12 VCR). With regard to segmental duration, native speakers' word-internal coda /l/s ranged from 60-85 ms, whereas word-final coda /l/s lasted between 75-105 ms. These two native speaker /l/ duration ranges were used as the native speaker baseline against which the learner data were chosen and manipulated for the perception stimuli.

From the corpus of isolated words, 20 tokens total produced by learners of Spanish (n = 13) that contained word-internal or word-final coda /l/s were selected based on the F2 values of the /l/s.[8] These included ten *high F2* tokens (i.e., with raw F2 values between 1495-1791 Hz; normalized F2 values between -.22 and .09 VCR) and 10 *low F2* tokens (i.e. with F2 values between 860-1159 Hz; normalized F2 values between -.63 and -.43 VCR). Within each group of 10 (i.e., the high F2 group and the low F2 group), five of the stimuli constituted word-internal codas and five were word-final codas. The duration of the lateral segment within each token was then manipulated to produce three versions of each token: a short version, a nativelike version, and a long version (see example in Figure 2), resulting in 60 target stimuli. The duration ranges (see Table 1) used for each version were selected using the segmental duration ranges observed in the native speakers' productions, as discussed in the previous paragraph, as the baseline. The ranges for long and short versions were extrapolated from these native ranges, keeping the size of the range the same as the nativelike range within each category (i.e., word-internal coda and word-final coda). The short and long ranges were equidistant from the nativelike range and their distance was selected to ensure that the duration range extremes were within the actual durations observed in the learner productions. The ranges used for short, nativelike, and long word-internal and word-final coda /l/s are presented in Table 1.

	Short	Nativelike	Long
Word-internal coda	20-45 ms	60-85 ms	100-125 ms
Word-final coda	25-55 ms	75-105 ms	125-155 ms

Table 1. Segmental duration ranges for /l/ manipulations

The stimuli were manipulated using the duration tool in Praat (Boersma & Weenik, 2009). Figure 2 is a spectrogram of the word *filtro* "filter," which was manipulated three times to produce a token with a lateral with a duration of 45 ms, one with a 83 ms lateral, and one with a lateral with a 105 ms duration. No other aspect of the original tokens was manipulated.[9] Twenty additional isolated words from six additional speakers, including native speakers, were used as distractors and were chosen, on an impressionistic basis, to represent a full range of native to very nonnative-sounding speech. These tokens were repeated three times in the task (20 tokens x 3 repetitions = 60 distractor items) to mirror the three iterations of target items, although the distractor items were not manipulated in any way.

[8] Because selection of stimuli tokens was conducted on the basis of the F2 value produced, it was not possible to ensure inclusion of tokens from each of the 20 learners who participated in the production study nor to balance the number of tokens included per participant. Instead, tokens for stimuli were selected solely on the basis of the F2 values of /l/ in the words produced; two tokens each were used from seven of the learners included in the study and the other six learners contributed one token each. Unfortunately, because of this, it was not possible to explore the effect of the individual speaker on the ratings (as, in many cases, a speaker only contributed one token, which had either a high or a low F2 value). This is a limitation of the current study.

[9] As one anonymous reviewer pointed out, it is possible that these manipulations resulted in changes to the nativelikeness of the intonational contours. Although this was not checked in the present study, given the relatively short durations of the lateral segments, the chances of such unintentional manipulations are low (as recognized by the reviewer as well).

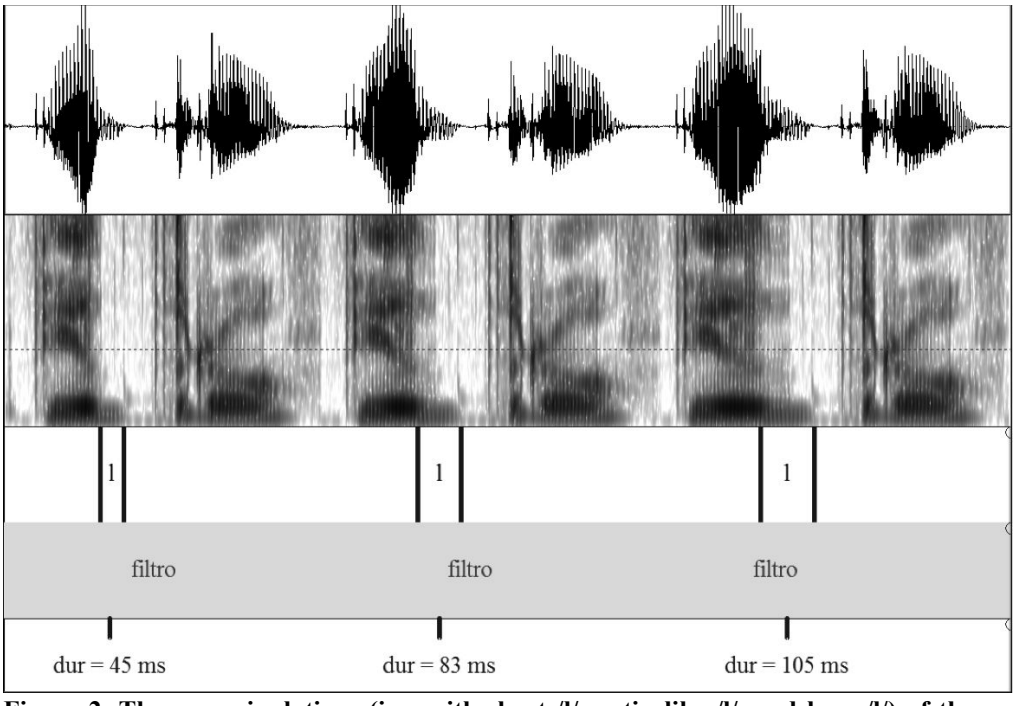

Figure 2. Three manipulations (i.e., with short /l/, nativelike /l/, and long /l/) of the word *filtro* "filtro"

4.4. Analysis

To examine the impact of tongue position and segmental duration of /l/ on the degree of perceived foreign accent, first, all ratings were transformed into *z* scores to standardize across raters' potentially different uses of the rating scale. Then, the effects of F2 and segmental duration on the foreign accent *z* scores were analyzed. Next, to control for the fact that the high and low F2 groups were comprised of distinct tokens, a difference measure was calculated by taking the rating for the token with nativelike duration as the baseline and calculating the difference between the foreign accent ratings of this token and that of that word's short and long counterparts. For example, if Listener A rated *filtro* with nativelike duration as a foreign-sounding *7*, the long version of *filtro* as very foreign-sounding *9*, and the short version as a *7*, then the difference measure for the long *filtro* was +2 (i.e., by subtracting the rating of the nativelike token [7] from the rating of the long token [9]) and the difference measure for the short version was 0 (i.e., by subtracting the nativelike rating [7] from the short rating [7]).[10] This difference measure normalized high-rated and low-rated tokens by just looking at the difference in ratings that resulted due to the duration manipulations. Then, for each participant, an average difference measure was calculated for eight categories of tokens crossing word position, duration, and F2 value (e.g., word-medial/high F2/long duration, word-final/high F2/long duration, word-medial/low F2/long duration, and so on). From these difference measures, we examined the interaction between segmental duration and tongue position as they impact foreign accent ratings (taking word position into account as well).

5. Results

5.1. Effect of F2 on foreign accent ratings

To gather observations about the effect of tongue position during /l/ production, as measured by F2 values, on the degree of perceived foreign accent, a repeated-measures ANOVA was conducted that

[10] It should be noted that, for ease of exposition, we exemplified the difference measure with raw foreign accent scores. Nevertheless, in the analysis, the difference measures were calculated using the *z* scores.

compared the mean ratings for all low F2 tokens with the mean ratings for all high F2 tokens in each of the two word positions (i.e., word-medial and word-final) by rater.[11] The results indicate a significant main effect for F2 value (i.e., high vs. low), such that tokens with coda /l/s with low (or velarized) F2 values were rated significantly more foreign sounding than coda /l/s with high (or nativelike) F2 values, $F(1, 37) = 7.93$, $p = .008$. Although there was no significant main effect of word position, $F(1, 37) = 3.61$, $p = .065$, there was a significant position × F2 interaction: In word-medial position, low F2 tokens were rated significantly more foreign accented than high F2 tokens, $F(1, 37) = 29.49$, $p < .001$, whereas, in word-final position, there were no significant differences between the ratings of high and low F2 tokens, $F(1, 37) = 1.64$, $p = .209$. These results are presented graphically in Figure 3.[12]

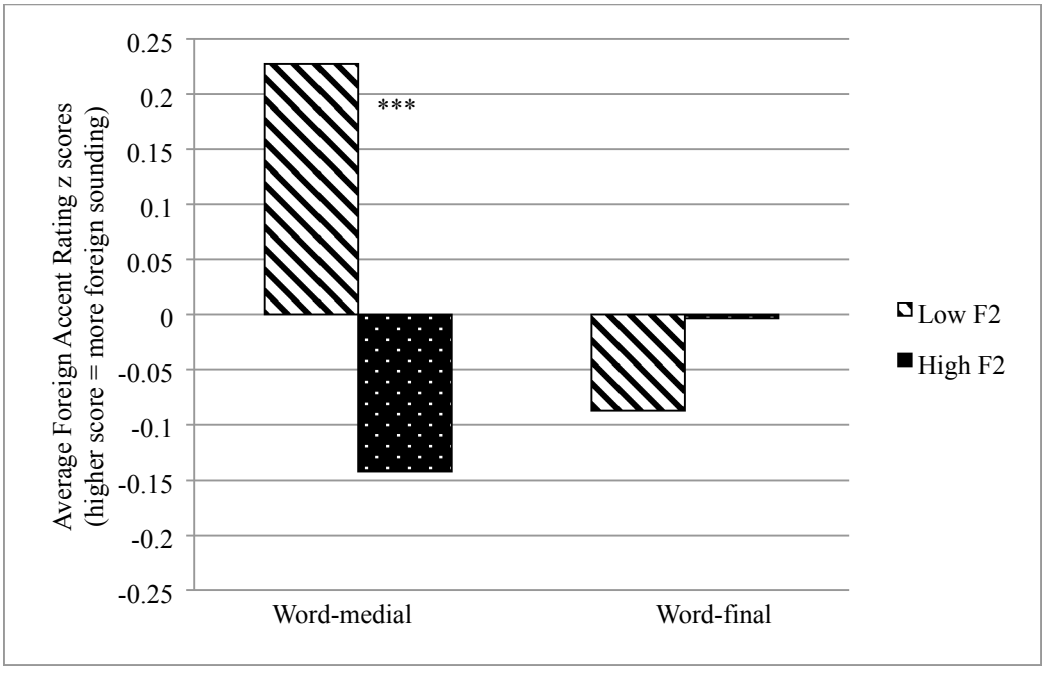

Figure 3. Effect of coda /l/ with high vs. low F2 value on average raw foreign accent ratings.

These results offer preliminary empirical evidence to support the claims that tongue position and, specifically, lateral velarization affect the degree of perceived foreign accent, although this effect may be mediated by position of /l/ in the word: Those tokens with velarized coda /l/s (i.e., with low F2 values) were perceived as presenting a higher degree of foreign accent than those tokens with nativelike /l/s (i.e., with high F2 values), but only in word-medial position. It is important to keep in mind, however, that, in this experiment, the formant values were not manipulated and, thus, each of the

[11] An anonymous reviewer suggested also taking speaker and rater into account in the statistical model. Unfortunately, as previously described, because of the design of the study, speaker effects cannot be tested. However, the choice of a repeated-measures ANOVA that compares means by rater was motivated by this suggestion and takes rater differences into account in the model.

[12] It was suggested by an anonymous reviewer that, given the large range of F2 values, a correlation analysis between the F2 value and the perceived foreign accent score could be interesting. Although I agree, because only 20 tokens with different F2 values were included in the present study and were selected precisely based on the F2 value falling within a certain range, such a correlation would be missing many of the values/tokens excluded and not rated. As such, I have my doubts about the fruitfulness of this analysis for the current study and have elected not to include discussion of such a correlation analysis here. Nevertheless, I do believe this is an important suggestion for future analyses.

high and low F2 tokens was different (i.e., there were no tokens that were identical except for the value of the F2 of /l/). Thus, it is possible, if not likely, that other factors (e.g., [non]nativelike VOT values or vowel realizations) may be confounding these results.[13]

5.2. Effect of lateral duration on foreign accent ratings

The effect of the duration of the lateral segments on the degree of perceived foreign accent was tested next; as with the examination of F2, word position was also included as a potential influencing factor. A repeated-measures ANOVA with word position and segment duration as within-subjects factors was conducted to compare the foreign accent rating *z* score averages for tokens in the short, nativelike, and long conditions in both word-medial and word-final positions, regardless of F2 values. Results indicated a significant main effect of duration, $F(1, 37) = 12.10$, $p < .001$. A pairwise comparison showed that tokens with long /l/ segment durations were rated as significantly more foreign sounding than tokens with /l/s with nativelike segment durations, $p < .001$. Tokens containing /l/s with short durations were not rated significantly different from tokens with either nativelike ($p = .085$) or long ($p = .130$) /l/ durations. These results held across both word-medial and word-final positions; no main effect of word position was found, $F(1, 37) = 3.66$, $p = .063$, nor was there a word position × duration interaction, $F(1, 37) = 0.62$, $p = .546$. These results are presented in Figure 4.

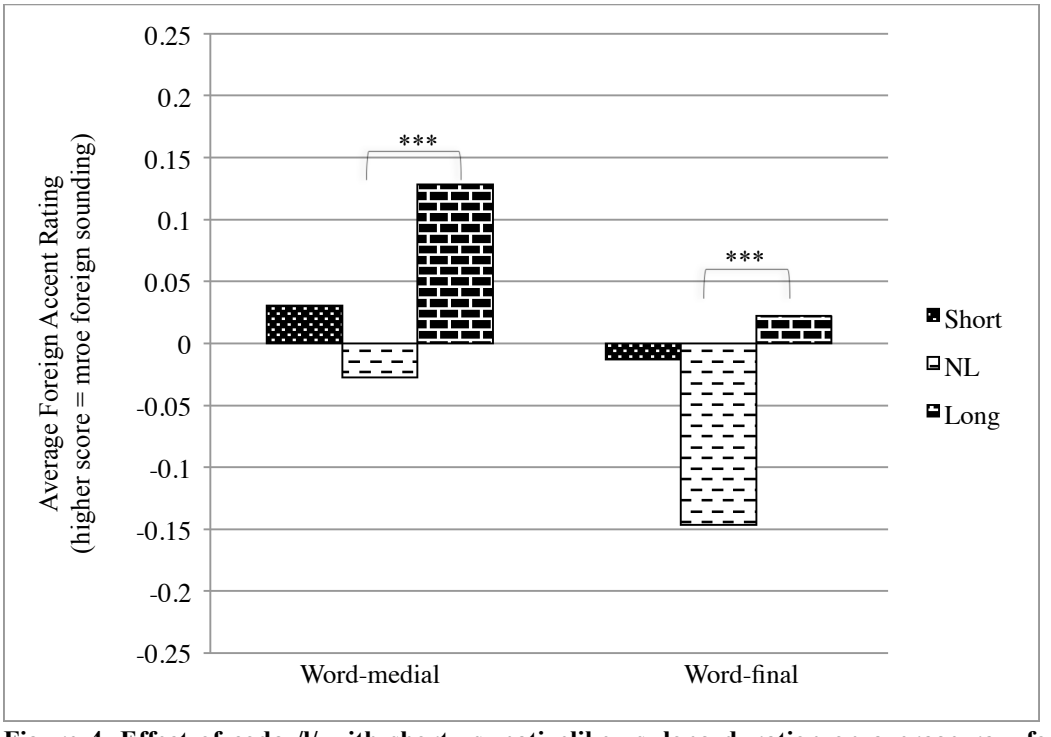

Figure 4. Effect of coda /l/ with short vs. nativelike vs. long duration on average raw foreign accent ratings.

[13] An anonymous reviewer suggested analyzing the foreign accent ratings of the distractor tokens to help determine if the ratings of /l/ were based truly on the /l/ manipulations and not on other factors. Although I believe this is a fruitful suggestion for future analysis, the distractors employed in the current design were not selected on the basis of particular features and, thus, would not offer much additional information regarding whether /l/ (and not other factors) was driving the patterns of ratings. However, this suggestion is an important future design consideration.

5.3. Effect of duration x F2 on foreign accent difference measures

Finally, the potential interaction between tongue position (i.e., F2 value) and segmental duration of the lateral on the degree of perceived foreign accent was assessed. To do so, a difference measure was calculated (as explained in the Analysis section) to represent the difference in foreign accent rating *z* scores between a token's nativelike durational version and its long and short counterparts. Then, a repeated-measures ANOVA with segment duration, F2, and word position as within-subjects factors was conducted to examine the variance of this difference measure between both word-medial and word-final tokens with (a) low F2 values and short durations, (b) low F2 values and long durations, (c) high F2 values and short durations, and (d) high F2 values and long durations. This test revealed a significant word position × duration × F2 interaction, such that, in word-medial position, tokens with low F2 values (i.e., velarized /l/s) were not rated statistically different from one another regardless of whether their lateral segments were long or short, whereas tokens with a high F2 value and a long duration were rated as significantly different than their high F2 counterparts with short durations ($p <$ .001). In word-final position, in contrast, tokens with high F2 values (i.e., nativelike /l/s) were not rated statistically different from one another regardless of lateral segment duration, whereas tokens with a low F2 value and a long duration were rated as significantly different than their low F2 counterparts with short durations (p = .048). In both comparisons, tokens with long /l/ durations were rated significantly more foreign sounding than their equivalent short duration tokens. These results are represented in Figure 5. Additionally, a one-sample *t* test conducted to test the difference between these ratings and those of tokens with nativelike /l/ durations also indicated that three out of four of the combinations including long segment durations were rated significantly differently (i.e., more foreign sounding) that their counterpart tokens with nativelike /l/ durations (i.e., word-final/high F2, p = .045; word-final/low F2, p = .006; word-medial/high F2, $p <$ .001). Word-final/high F2 tokens with short durations were also rated as significantly more foreign sounding than their nativelike counterparts (p = .018).

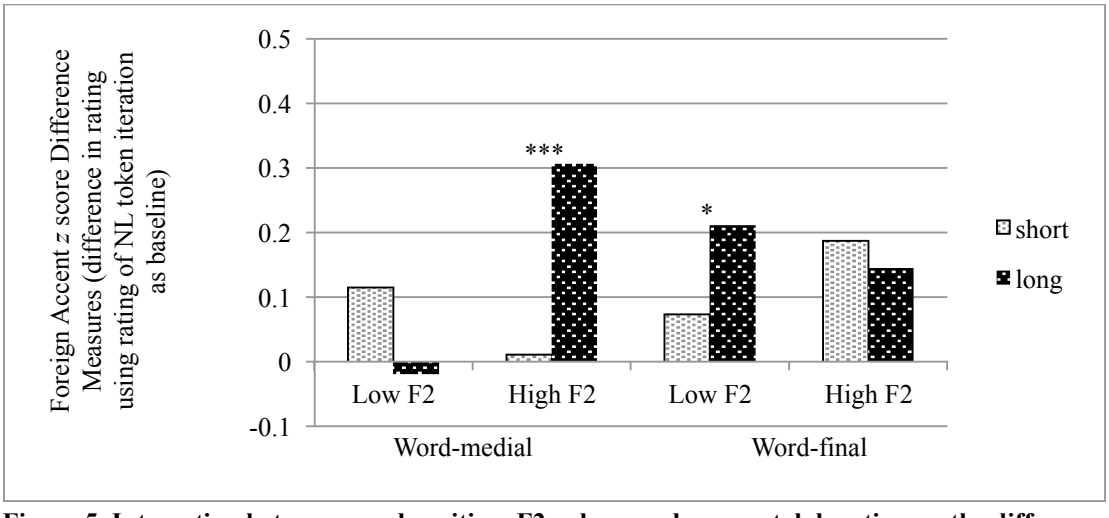

Figure 5. Interaction between word position, F2 values, and segmental duration on the difference in foreign accent ratings.

These results suggest that duration not only significantly affects overall foreign accent ratings on its own, but it also interact with other factors such that, in word-medial positions, it can contribute to the perception of a greater degree of foreign accent on tokens with nativelike F2 values. Additionally, in word-final positions, it can enhance the perception of accentedness of tokens that already exhibit velarized or low F2 values.

6. Discussion

The present study offers preliminary empirical evidence to substantiate the claim that lateral velarization can and does contribute to the degree of perceived foreign accent. As shown in Figure 3, those tokens that contained a velarized coda /l/ were rated as significantly more foreign sounding than tokens that contained coda /l/s with nativelike F2 values, but only in word-medial position. Nonetheless, as previously discussed, lateral velarization was likely not the only cue to foreign accent present in the tokens and, because distinct tokens were used to make up the high and low F2 groups, the role of confounding factors cannot be empirically separated or removed from the data. Thus, these results concerning the role of F2 in foreign accent perception should be interpreted with caution.

Lateral segmental duration also appeared to play a significant role in overall foreign accent perception. When examining the effect of lateral segmental duration on tokens manipulated to have short, nativelike, and long iterations, the foreign accent ratings for tokens with /l/s with long durations were rated as significantly more foreign sounding that tokens with /l/s with nativelike durations, as shown in Figure 4. This result held across word position.

When these two cues (i.e., tongue position as measured by F2 and segmental duration) were examined in tandem (along with word position), all three factors interacted to influence foreign accent perception. In word-medial positions, tokens with velarized /l/ were perceived equally as foreign sounding regardless of the duration of the lateral segment, whereas tokens with /l/s with high (i.e., nativelike) F2 values that also had long durations were perceived as significantly more foreign sounding than their counterpart high F2 tokens with nativelike and short lateral segmental durations. In contrast, in word-final positions, it was tokens with low or velarized F2 values that also showed an effect for duration such that tokens with long /l/s were rated as more accented than tokens with shorter /l/s. These results suggest that both cues (i.e., F2 values and segment duration) influence /l/'s in the perception of a foreign accent, although the effects of these cues appear to interact differently in word-medial as compared to word-final positions.

Considering that previous research on lateral velarization in the L2 Spanish of native English speakers (i.e., Díaz-Campos, 2004) has primarily been analyzed impressionistically, the present findings suggest the possibility that both tongue position and lateral segmental duration could have influenced the raters' judgments of lateral velarization. From an acquisition standpoint, thus, in future studies of L2 Spanish lateral production and development, it could be important and interesting to track whether or not learners attune both tongue position and segmental duration to more targetlike values, and, if so, at what rates, or in what order, these cues are adjusted relative to one another. Additionally, from an instructional or training perspective, the fact that, even within one particular segment, multiple cues can contribute to degree of perceived foreign accent suggests that teachers and pronunciation instructors may find it useful to focus both on temporal as well as articulatory aspects of speech production during pronunciation training.

Overall, the present study has demonstrated that, in fact, lateral velarization does contribute to the degree of perceived foreign accent. Nevertheless, it has also shown that global foreign accent ratings can be influenced by several factors even within one segment—in the case of the present study, tongue position and segmental duration of /l/. Several avenues for expansion of the current study present themselves. First, as previously mentioned, the lack of control of confounding factors detracts from the strength of the findings that support claims that velarized laterals contribute to the perception of a greater degree of foreign accent. Therefore, future expansions of the present study could manipulate formant values of identical tokens so as to control for extraneous features of the oral tokens. With regard to the duration manipulations, because the durations of the lateral segments were manipulated to ensure that each original token had three iterations—a short, a nativelike, and a long version—some tokens were manipulated twice, although most were manipulated three times. Additionally, because the Praat (Boersma & Weenik, 2009) duration tool was used to manipulate the duration of each token to fall within each of the three duration ranges, and the original duration of each token varied widely, the degree of manipulation was not necessarily uniform across tokens. With greater token counts, future studies could easily test for the potential impact of manipulation as compared to no manipulation as well as the impact of the difference in degree of manipulation on the perception of a foreign accent to

rule these out as contributing or confounding factors. Finally, given the implications of the present study for L2 learners of Spanish and their communication with native speakers, a logical follow-up to the current study could include learner listeners in addition to the native Spanish listeners to gauge whether, to what degree, and at what point in their language acquisition process learners use these cues to rate foreign accent in a nativelike way.

Despite these limitations, however, the present study offers important preliminary data regarding the impact of lateral velarization and segmental duration on the perception of a foreign accent in L2 Spanish.

7. Conclusion

The present study has offered empirical evidence in support of the influence of lateral velarization, as measured by F2 values, and lateral segmental duration on the degree of perceived foreign accent as well as the interaction between these two cues across word-medial and word-final positions. As predicted by the literature, tokens that included laterals with lower F2 values (i.e., laterals that were darker) were rated as statistically more foreign sounding than laterals with higher F2 values (i.e., light or nativelike laterals) in word-medial position. Additionally, the duration of the lateral segment significantly influenced foreign accent ratings, such that tokens with longer lateral segments were rated as more accented than tokens with nativelike or short segmental durations. Finally, when the interaction between F2 values and segmental duration was analyzed, results indicated that, depending on the lateral segment's position in the word, segmental duration and F2 values interact albeit in different ways. Thus, both F2 and lateral segment duration play a role in foreign accent perception and both cues may need to be adjusted for more targetlike productions of the lateral segment in L2 Spanish.

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