

Final Lengthening and Pause Duration in Three Dialects of Spanish

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1. Introduction

Since the 1980s, the study of prosody and intonation has shown significant growth from both empirical and theoretical perspectives, in large part due to Prosodic Phonology (Nespor & Vogel 1986, Selkirk 1984, 1986) and the Autosegmental Metrical (AM) model (Pierrehumbert 1980, Pierrehumbert & Beckman 1988). For Spanish, studies over the past three decades have discussed topics such as prosody-syntax mapping, representations of pitch accents in declaratives and interrogatives, prosodic manifestations of broad and narrow focus, acoustic correlates of stress, and phonetic cues to phrase boundaries, just to name a few. This particular study investigates one item from this list, the phonetic correlates utilized to divide discourse into prosodic phrases.

Prosody is used to parse information into chunks that demonstrate definite size and internal structure (D'Imperio et al. 2005, Selkirk 1984, Zubizarreta 1998). Based on AM theory, speech is organized in accordance with abstract, hierarchically leveled constituents. This arrangement is displayed in (1).¹ In this hierarchy, each lower-level constituent is contained within higher-level constituents. Furthermore, concrete phonetic cues found in pitch contours correlate with the abstract constituents of this phonological hierarchy. While early studies in SPE Phonology (Chomsky & Halle 1968) assume strong overlap between prosodic and syntactic constituents, work in the past two decades posits that the elements in (1) are separate from (but related to) syntactic structure.

(1) Phonological constituents (from Gussenhoven 2002, p. 271).

U	Utterance
IP	Intonational Phrase
PPH	Phonological Phrase
PW	Phonological Word (i.e. Prosodic Word)
F	Foot
σ	Syllable

Of the various levels in (1), the IP, PPH and PW are the most pertinent to this paper. In general, IPs have easily perceived pauses before and after the left and right edges, respectively. They also have boundary tones, are non-isomorphic in relation to syntactic structure, and are units that carry meaning (van Heusinger 2007). In Spanish, the conclusion of an IP is mainly signaled by a final high (H) or low (L) boundary tone (%), a clear pause, extreme final lowering of pitch, and lengthening of syllables, vowels and words (D'Imperio et al. 2005, Prieto 2006, Rao 2007, Sosa 1999, among others). Based on these cues, an IP can be categorized as a terminal break that signals the conclusion of a thought.

A PPH provides a second, lower tier of phrasing. It is similar to the intermediate phrase that is commonly cited in work using AM theory (for example, in Nibert 2000). A major difference between PPHs and IPs is that the disjuncture at PPH boundaries is less clearly defined. The boundaries of PPHs can be located in Spanish through cues such as fundamental frequency (F0) continuation rises, lengthening of syllables, vowels and words, large degrees of pitch increase or decrease, and short pauses (D'Imperio et al. 2005, Elordieta et al. 2003, Prieto 2006, among others). These cues indicate

¹ For a similar hierarchy discussed within the framework of Prosodic Phonology see Nespor & Vogel (1986) or Selkirk (1984, 1986). The AM representation of constituents is selected here because this study deals with intonation from a phonological rather than a syntactic perspective.

that a PPH is viewed as a non-terminal break, indicating that an idea will continued to be discussed. Although those such as Beckman et al. (2002) and Sosa (1999) claim that a second level of phrasing is unnecessary in Spanish, Hualde (2002) and Nibert (2000) disagree. In particular, Nibert (2000) finds that two levels of phrasing help disambiguate meaning in certain utterances. The present study follows Hualde and Nibert, assuming a major and minor level of phrasing. Other noteworthy findings related to IP and PPH boundaries come from European Portuguese. Specifically, concerning simultaneous boundary markers, the findings of Freitas (1990) and Frota (2000) allow us to deduce that longer pauses at IP boundaries correlate with increased final lengthening, while shorter pauses at PPH boundaries are tied to a lesser degree of lengthening.

A PW is a phonologically relevant idea that plays a metrical role in describing main word stress (Selkirk 1984). It is widely assumed in Spanish that a lexical item is a PW if it is prosodically accented, meaning it contains F0 movement through the stressed syllable. The connection between pitch excursions and lexical stress in Spanish has been noted as far back as Navarro Tomás (1944), and more recently by Quilis (1993) and Face (2003). Though F0 is one possible cue to stress, Willis (2002) notes that increases in duration and intensity can also play a role.

With regard to the two types of phrases shown in (1), one of the main cues documented as correlating with both IP and PPH boundaries is increased duration, or final lengthening of various constituents, such as syllables and words. In terms of such temporal correlates to phrase boundaries, Frota (2000) states that they can be manifested as lengthening of final segments due to an adjacent boundary, pauses, and lengthening of segments due to nearby pause. These temporal markers are at times accompanied by melodic cues associated with F0 movement.

Overall, while lengthening has been detailed in studies on phrasing in many languages, it is mainly addressed from an intuitive standpoint, meaning few empirical, statistically driven studies show exactly how much lengthening of constituents is taking place at phrase boundaries. Moreover, it is also possible that, within languages, dialectal variation and co-occurring cues can lead to changes in degrees of lengthening at different constituent boundaries. Therefore, the aim of the present paper, which addresses syllabic and word duration in domain final position of IPs and PPHs, is to fill in research gaps by: i. empirically examining whether or not final lengthening does exist in Spanish in stressed and final syllables and words in phrase final position; ii. statistically showing how much lengthening occurs; iii. figuring out whether pause length correlates with increased lengthening.

The research objectives of the current study are achieved through an analysis of data produced via read, lab speech. Lengthening of syllables and words based on position in the PPH and IP is calculated for speakers from Cuba, Ecuador, and Spain. The major findings reveal that final lengthening is observed in all constituents at a significant level across dialects at the ends of PPHs and IPs. Across speakers and dialects, lengthening is greatest when a short pause associated with a PPH boundary is present. Though this is the case, any type of pause increases lengthening over cases with no pause.

The remainder of this paper is organized as follows: Section 2 justifies the main research questions through a review of previous relevant literature, Section 3 describes the main corpus of data, phonetic analysis procedures, and statistical tests, Section 4 provides a series of tables interpreting the statistical results and discusses the implications of the results, and Section 5 concludes by summarizing the contributions of the present study and suggesting future research paths.

2. Previous studies on final lengthening

The majority of previous literature on prosodic phrasing in Spanish examines phonetic cues that can be used to parse phrases, the distribution of PWs across PPHs and IPs in utterances with increased syntactic complexity, and the changes in meaning produced by different phrasing patterns (Beckman et al. 2002, D'Imperio et al. 2005, Elordieta et al. 2003, Nibert 2000, Prieto 2006, Rao 2007, among others). Among these main areas of research, the current study is concerned with phonetic cues to phrase breaks, and more specifically, final lengthening of syllables and words. Therefore, the remainder of this literature review will be dedicated to prominence-related issues that will help inspire the formal research questions set forth at the end of this section.

Segmental duration relies on many conditions. Literature on other languages such as English, French, and Italian has shown that phonetic context, stress pattern, and sentential position are key

factors influencing segmental duration in general (Farnetani & Recasens 1993, Laeufer 1992, van Santen 1992, among others).² Beckman & Edwards (1990) differentiate two types of final lengthening. One type, which the present study addresses, is lengthening associated with clearly defined edges of prosodic constituents. Therefore, in Beckman & Edwards's terms, this first type of final lengthening solely influences words or segments directly prior to a prosodic boundary. This phenomenon distinguishes itself from increased duration caused by stress, which cues a phonological head. Furthermore, according to Hayes (1997), final lengthening of segments, which can also be called 'pre-boundary lengthening,' is a common manner in which PPHs are divided in many languages. In fact, Vaissière (1983) goes so far as to say that final lengthening of segments is a universal phenomenon. However, Hockey & Fagyal (1998) point out that it is difficult to jump to such a conclusion since languages with phonemic length contrasts, such as Estonian and Finnish, may not use final lengthening in the same sense as what is being referred to in the present discussion. Additionally, Hockey & Fagyal (1998) connect lengthening with the function of separating speech into particular meaning-bearing units. Moreover, though lengthening may be quite common in languages, Hirst & Di Cristo (1998) point out that related languages and even dialects within languages exhibit different durations of final segments (see Delattre 1968 and Hoequist 1983 as well). Dutch and French are two languages for which dialectal differences in lengthening have been noted. Expanding upon this idea of variation, Beckman (1992) asserts that while such lengthening of higher prosodic constituents might be universal, related effects show variation. An example supported by those such as Beckman & Edwards (1994) and Ortega-Llebaria & Prieto (2007) is that while increased duration of segments is crucial to the stressed versus unstressed prominence contrast, it plays a much more secondary role in the F0-related accented versus unaccented contrast. When looking at lengthening of specific syllables, Kim (1974) suggests that final syllable lengthening can be done in an effort to overcome low levels of intensity in said syllable. He states that intensity and F0, along with subglottal air pressure, tend to decrease toward the end of sentences. In order to saliently make up for this loss, lengthening occurs in final syllables. Another contribution to lengthening is made by Cooper (1976), who claims that phrase final lengthening is communicatively important because it gives the speaker a bit more time to prepare the next phrase to be uttered. Along the lines of needing more time, Klatt (1975) believes that increasing final duration of segments enables a more effective manifestation of F0 movement signaling terminal or non-terminal breaks.

Studies in the past few decades based on the prosodic hierarchy in (1) suggest a lack of consistency across languages in the number of constituents whose boundaries are cued by final lengthening. One case of this is that we see evidence of lengthening four levels superior to the PW in English, but only three such higher levels in French (Ladd & Campbell 1991). In terms of lengthening based on position of the syllable in the word, phrase or sentence, those such as Hoequist (1983) and Lee & Seong (1996) show that later syllables at any of these prosodic levels tend to show lengthening ratios over one when compared to earlier syllables. These results come from languages such as English, Spanish, Japanese, and Korean. Furthermore, within each prosodic domain, rules have been proposed that account for increased prominence in specific phrase positions. First, Chomsky & Halle's (1968) Nuclear Stress Rule states that the last word of a domain should be given prominence. In Romance, this rule is followed closely in constituents in broad focus (see, for example, Prieto 2005). Actually, final lengthening to show prominence is perceived to be so common in Spanish that it is associated with a stereotyped or stylized pattern (Hirst & Di Cristo 1998). Even repeated information in IP-final position usually has stress in Spanish and Italian, often conveyed through final lengthening (Gussenhoven 2004, Hualde 2007, Ladd 1996). In Spanish, final lengthening is often used in such cases to account for the absence of pitch movement (i.e. final lowering) that is often found in IP-final position. Lengthening effects in Spanish have also more recently been tied to signaling prominence in contexts lacking pitch accents (Ortega-Llebaria & Prieto 2007).

Research on European Portuguese addressing the relationship between pauses and lengthening at IP and PPH boundaries serves as a central source of inspiration for the current study. In examples of simultaneous cues to boundaries, Frota (2000) asserts that both F0-related melodic and temporal marking together signal prosodically higher ranked boundaries while lengthening alone is indicative of

² Those such as Del Barrio & Torner (1999), Martínez Celdrán (1989), and Mendoza et al. (2003) have shown that Spanish segments have intrinsic differences. Methodological challenges involved with including segmental composition of syllables as a variable in the current study are addressed in Section 3.

lower boundaries. Pauses generally seem to correspond with higher-level boundaries and both durational and F0-related boundary cues (Vaissière 1983). Furthermore, after reviewing work from various languages, Frota (2000) summarizes the main domains of preboundary lengthening as the final syllable, the final stressed syllable and the final word of a phrase. When looking in particular at the relationship between pauses and durational effects, Freitas (1990) and Frota's (2000) results for European Portuguese suggest that the length of pauses seems to exhibit a positive correlation with level of prosodic boundary, while IPs show more significant preboundary lengthening than PPHs, which do not consistently display a clear set of boundary cues. Frota's results demonstrate that lengthening is emphatically more associated with IPs than PPHs (or PWs). She specifically concludes that at the end of IPs, final lengthening alone differs from prepausal lengthening because the latter condition elicits a further durational increase of stressed syllables. She is also able to distinguish the appearance of different phonetic cues to boundaries based on IP length; weaker boundary signals are present at short IP junctures, while a stronger set of cues is manifested at non-short IP boundaries (often next to a pause). Based on these studies on European Portuguese, one can hypothesize that longer pauses correlate with increased lengthening at IP boundaries, while shorter pauses and less lengthening occur at the PPH boundary. In sum, stronger aggregates of phrase boundary markers indicate higher-level prosodic constituents.

This introduction to final lengthening and its related concepts motivates the following research questions for the present study on Spanish: i. Is there empirical evidence for final lengthening in the current data? That is, do syllables and words in final position of the IP and PPH increase in duration when compared to syllables and words that are not phrase final?; ii. Do other cues like pauses influence lengthening and does this reflect the previous results for European Portuguese? If there are differences, what are the implications?; iii. Do dialect and gender affect degree of final lengthening?

3. Methods³

The lab speech data analyzed comes from Dalbor's fieldwork corpus, which contains readings of a passage entitled *En el campo* ('In the countryside').⁴ The passage is about an adult reflecting back upon his/her childhood, during which he/she spent months at a time in the countryside with family members. The portion utilized here has 421 total stressed words that comprise 30 declarative utterances with varying syntactic complexity. While the entire body of data from this particular passage encompasses a vast range of speakers from several dialects, the current study selected two speakers (one male and one female) from three different regions of the Spanish speaking world- Cuba, Ecuador, and Spain- for a total of six speakers. The two speakers that share a country of origin are from geographically similar areas. These six particular speakers were selected because they produced the passage at what is characterized as a 'normal' speech rate, which is defined as approximately 5-7 syllables per second following the methodology of Marín Gálvez (1994). Through this type of normalization, and the fact that all speakers read the same passage, we can propose a more valid statistical comparison of lengthening across speakers and dialects.

The 30 declaratives for each speaker were chunked into IPs and PPHs using previously documented phonetic cues to phrase boundaries as well as syntactic information.⁵ For PPHs, the cues are F0 continuation rises, perceived lengthening, drastic pitch reset, and short pauses. Boundary tones

³ An attempt was made to include the effects of segmental structure of syllables on lengthening. The most experimentally controlled conditions would limit the types of consonants and vowels that are used, for example only sonorants and vowels, or set up a script in which the order of segments, for example, sonorant-vowel, is fixed. With no such organization in this data, the numerous combinations of different segments found within syllables made the classification of syllable structure quite complicated. While an eight category scheme was developed and statistically found to have significant effects on lengthening, the lack of control points to less than reliable results. This type of confounding variable should be reduced in future work.

⁴ The fieldwork corpus was provided by Travis Bradley, who received the data from John Dalbor at the Pennsylvania State University. The data was digitized by Eric Baković at the University of California, San Diego.

⁵ According to Truckenbrodt (1999), the PPH and IP differ in that the former refers specifically to syntactic phrases (XPs) with heads that dominate other constituents, such as Noun Phrases, Verb Phrases, and Adjective Phrases, while the latter deals with larger syntactic clauses. Also, due to the nature of read speech style, there were not cases of devoicing, even though this is very common in domain final position. Aspiration was not an issue either in this data set.

(usually L%), lengthening, and longer breaks in discourse are indicative of IP boundaries. Once the IP and PPH boundaries were located, lengths of final syllables, stressed syllables, and words in phrase final position were calculated for each normally stressed word in the passage. Quilis (1993) was an invaluable resource for this process since he provides lists of *palabras acentuadas e inacentuadas* ('stressed and unstressed words') in Spanish.⁶ Once filtered out, the unstressed words were no longer relevant to the data analysis, and thus, henceforth, we will simply use 'words' or 'PWs' to mean 'those that are normally stressed.' Words were categorized as 'yes' or 'no' with respect to being located in phrase final position. For pauses corresponding with a phrase boundary, three categories were created. Using a perceptual test with native speakers of each dialect facilitated the formation of pause categories. While listening to the production of the passage, these speakers indicated locations where they felt pauses were 'long,' 'short,' or 'absent.' Based on these perceptual results, it was determined that a 'long pause' would correspond with a disjuncture of over 400 milliseconds (ms), a 'short pause' would point to a break of less than 400 ms, and 'no pause' would label a lack of any perceived stoppage of discourse. Lastly, once the data set had been ordered and appropriately coded, it was subjected to a mixed model statistical comparison. This type of test is employed when the goal is to find correlations between multiple observations per subject. The results in the following section are based on the output of this model, which tells us, for example, whether the length difference between phrase final constituents before short pauses and long pauses is significant. If lengthening is present, we will also discover whether there is dialectal/intersubject variation. The findings will provide support for previous studies and shed new light on previously unaddressed issues.

4. Results and discussion

This section displays a series of figures and tables that contain findings that answer the research questions outlined earlier.⁷ Tables are created only for those results that are found to be statistically significant. First, lengthening in phrase final position is detailed in general, followed by a look at the effects of pause length on lengthening at PPH and IP boundaries. The final portion of this section provides remarks on the influence of dialect and gender on duration. In total, the corpus of data for all six speakers contains 1,354 PWs, 633 of which are labeled as being located in phrase final position. There are 423 PPHs in the data, divided into 210 IPs. Therefore, out of the 633 phrase final words, 423 occur at the ends of PPHs and 210 are located at the termination of an IP. The PPH and IP numbers show that on average, each IP houses two PPHs.

In order to physically supplement the information in the upcoming tables, Figures 1 and 2 show the durational difference of the stressed syllable, /sa/, produced by a female Ecuadorian speaker, when occurring in PPH final, and non-final contexts. The middle portion of each figure displays intensity and the lower portion illustrates F0 movement. In Figure 1, /sa/ is part of the word *pasaba* ('I used to spend'), which is in initial position of the PPH (*pasaba once meses*) ('I used to spend eleven months'). The syllable measures 153.2 ms. In this position, /sa/ ends with an increase in F0 to a plateau around 280 Hertz (Hz), which is indicative of the idea continuing. On the other hand, in Figure 2, the same syllable is in the word *manzanas* ('apples'), which occurs in final position of the PPH (*una de estas manzanas*) ('one of these apples'). The syllable in this case measures 184.7 ms, which evidences final lengthening. The portion of the PPH in Figure 2 is also IP final, which explains the final lowering of F0, as well as the decreased intensity, when compared to that of Figure 1. In fact, the syllable in Figure 1 is more than twice as intense as that in Figure 2. Based on the comparison of duration, F0, and intensity of these two figures, we can hypothesize that phrase final position results in increases of duration, but decreases in intensity and F0. The changes in F0 and intensity noted here will be crucial to exploring possible explanations of the durational data in the next section. As the subsequent tables

⁶ The debate as to which phonetic correlate of stress is the most reliable in Spanish (i.e. duration, F0 movement, intensity) is beyond the scope of this paper. However, it is worth mentioning that using a list of normally stressed words such as that in Quilis (1993) becomes slightly less reliable when investigating spontaneous speech, since factors such as increased emotion may cause a generally unstressed word to phonetically manifest a cue to stress. See Face (2003), Hualde (2007) and Rao (2009) for further discussion of stress in Spanish.

⁷ Although the segmental makeup of each syllable is not considered as a variable here, the types of syllables and words had enough segmental similarities to be subjected to a valid statistical comparison. This was confirmed before any statistical tests were conducted.

will uncover, the type of final lengthening observed in the comparison of Figures 1 and 2 is typical of speakers in this data set.

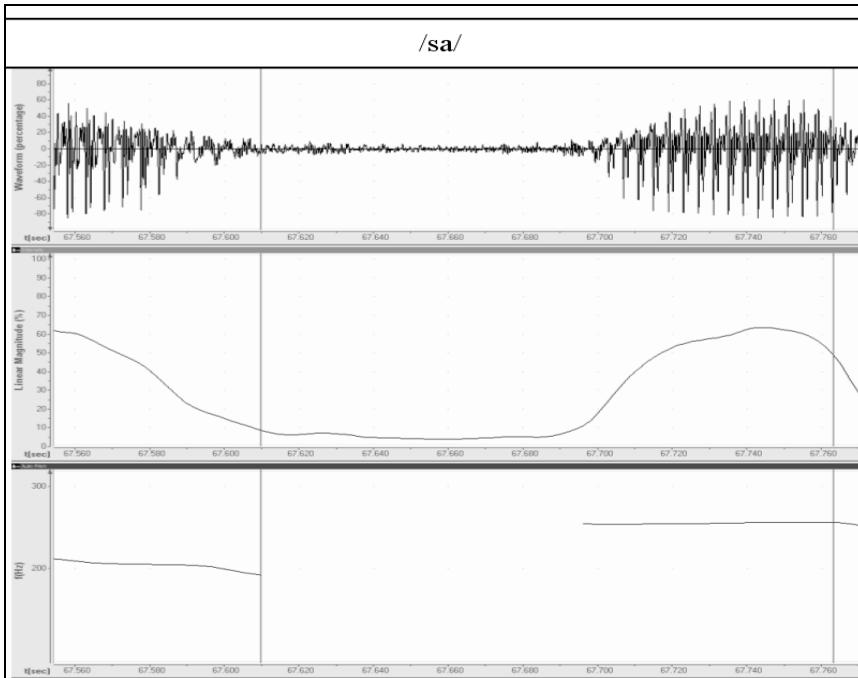


Figure 1: The stressed syllable /sa/ belonging to the word *pasaba* ('I used to spend'), as produced by an Ecuadorian speaker. The word is in PPH initial position and the syllable in question measures 153.2 ms.

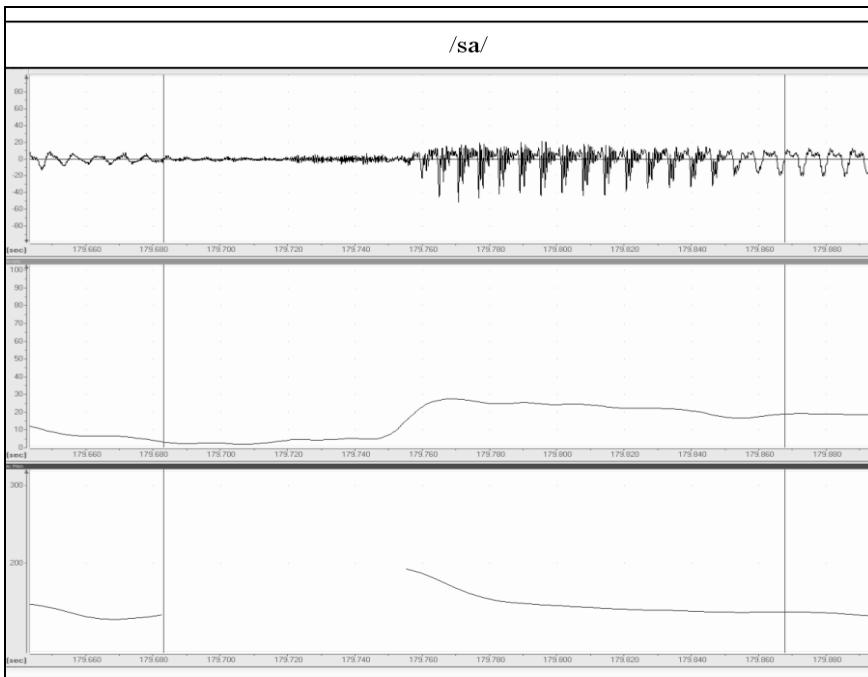


Figure 2: The stressed syllable /sa/ belonging to the word *manzanas* ('apples'), as produced by an Ecuadorian speaker. The word is in PPH final position and the syllable in question measures 184.7 ms.

4.1. Comments on final lengthening

Table 1, which considers comparable numbers of words of different lengths and syllable structures across the data, reveals that the average length of a word in PPH or IP final position is 183.8 ms longer than the duration of a word that is not phrase final. This significant difference indicates that final lengthening does occur in the speech produced by the speakers in this data set at both phrasal levels. Such a finding was predicted based on previous research. Showing that final lengthening deals with the word level reaffirms proposals regarding nuclear prominence in phrases applying beyond the constituent that we normally associate with ‘stress,’ or the syllable. Based on previous literature, it appears that a lengthening of phrase final words takes place in order to compensate for a gradual loss in intensity across words in a phrase.⁸ Since there are generally more segments in words than in syllables, there is more content over which intensity has time to diminish. The consequence of increased time for intensity to diminish is also increased time for duration to recuperate the loss in prominence. Therefore, the difference in lengthening between domain final words and non-domain final words will be greater than the same difference when considering syllables. Tables 2 and 3 provide evidence in favor of such an idea. Concerning the prosodic hierarchy, it seems that the durational disparity between final and non-final constituents becomes wider as we climb the hierarchy. Communicatively speaking, the increased length of a word gives speakers significantly more time to think about and articulate upcoming thoughts, which reflects the thoughts of Cooper (1976) and Klatt (1975).

Effects of domain final position on word duration	
Domain Final	Mean word duration (ms)
Yes	458.5
No	274.7

Table 1: The effects of PPH and IP final position on mean word duration ($p < .0001$). Words that are domain final are significantly longer than those that are not.

The six speakers included in this study also demonstrate final lengthening of the stressed syllable. Table 2 indicates that stressed syllables in phrase final position are on average 35.3 ms longer than those that are phrase initial or medial. The decreased difference in lengthening of syllables in phrase final position when compared to final words is due to the fewer segments contained in a syllable. In general, stressed syllables are predicted to manifest acoustic correlates of stress, such as increased duration. In phrase final position, lengthening is used in an exaggerated fashion in order to provide the further salience predicted by the Nuclear Stress Rule. Although melodic correlates are not investigated in the present study, final lengthening of the stressed syllable can have two possible connections with F0. First, such lengthening may help enhance the manifestation of melodic cues to boundaries by creating more time for pitch excursions. Based on the fact that PPHs generally associate with continuation rises, this explanation seems likely for PPH junctures. Second, final lengthening can compensate for a lack of F0 movement, which occurs in final lowering at the ends of IPs (following Ortega-Llebaria & Prieto 2007).

Effects of domain final (DF) position on stressed syllable duration	
Domain Final	Mean stressed syllable (SS) duration
Yes	173.7
No	138.4

Table 2: The effects of PPH and IP final position on mean stressed syllable duration ($p < .0001$). Stressed syllables that are domain final are significantly longer than those that are not.

When comparing the values of final syllable length in domain final and non-domain final positions, we observe that such syllables that are domain final are on average 53.9 ms longer than those that are not. The slightly longer domain final mean value of final syllables when compared to

⁸ Intensity measurements are not provided in the tables of this paper, but the data does clearly illustrate a loss of intensity at the end of phrases, as the insight of Kim (1974) predicts.

stressed syllables can be explained by the increased loss of intensity in segments closer to phrase boundaries (Kim 1974). As such, final syllables increase their duration in order to maintain the prominence lost due to severe decreases in intensity and often F0 as well. Increasing this final preboundary syllable is also functionally important because it provides more planning time for speakers to articulate upcoming thoughts (Cooper 1976 and Klatt 1975). However, this additional planning time may be more valuable in unscripted speech, since that is the type of context in which ideas are truly unplanned.

Effects of domain final (DF) position on final syllable duration	
Domain Final	Mean final syllable (FS) duration
Yes	177.8
No	123.9

Table 3: The effects of PPH and IP final position on mean final syllable duration ($p < .0001$). Final syllables that are domain final are significantly longer than those that are not.

4.2. *The effects of pauses on final lengthening*

Now that it has been clearly shown that final lengthening does exist in all three types of constituents examined in this study, we can move on to the effects of pause length on syllables and words in domain final position. In these cases, it is important to remember that the absence of pauses and short pauses are tied to PPHs and long pauses to IPs. When there are no pauses, the PPH boundary is cued via melodic means, though F0 is not specifically measured. In phrase boundaries with pauses, durational effects combine with melodic effects like F0 rises at the majority of PPH boundaries, and final lowering at IP boundaries (though only duration of segments is of interest here). The next series of tables will reveal how Spanish behaves in terms of pauses, final lengthening, and prosodic phrasing. Relevant comparisons to European Portuguese will also be considered. In Tables 4-6, the statistical tests only apply to syllables and words that are in phrase final position, and thus, these tables give us more specific information than the previous three.

Table 4 breaks down mean word durations based on types of pauses. It is apparent that when either pause is present, word duration is significantly longer than when there is no perceived disjuncture. When a short pause is present, lengthening of words tends to increase by 159.4 ms over cases when no pause is present. Similarly, when comparing cases of long pauses to no pauses, we see that long pauses lead to a 130.7 ms increase in lengthening. Lengthening before long and short pauses reveals a pairwise comparison that is insignificant (though the raw numbers approach significance). Even though this is the case, the mean word length before each type of pause suggests that words occurring before PPH boundaries are generally longer than those located before IP breaks. This relationship between pause length and lengthening clearly differs from what is observed in European Portuguese, where lengthening effects are not even observed at PPH boundaries. In fact, in Frota's (2000) study, the lack of cues to PPH boundaries makes their behavior more closely resemble PWs than IPs. The disparity between the aggregate of phonetic cues to boundaries at the IP and PPH levels is not as strong here as is the case in European Portuguese. This finding is important, as it emphasizes the complexity of acoustic cues to phrase boundaries, even within related languages. While cues are often documented as being similar cross-linguistically, the manifestations of such cues show clear variation.

Effect of pause length on word duration	
Pause type	Mean word duration
No Pause	317.5
Short Pause	476.9
Long Pause	448.2

Table 4: The effects of pause length on word duration ($p < .0001$). Though overall differences are significant, a pairwise comparison shows that the difference between SP and LP is not ($p = .056$).

In order to attempt to further validate the explanations associated with Table 4, it is necessary to explore the effects of pause length on stressed and final syllable durations. Tables 5 and 6 show that the effects of pause length on each syllable type are more salient than what is observed for words. The results in Table 5 for stressed syllable means indicate significant effects between pause types and when comparing each pause type to the absence of a pause. The same pattern from Table 4 emerges here in that the longest stressed syllables occur before short pauses, or PPH boundaries. The stressed syllables before pauses associated with PPH boundaries are on average 13.5 ms longer than those associated with IP boundaries. Once again, it is clear that either type of pause leads to a drastic increase in stressed syllable length when compared to contexts with no perceived pause. These findings, which deviate from those for European Portuguese, may point to the fact that IP and PPH boundaries are not that far apart in prosodic strength. This could be due to a type of compensation effect; increasing segmental duration at PPH boundaries makes up for the expected shorter pauses that are observed at these minor phrase boundaries. On the other hand, at IP boundaries, speakers anticipate a longer pause that cues this type of boundary, and thus do not see the need to increase their syllable duration as drastically. Pragmatically speaking, one may posit that increased lengthening and shorter pauses helps cue the continuation of an idea, as traditionally seen at PPH junctures, while increased pause length and slightly decreased lengthening signals the end of an idea, as is the case at IP breaks. Although pitch must also be considered, since a lack of prominent F0 movement may also be a cause for increased lengthening at the ends of phrases, as suggested by those such as Ortega-Llebaria & Prieto (2007), these findings suggest a communicative reason behind the inverse relationship found here between stressed syllable length and pause length at PPH and IP boundaries. This explanation combines many of the ideas that originally motivated this study, which are outlined in Section 2 (Cooper 1976, Kim 1974, Klatt 1975, Ortega-Llebaria & Prieto 2007, among others).

Effect of pause length on SS duration	
Pause type	Mean SS duration
No Pause	148.6
Short Pause	184.2
Long Pause	170.7

Table 5: The effects of pause length on SS duration ($p < .0001$). Pairwise comparisons confirm significant differences between each pause type.

Table 6 further supports the claim that increased lengthening of segments takes place at PPH boundaries in Spanish, as final syllables are 17 ms longer before short pauses than before long pauses. The final syllable means before both types of pauses are higher than the values for stressed syllables in Table 5. For short pauses, which are at PPH boundaries, final syllables are 30.2 ms longer than stressed syllables, and when long pauses are present, final syllables are 27.7 ms longer than stressed syllables. Also, the disparity between mean values before each pause type and the mean value in the absence of a pause is even further enhanced for final syllables. As referenced before, this may be due to articulatory reasons. When there is no pause, the stressed syllable is naturally the most prominent and salient, which can be cued temporally by increased duration. However, when a pause is incorporated, there is an increased loss in intensity as a boundary approaches, meaning final syllables are the least intense. In order to compensate for this loss, such syllables are lengthened further, which clearly explains the difference between Tables 5 and 6. Increasing the length of this last syllable before a pause also increases planning time for subsequent ideas. Overall, Table 6 builds upon Table 5 by illustrating differences in the relationship between temporal cues to phrase boundaries between Spanish and European Portuguese; in Spanish, increased pause length at IP boundaries does not lead to the increased duration that is suggested for European Portuguese. Therefore, the difference in strength between the IP and PPH is more highlighted in European Portuguese than for Spanish. In fact, it could be the case that both IPs and PPHs are labeled as ‘strong’ domains in Spanish, which opposes the weak and strong status of European Portuguese’s PPHs and IPs, respectively. Confirming these claims about strength for Spanish requires more analysis of melodic, rhythmic and sandhi related issues.

Effect of pause length on FS duration	
Pause type	Mean FS duration (ms)
No Pause	137.8
Short Pause	214.4
Long Pause	197.4

Table 6: The effects of pause length on FS duration ($p < .0001$). Pairwise comparisons confirm significant differences between each type of pause.

Through a detailed look at Tables 1-6, we have observed two types of articulatory compensation taking place in Spanish at prosodic boundaries; intensity loss leading to final lengthening, and shorter pauses influencing increased final lengthening. The latter effect, possibly accompanied by an increase in or recuperating the loss of F0 movement, pragmatically signals an important break in discourse, but a break that is indicative of an incomplete idea. Finally, the lack of a significant difference between lengthening before short and long pauses at the word level is important to note, since we see that this is not the case in the two types of syllables under investigation. This demonstrates the idea that articulatory compensation through longer final lengthening at the PPH boundary, to create durational balance with the expected upcoming shorter pause, is most evident at lower levels of constituents. Therefore, though lengthening can help make up for a shorter pause at lower prosodic levels, it is unable to have the same influence as more segments combine to form longer constituents, which suggests that this proposed articulatory strategy at phrase boundaries has limits.

4.3. Comments on gender and dialect

Gender and dialect are found to be statistically significant with regard to constituent length across the data, but not specifically in phrase final position. These results are still noteworthy because they motivate the possibility of these two variables playing a role in other temporal effects such as final lengthening, perhaps in a more robust data set, or in a corpus containing a different style of speech. The feasibility of finding significant findings for the effects of dialect on final lengthening is supported by studies in Section 2, such as Hirst & Di Cristo (1998). Therefore, the effects of gender and dialect on duration of syllables and words will be briefly detailed in this section.

Table 7 breaks down mean word and syllable duration in ms across the data by gender. In general, females produce words that are 38.8 ms longer than those of males. Furthermore, the stressed and final syllables of females are 14.9 ms and 14.4 ms longer than those of males, respectively. The longer average length for stressed syllables for both genders is expected since such syllables naturally are the most prominent in speech. One phonetic cue to this prominence is increased duration, which is evidenced in this data. The almost identical differences in means for the two types of syllables indicates that gender effects may be somewhat systematic at the syllable level; means differ by similar amounts, while stressed syllables slightly increase each individual mean by the same amount. The lower means of males for all three constituents measured suggests that they produce speech at a faster rate in this particular task. However, it is difficult to generalize this finding past scripted, lab, reading style tasks, since unscripted, more spontaneous speech clearly demonstrates differences when compared to lab speech (see Face 2003). Overall, this result is mentioned in order to trigger further thoughts on gender and constituent lengthening, an area that surely merits future work.

Effects of gender on duration			
Gender	Mean word duration	Mean SS duration	Mean FS duration
Male	347.2	148.6	143.6
Female	386	163.5	158

Table 7: The effects of gender on word, stressed syllable and final syllable duration across the data ($p < .0001$ for each constituent). Females produce longer constituents than males in general.

Table 8 displays mean values for word and syllable length based on dialect. The numbers indicate a systematic effect of dialect on mean values; Cubans produce the shortest constituents across the board, while Spaniards produce the longest. The overall effect of dialect on each constituent is significant; however, pairwise comparisons show that the differences between Ecuadorians and

Spaniards are not significant for word or stressed syllable length. Additionally, the effect of dialect on final syllables is not significant when comparing Cubans and Ecuadorians. Therefore, the Ecuadorian speakers and the Peninsular speakers are similar in word and stressed syllable durational behavior, while the Ecuadorians and the Cubans share this type of commonality for final syllables. Whether or not these shared temporal traits extend beyond dialects to macrolects is a question that can be addressed in additional studies. We can generalize the results here by saying that in this sample of read, scripted speech, Cubans have the fastest speech, while Spaniards have the slowest speech. The values for each syllable type once again support the fact that stressed syllables increase their prominence through the manifestation of longer duration. This, along with the results for gender and syllable length, supports previous research documenting duration as one important acoustic correlate of stress. However, once again, we must seek to extend such findings to studies on other speech styles and more dialects in order to gain a complete picture of how these factors influence the length of constituents, especially in final position of a prosodic domain. This introduction hopes to spark such a discussion.

Effect of dialect on duration			
Dialect	Mean word duration	Mean SS duration	Mean FS duration
Cuba	353.6	147.6	144
Ecuador	371.2	159.2	149.9
Spain	375.1	161.4	158.6

Table 8: The effects of dialect on word and syllable duration ($p = .037$ for words and $p = .0001$ for stressed and final syllables). There are overall differences between dialects, but pairwise comparisons show that the difference between Ecuadorians and Spaniards is not significant for words ($p = .66$) and stressed syllables ($p = .41$). For final syllables, Cubans and Ecuadorians fail to show a significant effect ($p = .0538$).

5. Conclusion

This paper empirically investigated the presence of phrase final lengthening in syllables and words in the scripted speech of speakers from three different dialects of Spanish. The paper also examined the influence of pauses on final lengthening in order to compare the current data for Spanish to previous findings on European Portuguese. Finally, preliminary comments discussing the effects of gender and dialect on duration were mentioned. The main findings revealed that final lengthening does indeed occur in all three constituent types studied both in preboundary contexts in general, as well as in prepausal situations. The prepausal condition lends itself to more lengthening of all three constituents involved. Explanations for this are phonetic and pragmatic in nature. It could be a strategy to compensate for the salience lost via decreased intensity at the ends of phrases and it could be used to increase planning time for upcoming ideas to be articulated. Furthermore, with regard to the effects of pauses, the results here run contrary to cited work on European Portuguese. Though pauses in general affected final lengthening more than cases with no pause, in this study, increased lengthening correlated with shorter pauses, or PPH junctures. Therefore, an inverse relationship between pause length and final lengthening of constituents was discovered. If the findings were to corroborate those from European Portuguese, we would expect a positive correlation between pause length and lengthening. For Spanish, the combination of increased final lengthening and decreased pause length (along with F0 effects) were posited to signal the continuation of an idea, while the opposite trend (along with final lowering of F0) was suggested as an indicator of the termination of an idea. As such, it is possible that for Spanish, it is not the case that there is some set of cues that indicate stronger or higher ranked phrase boundaries (as seen in Frota 2000 for European Portuguese), but rather that the same cues may just function differently in order to cue different phrase boundaries and provide different pragmatic and communicative functions. These empirical findings have theoretical implications as well. For example, when considering pauses, F0, and lengthening, perhaps it is the case that the presence of just one or two of these variables may lead to a *weaker* PPH boundary, while the presence of all three may be a *stronger* PPH boundary. The same could be the case for IPs, which implies that each type of phrase may have subcategories based on strength similar to what is suggested by Frota (2000) for European Portuguese. An additional item she examines, which could be relevant to

Spanish as well, is whether phrase length affects boundary strength. In sum, the ability to further categorize prosodic phrase types based on boundary strength is an area that merits future investigation. Overall, the main contribution of this study is that it provides increased insight into variation in boundary phenomena, even within related languages.

While the significance of this study has been set forth, it is important to mention some limitations, which will help inspire methodological innovation in future studies. In order to examine the effects of syllable structure on duration of constituents, future data elicitation tasks should control the segmental composition of syllables (and possibly limit them to sonorants and certain vowels). Furthermore, and in somewhat of an opposition to the control of variables just reviewed, it is important to realize that the speech samples used here come from a reading task, which is not a representation of natural speech. Therefore, studies on lengthening effects in spontaneous speech should also be pursued by researchers in Spanish intonation. Such an endeavor is one of the most challenging aspects of studying intonation, since so many factors need to be controlled for the purposes of software programs and reliable measurements. Additionally, for future research, it would be useful to further explore how the presence of melodic phrase boundary cues affect the degree of final lengthening. Also, dialectal differences with regard to boundary cues in general can be further addressed with different data sets. For example, it is well documented that Peninsular Spanish tends to show F₀ rises as cues to PPH boundaries, but whether this trend is as pronounced in all Latin American varieties is still to be determined. Final lengthening, in addition to focus and topic type lengthening, needs to be detailed in more segments in more dialects. Also, lengthening in other phrase positions can be further studied, as Fougeron & Keating (1997) and Pierrehumbert & Talkin (1992) have done to illuminate IP initial strengthening at the segmental level. Finally, the effects of IP and PPH length and complexity should be explored in connection with lengthening and strength of boundaries (following Frota 2000).

Overall, few empirical studies on final lengthening exist for Spanish. Therefore, while the present study contributes new insight to the field, it also aims to motivate the continued study of lengthening and prominence in Spanish as well as other languages.

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Selected Proceedings of the 4th Conference on Laboratory Approaches to Spanish Phonology

edited by Marta Ortega-Llebaria

Cascadilla Proceedings Project Somerville, MA 2010

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Rao, Rajiv. 2010. Final Lengthening and Pause Duration in Three Dialects of Spanish. In *Selected Proceedings of the 4th Conference on Laboratory Approaches to Spanish Phonology*, ed. Marta Ortega-Llebaria, 69-82. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #2368.