



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

## Vowel compression in Altiplateau Mexican Spanish

**Citation for published version:**

Ramsammy, M & Marchini, G 2022, 'Vowel compression in Altiplateau Mexican Spanish', *Isogloss*, vol. 8, no. 4, pp. 1-27. <https://doi.org/10.5565/rev/isogloss.171>

**Digital Object Identifier (DOI):**

[10.5565/rev/isogloss.171](https://doi.org/10.5565/rev/isogloss.171)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Publisher's PDF, also known as Version of record

**Published In:**

Isogloss

**General rights**

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

**Take down policy**

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact [openaccess@ed.ac.uk](mailto:openaccess@ed.ac.uk) providing details, and we will remove access to the work immediately and investigate your claim.



# Vowel Compression in Altiplateau Mexican Spanish

Gilly Marchini

The University of Edinburgh  
G.E.M.Marchini@sms.ed.ac.uk

Michael Ramsammy

The University of Edinburgh  
m.ramsammy@ed.ac.uk



Received: 30-07-2021  
Accepted: 29-08-2022  
Published: 15-12-2022

How to cite: Marchini, Gilly & Michael Ramsammy. 2022. Vowel Compression in Altiplateau Mexican Spanish. RLLT18, eds. Jonathan MacDonald, Zsuzsanna Fagyal, Ander Beristain & Robin Turner. Special Issue of *Isogloss*. *Open Journal of Romance Linguistics* 8(4)/2, 1-27.

DOI: <https://doi.org/10.5565/rev/isogloss.171>

## Abstract

---

This paper presents an exploratory study of coda-driven vowel compression in Altiplateau Mexican Spanish (AMS). Previous research has led to the claim that pan-dialectal, coda-driven compression does not occur in Spanish and that, instead, only onset complexity drives the shortening of following vowels (Aldrich & Simonet 2019). Based on acoustic analysis of continuously read speech, we find that mid and low vowels in AMS centralise in closed unstressed syllables, and they also display significant shortening in CVC contexts (relative to their uncompressed duration in CV syllables). By contrast, onset complexity does not induce significant compression in our data. Inferential testing confirms that it is an interaction between stress and syllable structure (i.e. coda presence in unstressed syllables) that is most significant in driving both qualitative and quantitative

compression. We argue that phonologically constrained, coda-driven compression occurs in Spanish, but it is dialect-specific and stress-dependent. We consider the implications of these variety-specific patterns in the context of debates concerning Spanish resyllabification, phonological rhythm and the acoustic marking of stress.

**Keywords:** acoustic phonetics, phonology, Spanish, vowel compression.

## 1. Introduction

It is well-established that vowel duration varies owing to segmental and suprasegmental factors. Nonetheless, a salient pattern among languages is vowel shortening relative to syllable structure. Vowel compression, or compensatory shortening, is the phonetic and/or phonological shortening of vowels relative to the number of segments within a syllabic unit: the greater the number of segments, the greater the shortening (Katz 2012; Munhall, Fowler, Hawkins & Saltzman 1991; Myers 1987). An example from English is given in (1) where the nucleus in *dreads* is shorter than in *dead* due to the complexity of its syllable structure: *dreads* has both a complex onset and coda (CCVCC), whilst in *dead*, both are simplex (CVC).

- (1) a. *dead*        [ˈdɛd]        CVC  
       b. *dreads*    [ˈdrɛdz]      CCVCC

Despite this, there is debate concerning whether onset and/or coda complexity drives the shortening of vowels. This study contributes to this debate and addresses claims that codas do not drive shortening in Spanish (Aldrich & Simonet 2019).

We begin by outlining current debates concerning compression and syllabic organisation, prior to contextualising reduction processes in Altiplateau Mexican Spanish and defining our research questions. Section 2 outlines the methodology of our study and Section 3 presents the results. We conclude by considering how dialect-specific compression effects may bear upon debates concerning the nature of resyllabification, phonological rhythm and the acoustics of lexical stress in Spanish (Section 4).

### 1.1 Vowel Compression

In the Closed Syllable Vowel Shortening Principle (CSV), Maddieson (1983) claims that there is sufficient evidence from the world's languages that coda-induced compression constitutes a phonetic universal. As outlined in (2), this is said to operate in a two-fold manner.

- (2) Closed Syllable Vowel Shortening Principle (adapted from Maddieson 1983)
- a. Vowels in closed syllables are universally shorter than those in open syllables.
  - b. Vowels adjacent to complex codas (i.e. those comprised of a cluster) are universally shorter than those adjacent to singleton codas (i.e. those comprised of stand-alone consonants).

For example, phonetic shortening of vowels in closed syllables is noted in English (Jones 1980), Finnish (Wiik 1965) and Korean (Han 1964). Moreover, it is observed in several languages—such as Italian (Antonetti & Rossi 1970), Dogri (Ghai 1980) and Hausa (Maddieson 1983)—that vowels adjacent to heterosyllabic geminate consonants (i.e. CVC.C) are shorter than those adjacent to singleton consonants (i.e. in CVC). Maddieson therefore concludes that coda-driven shortening is incremental: the more complex the coda, the greater the compression.

Regarding the examples in (1), the claim is that the shortened [ɛ̃] in *dreads* results solely from the complex coda: under the CSVS Principle, the complexity of the onset has no bearing on shortening. In fact, there are several examples of languages in which phonetic shortening of vowels in closed syllables or geminate contexts has been phonologised. In Ngzim (Schuh 1978) and Scottish English (Aitken 1981), long vowels occur only in open syllables. Although certain exceptions have been noted, Maddieson claims that patterns like these can be explained by the historic operation of CSVS (see also discussion on French in Maddieson 1983).

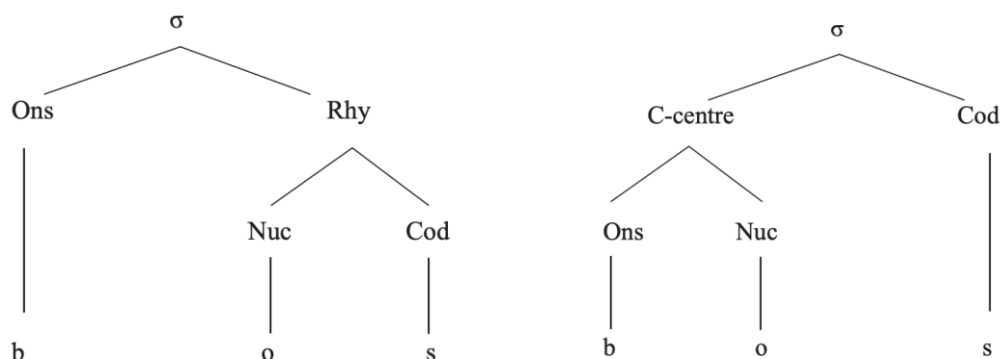
Additionally, Italian data from Farnetani & Kori (1989) support the CSVS Principle, showing that, although coda complexity drives shortening of vowels in closed syllables, onset complexity shortens vowels in open syllables. As such, Farnetani & Kori conclude that compression in Italian is anticipatory: changes in the following sound influence vowel length. Similarly, Munhall, Fowler, Hawkins & Saltzman (1991) show that, in English, vowels adjacent to complex codas are, on average, 13ms shorter than those adjacent to simplex codas. Instrumental measurements also reveal that vowels preceding complex codas are articulated with shorter jaw movements than vowels preceding simplex codas. In both of these studies, the authors take their findings as evidence that coda-induced compression is a cross-linguistic phenomenon resulting from *universal* syllabic organisation principles. This is to say that vowels and codas form a rhymal macro-unit—something that Maddieson (1983) also argues for—such that articulatory gestures for nuclei and codas are likely to be blended or significantly overlapped.

Nevertheless, recent research has questioned the universality of coda-induced compression. For example, both Peters & Kebler (2014) and Schmitz, Cho & Niemman (2018) highlight the role of complex codas in shortening vowels in German. Furthermore, two works are of specific relevance here: Katz (2012) on English and Aldrich & Simonet (2019) on Spanish. Katz (2012) highlights that if, as previously claimed, coda-induced compression is the sole result of universal syllabic organisation within the rhyme, the manner of the coda (clusters) would not impact upon compression effects. By contrast, the results of Katz's acoustic study on English reveal that vowels in CVC syllables are shorter than those in VC and CV contexts, suggesting that both onset and coda-induced compression occur. Nonetheless these results display strong speaker-specific trends: certain speakers showed consistent onset-induced compression whilst others showed consistent coda-induced compression. Moreover, vowels adjacent to onset and coda clusters are shorter than those adjacent to simplex consonants. Compression is also shown to depend on consonant manner: clusters containing liquids induced both coda and onset-driven shortening whilst those containing nasals induced only onset-driven shortening. Furthermore, although liquids drove both onset and coda-induced compression, their significance in coda position was greater. Katz therefore interprets these results to be in direct contrast to the rhymal gestural overlap hypothesis, arguing that if nuclei aligned with codas, onset-induced

compression would not occur and variability in compression due to consonant manner would not arise. By contrast, Katz proposes that there is a trade-off between the language's grammar and articulation so that segments remain perceptually salient; yet syllable duration is maintained despite this.

Similar results are presented for Spanish by Aldrich & Simonet (2019). This study shows that, despite previous claims of consistent vowel length in Spanish (e.g., Pike 1945), compression effects occur. Under controlled experimental conditions (comprising a combination of lexical and pseudo-words), stressed vowels in open syllables with complex onsets (CCV) are shown to be shorter than those with simple onsets (CV). Vowel-specific effects are also noted whereby /a/ exhibits relatively greater shortening than /i/. Interestingly, the presence and/or complexity of the coda does not significantly affect shortening; rather, vowel duration remains largely invariant across CV, CVC and CVCC syllable types. For onset complexity however (i.e. CV-CCV comparisons), the additional onset leads to vowel shortening. As such, Aldrich & Simonet agree with Katz (2012) that nuclei align with syllabic onsets not offsets. Moreover, they conclude that the shortening of the vowels in the context of overall lengthening of the syllable (i.e. through onset complexity) may indicate that phonological processes compensate for reduction effects. That is, a degree of consistency in syllable length is preserved: as a macrounit containing the onset and nucleus is lengthened, the vowel is shortened to compensate for this. This is referred to as the C-centre hypothesis and is illustrated in Figure 1.

**Figure 1.** Syllable trees for *voz* ('voice', [ˈbos]) according to rhyme hypothesis (left panel) and c-centre hypothesis (right panel)



Despite these studies which aim to directly test the predictions of CSVS, gaps in the scholarship remain. As Aldrich & Simonet highlight, although coda-induced compression is not visible in their supra-dialectal analysis, it is possible that dialect-specific compression effects occur at a microtypological level. There is also further scope to explore how compression interacts with other language- and dialect-specific phonological processes which have been shown to cause variation in duration: the role of stress, for example. As discussed below, our analysis of Altiplateau Mexican Spanish provides initial evidence that compression as a phenomenon can have dialect-specific outcomes.

## 1.2 Altiplateau Mexican Spanish

Altiplateau Mexican Spanish (henceforth AMS) is the variety of Spanish spoken in Mexico's central valley and surrounding highlands. It is characterised by several features; however, its most salient characteristic is Unstressed Vowel Reduction (henceforth UVR). Although extensively researched in Andean Spanish (Delforge 2008, 2009; Lipski 1990), there has been no in-depth acoustic analysis of UVR in AMS. There are, however, reports of several patterns of interest.

Firstly, it has been claimed that the acoustic effects of UVR are variable and exist along a continuum, with shortening, centralisation, devoicing as potential successive stages towards apparent elision (Boyd-Bowman 1952; Canellada & Zamora Vicente 1960; Dabkowski 2018; Lope Blanch 1960). This is illustrated in (3) with the example of /e/ in *grandes*.

### (3) Continuous Unstressed Vowel Reduction in AMS

- |                   |              |
|-------------------|--------------|
| a. Shortening     | [ˈgran.dɛ̃s] |
| b. Devoicing      | [ˈgran.dɛ̥s] |
| c. Centralisation | [ˈgran.dəs]  |
| d. Elision        | [ˈgrands]    |

Interestingly, Dabkowski (2018) highlights that although both devoicing and shortening occur in unstressed vowels, there appears to be no interaction between these processes. In other words, vowels are rarely devoiced and shortened simultaneously. Furthermore, despite impressionistic claims of centralisation (Boyd-Bowman 1952; Canellada & Zamora Vicente 1960; Dabkowski 2018; Delforge 2008, 2009; Lope Blanch 1960), acoustic changes in quality may occur only as a secondary result of weakening: unstressed, weakened (devoiced and/or shortened) vowels are likely to raise following devoicing or shortening. In other words, centralisation also rarely occurs independently of weakening. However, it is important to note that Dabkowski did not analyse the acoustic quality of non-shortened vowels; thus, it remains unclear whether independent centralisation occurs. Similarly, there is substantial debate on the existence of complete elision. Although elision is impressionistically perceivable and acoustically observable (i.e. a lack of spectral energy), a lack of articulatory research on this phenomenon means that it is unclear whether elision involves the complete deletion of a vocalic gesture in contexts like (3d).

Of particular interest to the present study are the phonetic and phonological constraints on reduction. Previous studies have confirmed that reduction targets unstressed vowels, particularly /e/ and /o/ whilst /a/ is most resistant (Boyd-Bowman 1952; Canellada & Zamora Vicente, 1960; Dabkowski 2018; Delforge 2008, 2009; Lope Blanch 1960). Further to this, Dabkowski (2018) confirms impressionistic claims from Canellada & Zamora Vicente (1960), noting that post-tonic vowels are 3.16 times more likely than pre-tonic vowels to undergo voice weakening and 9.77% of all weakened tokens appear in word-final position. Lastly, an emerging pattern for reduction is its dependency on syllable structure, in particular the syllabic affiliation of the following consonant. For Dabkowski (2018), 7.25% of vowels in closed syllables were devoiced compared to 0.89% of vowels in open syllables.

Similar effects are noted in Andean Spanish, where vowels adjacent to canonical codas were significantly more likely to be reduced than those adjacent to codas that had been resyllabified to the following syllable (Delforge 2008). Phonotactic

factors were also significant, with reduction most extreme between voiceless consonants (i.e. /C<sub>1</sub>VC<sub>2</sub>/) where C<sub>2</sub> was /s/ (Boyd-Bowman 1952; Canellada & Zamora Vicente 1960; Dabkowski 2018; Delforge 2008, 2009; Matluck 1951). Again, weakening effects were greater when /s/ occurred in canonical coda position (Dabkowski 2018; Delforge 2008, 2009).

### 1.3 Research questions and motivation

Previous studies have highlighted that UVR involves interactions between vowel quality, stress and syllable structure. However, there are outstanding questions about the operation of UVR, particularly in a dialect like AMS. Not least, analysis of dialect-specific compression effects across stress contexts in connected speech remains to be undertaken. With this in mind, the study reported on here is guided by the following research questions:

- RQ1. To what extent are compression effects coda- or onset-driven in Altiplataean Mexican Spanish? What is the role of onset and coda complexity in driving compression?
- RQ2. To what extent does compression correlate with stress?
- RQ3. Can studying compression in AMS provide insights into wider debates concerning the dialect-specific nature of resyllabification, phonological rhythm and lexical stress in Spanish?

## 2. Methodology

### 2.1 Data collection

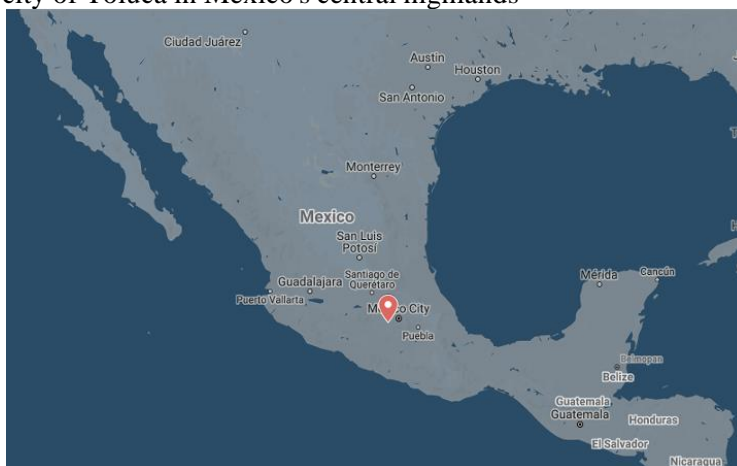
The data reported on below come from a corpus of audio recordings compiled by the first author. The full corpus contains recordings of wordlists, sociolinguistic interviews and a reading passage. For this study, we took advantage of the possibility of studying compression in continuous speech by focusing on the reading passages (cf. Section 6.1). Data from six participants aged between 18 and 25 are analysed here. All six self-identify as female and are native speakers of the variety of Spanish spoken in Toluca (see map in Figure 2), having been born and raised in the city. None reported any speech or hearing pathologies. Prior to participation, speakers were made aware of the phonetic nature of the study but not the exact focus on vowel compression. Recordings were conducted in a quiet room (at a suitable distance from windows) at the Universidad Autónoma del Estado de México through the *Audacity* software environment (Audacity Team 2017). As a sound-attenuated studio was not available for recording, sound-to-noise ratio (SNR) checks were conducted on all recordings to ascertain their suitability for acoustic analysis. Only recordings with an SNR value of 50 and above were included in the analysis.

### 2.2 Procedure

The data were segmented using the *Montreal Forced Aligner* (McAuliffe, Socolof, Wagner & Sonderegger 2017) and manually checked in Praat (Boersma & Weenink 2021) following established protocols (Turk, Nakai & Sugahara 2006). Segment boundaries corresponded with acoustic landmarks visible in the spectrogram, typically formant frequencies and spectral energy. The onset and offset of vowels were

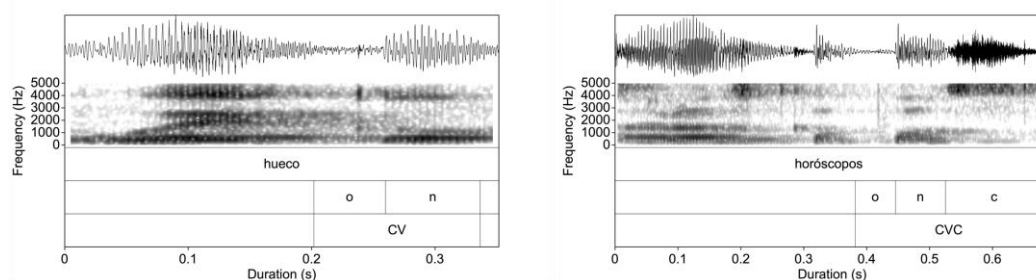
determined by observing changes in formant contours, often coinciding with the onset or offset of the surrounding consonants (see Figure 3). In instances in which the vowel appeared in pre-pausal, open syllables, the offset of the vowel was determined by the disappearance of consistent F2 energy. Changes in the waveform were used as a secondary diagnostic where changes in the spectral landmarks were more difficult to isolate. Boundaries were consistently established on the zero crossing in the waveform. We did not consider the voice bar as a reliable metric for segmentation since assimilatory voicing effects are often visible in natural speech. As also noted, devoicing is a common outcome of phonetic reduction in highland, transatlantic varieties of Spanish (Delforge 2008, 2009). As such, devoiced tokens were segmented in line with visible spectral energy (Delforge 2008, 2009). Further to this, vowels were considered acoustically elided where no spectral energy was observable in the frequency regions where formants would otherwise be expected to occur.

**Figure 2.** The city of Toluca in Mexico's central highlands



Source: Google maps

**Figure 3.** Segmentation in the final CV syllable of *hueco* (left panel) and final CVC syllable of *horóscopos* (right panel) where ‘o’ denotes ‘onset’, ‘n’ denotes ‘nucleus’ and ‘c’ denotes ‘coda’



Following segmentation, Praat scripts were written to extract durational, formant-frequency and intensity measurements. This set of measurements was chosen as previous research has established that they can provide reliable correlates of vowel compression (in addition to the experimental studies cited above, see also Ortega-Llebaria 2006 and Ortega-Llebaria & Prieto 2010 on the use of intensity measurements in the analysis of Spanish lexical stress). Formant frequency measurements were



extracted from the mid-point of the vowel.<sup>1</sup> Mean intensity was calculated over the full duration of the vowel. However, we observed generally low variability across test contexts and therefore took the decision to discount intensity measurements. The analysis reported in Section 3 therefore relies on formant-frequency and durational measurements exclusively.

### 2.3 Data coding

The analysis focuses on the vowels /e, o, a/ in word-final syllables. Vowels in word-final syllables were chosen because, as stated above, this is the primary locus of UVR in AMS (Canellada & Zamora Vicente 1960; Dabkowski 2018; Delforge 2008, 2009). The high vowels (/i, u/) were excluded from the analysis due to their infrequency in appearing word-finally, particularly in open syllables (Melgar Martínez 1994, Rojo 1991). To avoid discrepancies in durational and formant-frequency measurements, fake geminates (e.g., in sequences like *lago o* [layo]) and diphthongs (e.g., *lago y* [layoi]) were discounted. The data were then coded using the scheme outlined in Table 1.

As shown, the data were initially coded according to whether the vowel in a word-final syllable was present or elided. The analysis focuses on cases of vowel reduction such that eight tokens exhibiting full elision of the final-syllable vowel were removed from the dataset.<sup>2</sup> Similarly, function words were excluded due to the focus on stress: only content words containing lexically stressable vowels were included. Following these exclusions, a total of 1197 tokens were included in the analysis (cf. Section 6.2).

The coda variable indicates the quality of the word-final consonant in each word, if one occurred. The phonological context preceding the target vowel was coded for as preceding manner and preceding voicing. The former variable captures the manner of articulation of consonants preceding the target vowel. The category of approximant includes all intervocalic instances of /b, d, g/ (i.e. [β, ð, ɣ] phonetically). Fricatives in the data included /s/ and /x/. We also coded instances of the affricate <ch> /tʃ/ and <ll> /ʎ/ with the fricatives: these sounds occurred too infrequently in the data to merit a separate affricate category. Liquids include instances of /l/, /r/ and /r/ and nasals include instances of /m/, /n/ and /ɲ/. Plosives included unvoiced /p, t, k/ as well as unapproximated allophones of /b, d, g/. Preceding voicing is a binary variable that codes whether the segment preceding the target vowel was phonologically voiced or voiceless.

Stress captures whether the target vowel occurred in a stressed or unstressed syllable and vowel quality codes whether target vowels were instances of /e/, /o/ or /a/.

<sup>1</sup> An anonymous reviewer points out that a potential shortcoming of this method is that some centralisation effects could be underestimated: e.g., in vocalic transitions at segment edges. Although we do not implement it here, a dynamic approach to formant analysis would potentially avoid this issue. We opted for mid-point measurements as these have the advantage of minimising coarticulatory effects from surrounding consonants: cf. Freeman & De Decker (2021).

<sup>2</sup> We note a greater incidence of elision in the sociolinguistic interviews recorded with the same speakers (not analysed here). This is indicative of style-shifting, such that the very low number of tokens in this dataset can be ascribed to fact that this is read speech.

We also included a continuous variable for syllable count for each word. Speaker was coded using anonymised participant codes and lexical word was also coded for.

Some specific comments on the coding of following context, syllable openness and syllable structure are necessary. Syllable structure codes the shape of the word-final syllable of the citation form of each word. Thus, a word like *hablar* is coded as CCVC on the basis of its final syllable, /βlar/. In this sense, we do not assume a priori that resyllabification operates in an exceptionless way across word boundaries. Instead, the *possibility* of phrasal resyllabification is encoded within following context: pre-vocalic and pre-consonantal code whether the word following the target word is vowel or consonant-initial, respectively; pre-pausal indicates that a target word occurs before an intonational break or pause.

In some cases, specifically when working with subsets of the data for the vowel formant analyses presented in Section 3.1, there are too few tokens of certain syllable types in the data to make syllable structure workable as a predictor of variation. In the analyses presented in Section 3.1, it was necessary to remove V and VC tokens from the data due to low numbers. Accordingly, we revert to a simpler variable for syllable shape in these analyses: syllable openness codes whether the word-final syllable is open (i.e. for CCV and CV syllable shapes) or closed (i.e. for CCVC and CVC).

**Table 1.** Coding of variables

*Dependent variables*

Midpoint measurements of F1 and F2 (Hz)  
Vowel duration (msecs)

*Independent variables*

category	2 levels: content, functional	(function words removed from analysis)
elision	2 levels: elided, unelided	(elided tokens removed from analysis)
coda	4 levels: l, r, n, s	
following context	3 levels: pre-vocalic, pre-consonantal, pre-pausal	
preceding manner	5 levels: approximant, fricative, liquid, nasal, plosive	
preceding voicing	2 levels: voiced, voiceless	
stress	2 levels: stressed, unstressed	
syllable openness	2 levels: open, closed	
syllable structure	6 levels: CCV, CV, CCVC, CVC, V, VC	
syllable count	continuous	
vowel quality	3 levels: /e/, /o/, /a/	
speaker	Coded as S1–S6	
word	201 included items in final analysis	

#### 2.4 Statistical Analysis

Statistical analysis was conducted using *R* (R Core Team 2020). Plots used for visualising patterns in the data were generated using both base *R* and the *ggplot2* package. Inferential testing was conducted using linear mixed-effects regression (*lme4* and *lmerTest* packages). Post-hoc, pairwise comparisons using estimated marginal means with Bonferroni corrections ( $\alpha$ -value of 0.05) were calculated using the *emmeans* package. Mixed-effects models were built additively and best-fit models for each dependent variable were identified through log likelihood tests. In maximal

---

models, all independent variables listed in Table 1 were included as fixed effects in addition to random intercepts for speaker and word.<sup>3</sup>

### 3. Results

#### 3.1 Vowel Quality

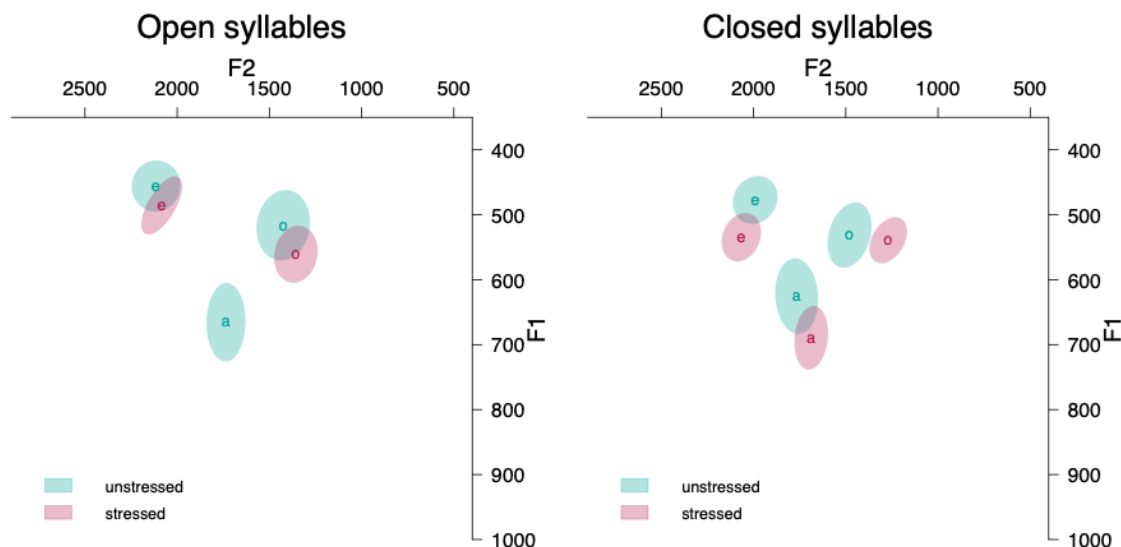
F1 and F2 values for stressed and unstressed vowels in open versus closed syllables are plotted below in Figure 4. The plots show that differences in vowel quality are observable across test contexts. In general, vowels in closed syllables occupy a more centralised position in the vowel space than those in open syllables. Potential correlations with stress are also noted: for both open and closed syllables, stressed vowels have a more peripheral quality than unstressed vowels. The direction of these effects, however, is clearly vowel-specific. For /o/ in open syllables, we see lower F1 values and higher F2 values in unstressed contexts than in stressed contexts. Thus, unstressed /o/ tends to exhibit a degree of raising and centralisation in open syllables. But in closed syllables, /o/ shows more dramatic centralisation. A similar pattern is observable for /e/: in both open and closed syllables, unstressed /e/ displays lower F1 values than stressed /e/. This effect is, again, more minor in open-syllable contexts and observably greater in closed-syllable contexts.

The same comparisons cannot be drawn for /a/ as there were no tokens of this vowel in a stressed, open-syllable context in the reading passage. However, in closed-syllable contexts, unstressed /a/ is observably centralised (i.e. raised) when compared to stressed /a/. Together, these results are consistent with the impressionistic generalisation that, in AMS, unstressed vowels raise and, in some instances, also centralise. Both effects are more extreme in closed syllables: this therefore suggests that effects on vowel quality are dependent upon the interaction between syllable structure and stress.

---

<sup>3</sup> The random intercept for speaker takes account of minor differences in speech rate and formant-frequency ranges (the latter being attributable to physiological differences between speakers). Based on initial exploration of the data, we determined normalisation of formant measurements to be unnecessary given that all participants in the study are female speakers of the same variety of Spanish.

**Figure 4.** Vowel plots for realisations of /e, o, a/ in stressed and unstressed contexts in open syllables (left panel) and closed syllables (right panel)



This observation is confirmed by inferential testing. Separate models were fitted to subsets of the data for /e/, /o/ and /a/ for both F1 and F2. As mentioned, it was necessary to remove V and VC tokens from the data set for these vowel-specific analyses due to low numbers of these syllable types. Moreover, we were unable to analyse the role of coda type due to low token counts in the vowel-specific data sets. Thus, working with the reduced data set including the remaining syllable types (i.e. (C)CV and (C)CVC tokens), the best-fit models were as follows:

(4)

/e/-F1 syllable openness \* stress + following context + syllable count + (1 | speaker) + (1 | word)  
 /e/-F2 syllable openness \* stress + following context + preceding manner + (1 | speaker) + (1 | word)  
 /o/-F1 syllable openness \* stress + following context + syllable count + (1 | speaker) + (1 | word)  
 /o/-F2 syllable openness \* stress + following context + syllable count + (1 | speaker) + (1 | word)  
 /a/-F1 stress + following context + preceding manner + (1|speaker) + (1|word)  
 /a/-F2 stress + following context + preceding manner + (1|speaker) + (1|word)

For /e/, a significant main effect of stress obtained in the F1 model and significant main effects of stress, following context and preceding manner were observed in the F2 model. Post-hoc testing confirms the patterns shown in Figure 4: /e/ has a significantly higher quality in unstressed closed syllables than in unstressed open syllables ( $\beta = 55.2$ ,  $t = 2.191$ ,  $p < .05$ ). Similarly, /e/ is significantly more centralised in unstressed closed syllables ( $\beta = 227.2$ ,  $t = 2.689$ ,  $p < .05$ ) than elsewhere. Regarding the other main effects on F2, /e/ has a more fronted quality in pre-pausal environments than in pre-vocalic environments ( $\beta = 171.4$ ,  $t = 2.617$ ,  $p < .05$ ). F2 is also slightly higher in /e/ after plosives than after approximants. Nevertheless, this comparison does not reach significance after  $p$ -value correction:  $\beta = -180.357$ ,  $t = -2.834$ ,  $p > .08$ .

For /o/, effects of interest on F1 are negligible. As shown in Figure 4, a minor difference in height in /o/ can be observed in open syllables only; but this effect is non-significant ( $\beta = 36.9$ ,  $t = 1.716$ ,  $p > .05$ ). In the F2 model, there is one significant main effect of stress. In agreement with Figure 4, post-hoc testing confirms that unstressed

/o/ is significantly centralised in closed syllables ( $\beta = -170.6$ ,  $t = -2.511$ ,  $p < .05$ ) but not in open syllables ( $\beta = -88.6$ ,  $t = -1.316$ ,  $p > .1$ ).

Due to the absence of stressed /a/-tokens in open syllables, the /a/-models are calculated on the subset of data from closed-syllable realisations (i.e. the righthand panel in Figure 4). For F1, there were main effects of stress and preceding manner, and for F2, of following context and preceding manner. As can be observed in Figure 4, /a/ is significantly centralised in unstressed, closed-syllable contexts ( $\beta = 65.2$ ,  $t = 3.094$ ,  $p < .01$ ). The strongest comparison for F1 is between preceding fricatives and preceding approximants (lower values in the former context and higher values in the latter). This effect is however too minor to reach significance after  $p$ -value adjustment:  $\beta = 78.4$ ,  $t = 2.952$ ,  $p > .05$  ( $p < .05$  without adjustment). For F2, differences between stressed and unstressed /a/ in closed syllables do not reach significance. Regarding following context, /a/ has a more fronted quality pre-pausally than pre-consonantly ( $\beta = -107.39$ ,  $t = -3.187$ ,  $p < .01$ ). Other comparisons of preceding manner are non-significant.

As noted in Section 2.3, items were coded based on their citation-form syllabification. An outstanding question, therefore, is whether consonant-final words display different compression patterns in pre-vocalic environments (i.e. in putative resyllabification environments).

**Figure 5.** Vowel plots for realisations of /e, o, a/ in unstressed, closed syllables in pre-vocalic (green), pre-pausal (blue) and pre-consonantal (red) contexts

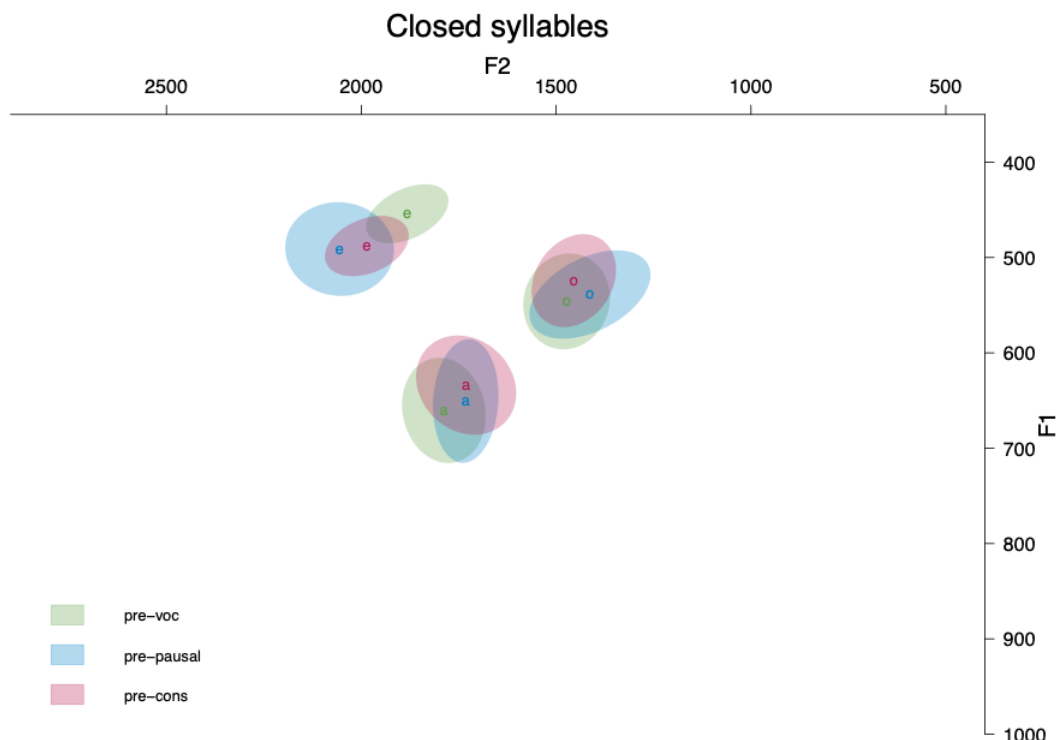


Figure 5 shows the F1 and F2 values for unstressed vowels in closed syllables in pre-vocalic, pre-pausal and pre-consonantal contexts. We can observe that for /a/ and /o/, there is very little difference between contexts. For /e/, pre-pausal vowels occupy a larger, more peripheral vowel space than pre-vocalic or pre-consonantal

vowels: this contributes to the significant effect of following context on F2, as already mentioned. We assume these effects may be related to pre-pausal lengthening (see Section 3.2 below for further discussion). Pre-vocalic vowels do appear to be more centralised and raised than pre-consonantal vowels, although this is a relatively minor effect. Inferential testing confirms that F2 is somewhat lower in /eC#V/ contexts, however the effect is too minor to reach significance ( $\beta = -24.5$ ,  $t = -0.414$ ,  $p > .1$ ). At least as far as vowel formant measures are concerned, the data therefore do not support the assumption of a categorical resyllabification process operating across word boundaries. We take up this point again in Section 3.2 and in the general discussion in Section 4.

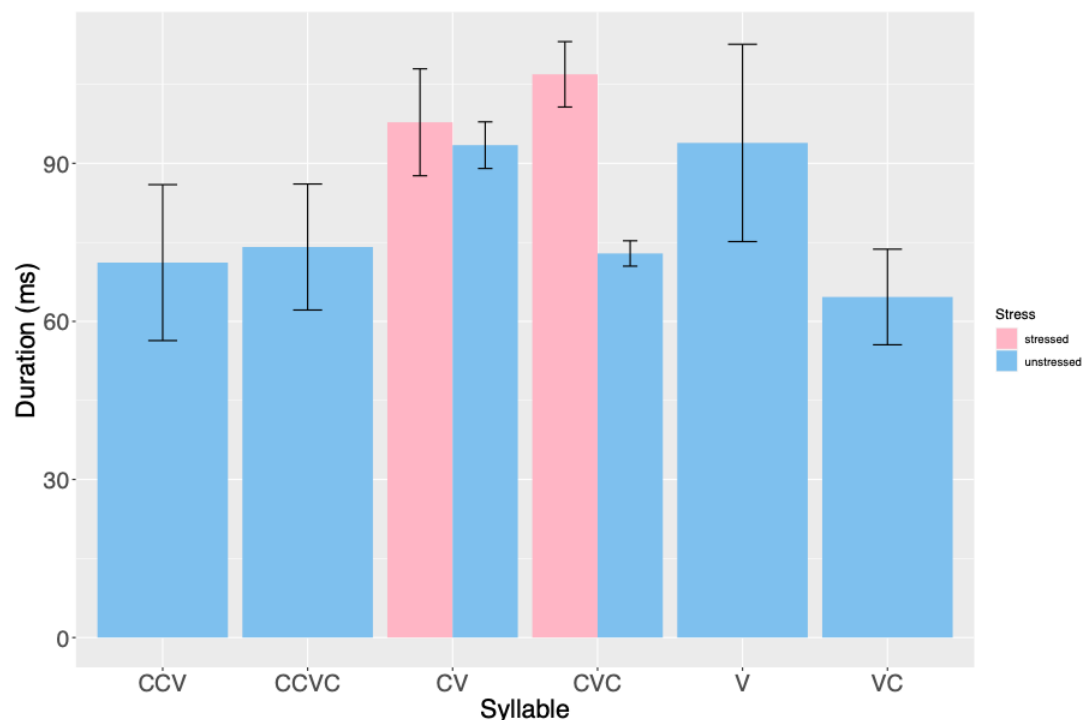
### 3.2 Duration

Figure 6 and Table 2 show the mean durations for all vowel categories in the dataset.<sup>4</sup> We see that in CV-CVC comparisons for stressed vowels, vowel shortening does not occur: in fact, vowels appear to lengthen with the addition of the coda from 97.783ms to 106.885ms. However, for unstressed vowels, the addition of the coda leads to a drop in mean duration from 93.441ms to 72.889ms. This suggests that coda-induced compression occurs but is strongly correlated with stress. Due to the reading text, there are no instances of stressed vowels outside of CV-CVC structures. Nonetheless, we do see coda-induced shortening for V-VC unstressed comparisons where mean duration drops from 93.87ms to 64.632ms. Interestingly however, shortening is not observable for structures with complex onsets. For CCV-CCVC, duration increases negligibly from 71.154ms to 74.114ms.

---

<sup>4</sup> Error bars in this and all following bar charts show 95% confidence intervals.

**Figure 6.** Mean duration (milliseconds) for vowels in stressed and unstressed contexts in CCV, CCVC, CV, CVC, V and VC syllables

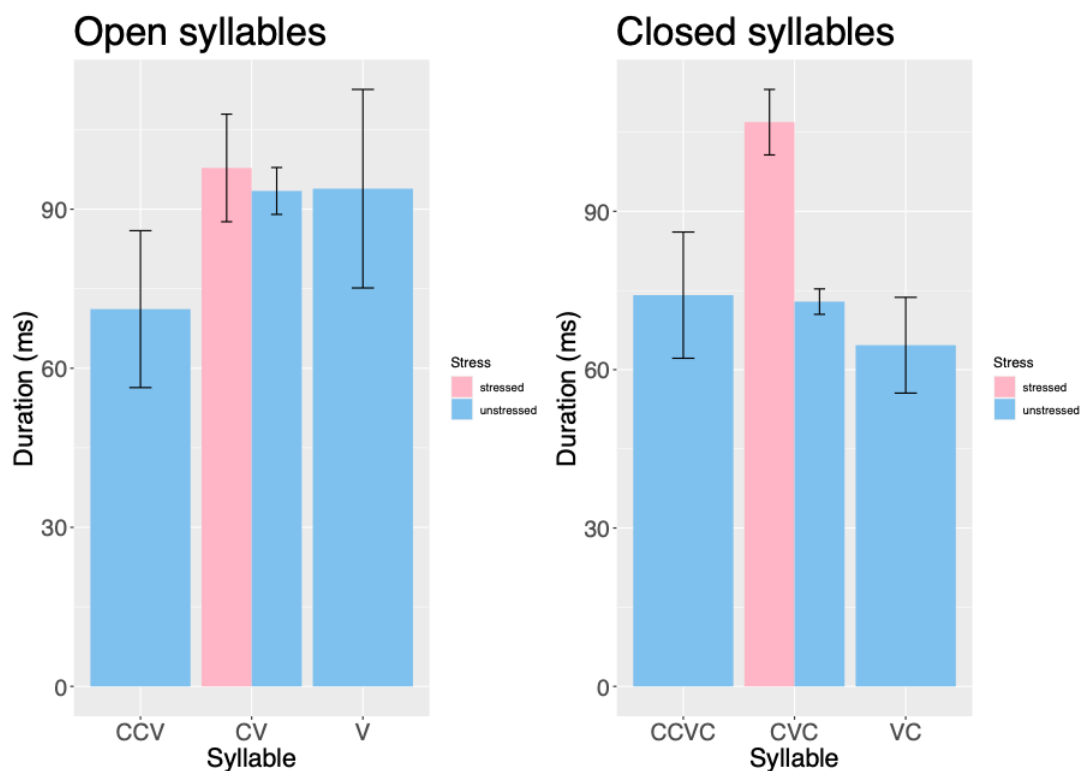


The data shown in Figure 6 are replotted in Figure 7 to aid comparison between specific syllable types (i.e. open vs closed syllables). In open syllables, we observe an effect of onset complexity: the more complex the onset, the shorter the vowel. Interestingly, however, onset-driven shortening is not observed in closed syllables where instead complexifying the onset leads to an increase in mean durations for vowels. Vowels in VC syllables are the shortest (64.632ms), and this value increases to 72.889ms in CVC contexts and 74.114ms in CCVC syllables. These results therefore suggest that coda-induced shortening occurs in AMS but is complex in nature, targeting unstressed vowels in simplex structures (V-VC, CV-CVC), but not those with complex onsets. In line with this, onset complexity appears to shorten vowels in open syllables but not closed.

The best-fit regression model for duration included vowel quality, stress, following context and syllable count as fixed effects and random intercepts for speaker and word. Main effects of vowel quality, stress and following context were observed. Post-hoc comparisons confirm that stressed vowels are consistently longer than unstressed vowels ( $\beta = 20.8$ ,  $t = 5.024$ ,  $p < .001$ ). There is also a significant effect of syllable type for the CV-CVC comparison confirming significant durational compression ( $\beta = 16.69$ ,  $t = 5.268$ ,  $p < .001$ ). Regarding vowel quality, /o/-realisations are shorter than both /e/ and /a/ overall. The /o/-/a/ comparison achieves significance ( $\beta = 11.04$ ,  $t = 3.060$ ,  $p < .01$ ) whereas the /o/-/e/ and /a/-/e/ comparisons do not ( $p > .1$  in both cases).

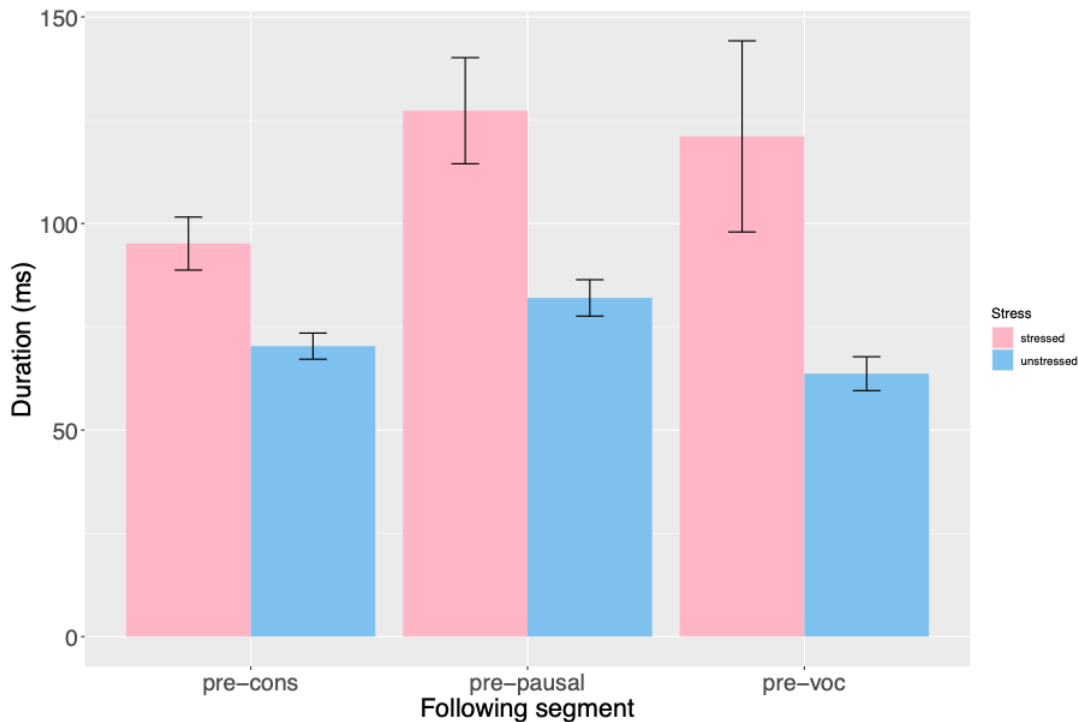
**Table 2.** Mean duration data (milliseconds) for stressed and unstressed subset for syllable type

Syllable	Stress	N	Duration (ms)	SD
CCV	unstressed	14	71.154	25.631
CCVC	unstressed	26	74.114	29.609
CV	stressed	69	97.783	42.238
CV	unstressed	406	93.441	45.334
CVC	stressed	142	106.885	37.403
CVC	unstressed	493	72.889	27.193
V	unstressed	22	93.87	42.228
VC	unstressed	24	64.632	21.485

**Figure 7.** Data subsets showing mean vowel duration values (milliseconds) for open syllables (left panel) vs closed syllables (right panel)

We further analysed whether assumptions about the syllabic affiliation of word-final consonants in citation forms had an impact on durational clipping. Duration values for the subset of data from words containing final consonants in citation forms (i.e. CCVC, CVC and VC syllable shapes) are plotted in Figure 8 and summarised in Table 2. We observe that stressed target vowels are somewhat longer in / $\check{V}C\#V$ / (pre-vocalic) environments than in / $\check{V}C\#C$ / (pre-consonantal) environments, and vowels in both contexts are shorter than in pre-pausal (i.e. / $\check{V}C\#\#$ /) contexts. However, this is not the case for unstressed syllables. In fact, target vowels in / $\check{V}C\#V$ / are shorter than in both / $\check{V}C\#C$ / and / $\check{V}C\#\#$ /.



**Figure 8.** Mean duration (milliseconds) for vowels in unstressed, closed syllables in pre-consonantal, pre-pausal and pre-vocalic contexts**Table 3.** Duration data (milliseconds) in closed syllables, subcategorised by following context

Context	Stress	N	Duration (ms)	SD
Pre-consonantal	stressed	87	95.128	30.094
	unstressed	275	70.298	26.621
Pre-pausal	stressed	39	127.294	39.606
	unstressed	165	81.976	28.657
Pre-vocalic	stressed	16	121.072	43.411
	unstressed	103	63.635	20.978

These durational effects were modelled using following context, stress, coda and preceding voicing as fixed effects, an interaction term for following context  $\times$  stress and random intercepts for speaker and word. Significant main effects of following context and stress were observed as well as a significant interaction. For stressed syllables, a significant difference obtained in the  $\acute{V}C\#C/-\acute{V}C\#\#$  comparison with vowels in the latter context being significantly longer ( $\beta = -25.71$ ,  $t = -3.702$ ,  $p < .001$ ). However, all comparisons involving  $\acute{V}C\#V$  fail to reach significance: this indicates that vowels in  $\acute{V}C\#V$  are neither significantly longer than in  $\acute{V}C\#C$  or  $\acute{V}C\#\#$  environments. A similar result obtains for the unstressed vowels: unstressed vowels in  $\acute{V}C\#\#$  are significantly longer than in  $\acute{V}C\#V$  ( $\beta = 18.60$ ,  $t = 4.402$ ,  $p < .001$ ) and in  $\acute{V}C\#C$  ( $\beta = -12.11$ ,  $t = -3.314$ ,  $p < .01$ ). But the comparison between phrase-medial  $\acute{V}C\#V$  and  $\acute{V}C\#C$  is non-significant ( $\beta = 6.49$ ,  $t = 1.739$ ,  $p > .1$ ). These results therefore indicate that consonants in putative resyllabification contexts (i.e.  $\acute{V}C\#V$ ) significantly drive compression of preceding vowels in the same way as consonants that

have never been argued to participate in phrasal resyllabification (i.e. /VC#C/). As discussed further in Section 4, there is therefore no evidence that citation-word-final consonants resyllabify across word boundaries in pre-vocalic contexts in this data from AMS.

### 3.3 Summary of findings

In sum, our results allow for the following generalisations to be made:

1. In comparison to stressed contexts, unstressed /e/, /o/ and /a/ display raising. These unstressed vowels also exhibit more extreme centralisation in closed syllables than in open syllables.
2. Stress is significant only in closed syllables in driving qualitative changes.
3. The presence of a word-final coda is significant in shortening vowels. This effect interacts with stress.
4. Onset complexity does not induce significant vowel compression.
5. Coda-induced shortening and centralisation occur in putative resyllabification environments.

We now consider the implications of these findings for our key research questions by situating the discussion around theoretical issues of resyllabification, phonological rhythm and stress.

## 4. Discussion

Returning to our initial Research Questions, RQ1 asks whether the presence of an onset or coda consonant drives compression in AMS, and to what extent complexity (i.e. onset and coda branching) may further impact compression. Relatedly, RQ2 queries what the nature of the interaction between stress and compression might be. Our results have confirmed that coda-driven compression does occur in AMS; however, its operation is complex. Vowels in closed syllables exhibit more extreme, stress-driven centralisation than those in open syllables. Moreover, unstressed vowels in CVC syllables shorten with the addition of the coda, whilst stressed do not. However, contrary to the results of Aldrich & Simonet (2019), we find no evidence that onset complexity is significant in triggering shortening (despite some observable but marginal patterns of compression in CCV structures).

The goal of RQ3 was to enquire to what extent the results from a study into vowel compression in AMS might provide insights into key theoretical debates in the following areas: (i) the nature of Spanish resyllabification; (ii) dialect-specific phonological rhythm; and (iii) dialect-specific acoustic marking of stress. We shall consider each of these in turn.

### 4.1 Resyllabification

As already discussed, resyllabification—and more specifically *phrasal* resyllabification—refers a phonological process that is argued to apply regularly in Spanish to word-final consonants in prevocalic environments: e.g., /los.o.tros/ → [lo.so.tros] 'the others'. Indeed, a number of theoretical works on Spanish have relied, to a greater or lesser extent, on the assumption of this process: e.g., Bermúdez-Otero (2011); Colina

(1997); Face (1999); Ramsammy (2013). Nevertheless, there are clear, dialect-specific patterns which are more challenging to explain if one assumes that resyllabification is categorical, exceptionless and pan-dialectal.

For example, Kaisse (1999) examined the patterning of the glottal fricative [h] in /s/-aspirating dialects of Spanish. The [h]-allophone typically occurs in word-final coda positions and the [s]-allophone otherwise occurs in onset environments. However, Kaisse notes that /s/-aspiration occurs in all pre-vocalic contexts in certain Caribbean dialects: this includes bleeding environments where pre-vocalic resyllabification of word-final /s/ would be predicted to block aspiration. The fact that aspiration is not blocked in these contexts suggests that /s/ consistently patterns as a coda in these varieties, which further implies that resyllabification may not be a feature of their phonology. Moreover, in other Caribbean varieties and Río Negro Argentinian Spanish, word-medial aspiration does not occur; however, aspiration is observed in word-final positions prevocally. This indicates that pre-vocalic /s/ behaves as an onset word-medially. Yet in phrasal contexts, word-final /s/ consistently aspirates regardless of whether the following word begins with a consonant or a vowel. This again provides evidence that word-final consonants are not always targets for resyllabification in all varieties of Spanish.

Similar results are presented by Robinson (2012) who shows that, on the basis of native-speaker judgements about syllable boundaries, allophonic realisations of /n/ and /s/—i.e. specifically word-final [ŋ] and intervocalic [z]—are always perceived as codas in Ecuadorian Spanish, regardless of whether they appear pre-vocally or not. This is in contrast to pre-vocalic [n], [s] and [l], which Ecuadorian speakers always judge as being onsets. Together these studies suggest that, whether supposedly resyllabified consonants pattern with canonical onsets or codas varies according to dialect and the phonetic identity of the sound. They are further indicative that resyllabification processes may indeed vary cross-dialectally.

The most in-depth study on the acoustics of consonants in resyllabification contexts comes from Strycharczuk & Kohlberger (2016) which examines the duration of /s/ in Peninsular Spanish. Results highlight that putative resyllabified onsets (i.e. *derived* onsets) are 11.84ms longer than word-final codas but 11.68ms shorter than canonical word-initial onsets. Furthermore, vowels preceding derived onset /s/ are 7.25ms shorter than those preceding canonical coda /s/. The authors consequently interpret these results as evidence that categorical resyllabification does not occur; but it is also arguably not the case that pre-vocalic consonants simply remain in coda position. Rather, Strycharczuk & Kohlberger suggest that ‘partial resyllabification’ occurs, with derived onsets falling between the two syllabic affiliations. Precisely what the nature of a partially resyllabified onset might be is not made fully explicit. However, Lipski (1991) proposes that in such cases, pre-vocalic codas may be ambisyllabic: i.e. word-final pre-vocalic consonants may simultaneously be affiliated to two linearly adjacent syllables.

Although the present study was not designed specifically to test theoretical predictions about the operation of resyllabification, our results clearly show that coda-induced vowel shortening occurs in AMS even in putative resyllabification environments: i.e. where consonant final words occur before vowel-initial words. The data therefore provide no positive evidence that vowels in putative resyllabification contexts are durationally distinct to those outwith these contexts, and therefore no positive evidence that complete and categorical resyllabification occurs in this variety (cf.

Ramsammy 2021). In addition, despite some attempts to demote the relevance of the syllable for phonological generalisations (e.g., Steriade 1999), the syllable as a phonological unit is crucial for the explanation of compression in AMS. Thus, whilst AMS may not be a resyllabifying dialect, the present results are still only explicable based on the assumption that CVC syllables are structurally different from CV syllables.

#### 4.2 *Rhythm and stress*

Debates concerning the classification of Spanish as a prototypical syllable-timed language are also relevant for our results. The key prediction of previous research in this area is that stressed and unstressed syllables respectively ought to display relatively uniform durations in syllable-timed languages. This contrasts to stress-timed languages where greater durational inconsistency is predicted between stressed and unstressed syllables (e.g., for English, see Abercrombie 1967; Pike 1945). However, our results reveal that AMS does not display a tight uniformity of vowel duration either across stressed or unstressed syllables. In fact, the compression effects we have discussed seem to align more closely with patterns expected of stress-timed languages (i.e. in which reduction in specific syllabic contexts is more commonly observed). Our results therefore bear upon the claim that a clear-cut dichotomy between syllable- and stress-timed languages may not exist. Indeed, a number of scholars have suggested that phonological rhythm is flexible and that individual languages exist along a rhythmic continuum. The position that languages occupy on the continuum thus predicts more or less 'syllable-timed' or 'stress-timed' tendencies (Dauer 1982; Pointon 1982).

For Romance, experimental results from Portuguese are particularly relevant here. Frota and Vigário (2001) examined rhythmic patterns comparatively in European Portuguese (EP) and Brazilian Portuguese (BP). Results based on measurements of vocalic and consonantal durational ratios showed that EP patterns with prototypically stressed-timed languages in displaying consistent vowel reduction. This means that vowels occupied a relatively small durational ratio in a given speech unit in comparison to consonants. By contrast, BP shows a more equal balance in vowel-to-consonant ratios and less extensive vowel reduction patterns. This prompts the authors to conclude that BP patterns more towards the syllable-timed end of the rhythmic continuum.

Outwith Romance, Ghazli, Hamdi & Barkat (2002) report that dialects of Arabic provide evidence for a rhythm continuum, and that these patterns may also reflect an East-West geographical distribution. Specifically, the more easterly the dialect, the more even the durational ratio between vowels and consonants. By contrast, the more westerly the dialect, the greater the relative imbalance of vowel and consonant durations. Thus, Ghazli, Hamdi & Barkat propose that easterly dialects exhibit syllable-timed tendencies and westerly dialects exhibit stress-timed tendencies.

Nevertheless, phonological rhythm and the use of timing metrics in quantifying it remains controversial. Arvaniti (2009, 2012) highlights that, despite partial success in classifying prototypical stress- and syllable-timed languages (e.g., English vs Spanish), metrics were often inaccurate for so-called 'unclassifiable' languages. Korean, for example, was classified as both syllable-timed and stress-timed depending upon the specific metric of reference. Indeed, Frota & Vigário's study on Portuguese also reveals some classificatory inconsistencies between metrics. In view of facts like these, Arvaniti concludes that the notion of rhythm should be reconsidered entirely, i.e. along the lines of proposals by Turk & Shattuck-Hufnagel (2013). Under this view,

rhythm should be seen as an abstract, psycholinguistic concept as opposed to a quantifiable and phonetically measurable one.

Our results, of course, do not resolve these issues; but they do point to the fact that we should perhaps expect Spanish dialects to differ quite considerably in terms of reductive tendencies. There is an apparent parallelism in the fact that AMS behaves in a way that neatly squares neither with assumptions of pan-dialectal resyllabification nor prototypical syllable timing. It is an open question whether these two facts are in any way correlated: i.e. whether Spanish dialects exhibiting more extreme reductive tendencies may also tend towards non-categorical syllabification.

However, a clearer takeaway from our findings is the connection between vowel compression and lexical stress. Cross-linguistically, it seems to be the case that all languages display differences between phonologically prominent and non-prominent structures. Yet the way in which this prominence is acoustically marked indeed varies from language to language (Gordon 2017). For example, with reference to Ibero-Romance, Ortega-Llebaria & Prieto (2010) showed that a drop in spectral tilt marked distinctions between stressed and unstressed vowels in Catalan, but not in Spanish. This is attributed to an interaction between well-studied patterns of phonological vowel reduction in Catalan and stress marking in the language. Similarly, Smith & Rathcke (2020) compared the marking of prominence in two varieties of English, namely Southern Standard British English (SSBE) and Glaswegian English (GE). The authors note that SSBE marks prominence on stressed vowels principally through manipulations of length and quality. GE, on the other hand, marks prominence through duration, pitch and intensity. Much like Ortega-Llebaria & Prieto's identification of phonological vowel reduction as being a factor of critical relevance for the marking of stress in Catalan, Smith & Rathcke relate the differences in stress marking between SSBE and GE to dialect-specific patterning of tense and lax vowels (i.e. as noted by Aitken 1981 for Scottish varieties of English).

These studies therefore further highlight that a range of phonological and phonetic behaviours may cluster together and impact vowel reduction and stress marking in an inter-related way. In light of the present results from AMS, it may be the case that the operation of vowel compression as a dialect-specific feature may have wider phonetic consequences that impact the ways in which prominence is acoustically signalled in this variety. We have noted connected patterns of durational clipping and vowel centralisation; yet the question of how these phenomena operate within the broader vowel system of the variety certainly merits further research. Our results therefore recommend a closer, dialect-focused approach to examining the potential mutual dependence of stress marking, vowel compression and syllabification across varieties of Spanish, as opposed to an approach that relies closely on assumptions that overstate the scope of pan-dialectal uniformities.

#### 4.3 *Limitations and future directions*

To close the discussion, we note here the limitations of this research. Most obviously, we acknowledge that this is a small-scale study utilising data from a very small sample of speakers, all of whom identify as female. As discussed, this has imposed limitations on some of the comparisons of relevance, for example, the lack of tokens of stressed /a/ in open-syllable contexts and analysis of coda type on vowel quality. Moreover, results concerning resyllabification effects are preliminary and would benefit from confirmation against a larger dataset and independent study. Additionally, the data

come from read speech. Existing research has shown that rhythmic variability can indeed be observed depending upon the experimental choice of data-elicitation method (Arvaniti 2009). There is therefore more work to be done to explore how compression effects in AMS, and the related phenomena, may vary stylistically.

Our analysis has relied on a number of phonological categorical factors. Although our results show effects of surrounding consonantal environment, there is clearly scope for more in-depth investigation into how coarticulatory environmental factors may impact vowel compression (for example, contextual devoicing has been shown to be relevant for UVR: see Dabkowski 2018; Delforge 2008, 2009). Relatedly, we wish to highlight that the operation of vowel compression in AMS may, at least in part, depend upon the fact that this is a variety that displays both /s/-retention and no final nasal velarisation. We therefore see advantages in comparing a variety like AMS to other dialects exhibiting different degrees of /s/-aspiration and sonorant lenition. Returning to a point already made, we take the view that these phenomena are potentially inter-connected and we see strong potential for exploring these dependencies further in future research.

## 5. Conclusion

This paper has presented the results of an exploratory study into vowel compression in AMS. Our results show that phonologically constrained, coda-induced compression occurs in AMS but correlates strongly with syllable structure and stress. Thus, unstressed vowels in closed syllables centralise and undergo shortening in CVC contexts. Onset complexity does not consistently produce significant amounts of compression for any vowel. Our key takeaway message is therefore that coda-driven vowel compression occurs in Spanish dialect-specifically; hence, the effects of compression may not be consistently observable in studies that pool data from multiple dialects (cf. Aldrich & Simonet 2019).

Nonetheless, gaps in the research remain, and the study reported here is limited by the small sample size and lack of comparisons to other, phonologically distinct varieties of Spanish. Despite this, our study is significant for several reasons. Firstly, it analyses the interaction of compression with stress, thus supporting the position that it is not sufficient to consider compression as solely correlating with syllable structure. Secondly, this is the first study to address gaps in the scholarship on UVR, showing that reduction and/or compression is constrained by syllable structure and that centralisation of unstressed vowels may exist independently of shortening. Lastly, this research focuses on an under-researched variety of Spanish. In doing so, it shows that dialect-specific phonetic-phonological interactions are sometimes overlooked in favour of pan-dialectal generalisation. We therefore highlight the importance of adopting a dialect-specific approach to analysing vowel compression and its connection to other phonological and phonetic phenomena, including resyllabification, phonological rhythm and the acoustics of lexical stress.

## Acknowledgements

We gratefully acknowledge input from Sophie Holmes-Elliott in the early stages of this research. We wish to thank the anonymous reviewers and attendees at LSRL51

who provided feedback on previous versions of this work. We have also benefitted from useful discussions with colleagues at the University of Edinburgh and at the Manchester Phonology Meeting. Any remaining errors are our own.

## References

- Abercrombie, David. 1967. Elements of General Phonetics. *Journal of Linguistics* 5(1): 153–164.
- Aitken, Adam J. 1981. The Scottish Vowel-Length Rule In M. Benskin & M.S. Samules (eds.). *So meny People Longages and Tonges*, 131–157. Edinburgh: University of Edinburgh.
- Aldrich, Alexander C., & Miquel Simonet. 2019. Duration of syllable nuclei in Spanish. *Studies in Hispanic and Lusophone Linguistics* 12(2): 247–280.
- Antonetti, Pierre, & Mario Rossi. 1970. *Préci de phonétique italienne: Synchronie et diachronie*. Aix-en-Procence: La Pensée Universitaire.
- Arvaniti, Amalia. 2009. Rhythm, Timing and the Timing of Rhythm. *Phonetica* 66: 46–63.
- Arvaniti, Amalia. 2012. The usefulness of metrics in the quantification of speech rhythm. *Journal of Phonetics* 40: 351–373.
- Audacity Team. 2017. *Audacity(R): Free Audio Editor and Recorder* [Computer program] Version 2.2.1.
- Bermúdez-Otero, Ricardo. 2010. Cyclicity. In M. van Oostendrop, C. Ewen, E. Hume & K. Rice (eds.), *The Blackwell companion to phonology*, 2019–2048. Malden, MA: Wiley-Blackwell
- Boersma, Paul, & David Weenik. 2021. *Praat: doing phonetics by computer* [Computer program]. Version 6.1.50.
- Boyd-Bowman, Peter. 1952. La pérdida de vocales átonas en la altiplanice Mexicana, *Nueva Revista de la Filología Hispánica* 6: 138–140.
- Canellada de Zamora, María Josefa, & Alonso Zamora Vicente. 1960. Vocales Caducas en el Español Mexicano, *Nueva Revista de la Filología Hispánica* 14: 221–241.
- Colina, Sonia. 1997. Identity constraints and Spanish resyllabification. *Lingua* 103: 1–23.
- Dabkowski, Meghan Frances. 2018. *Variable Vowel Reduction in Mexico City Spanish*, Ph.D. Thesis, Ohio State University.

- 
- Dauer, R.M. 1983. Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics* 11: 51–62.
- De Decker, Paul, & Valerie Freeman. 2021. Remote sociophonetic data collection: Vowels and nasalization over video conferencing apps. *Journal of the Acoustical Society of America* 149: 1211–1223.
- Delforge, Ann Marie. 2008. Unstressed Vowel Reduction in Andean Spanish. In L. Calantoni & J. Steele (eds.), *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*, 107–124.
- Delforge, Ann Marie. 2009. *The Rise and Fall of Unstressed Vowel Reduction in the Spanish of Cusco, Peru: A Sociophonetic Study*. Ph.D. thesis, University of California.
- Face, Timothy L. 1999. Re-examining Spanish ‘Resyllabification’. In T. Satterfield, C. Tortora & D. Cresti (eds.) *Current issues in Romance languages: Selected papers from the 29th Linguistic Symposium on Romance Languages (LSRL)*, 81–94. Amsterdam, Philadelphia: John Benjamins
- Farnetani, Edda, & Shiro Kori. 1986. Effects of syllable and word structure on segmental durations in spoken Italian. *Speech Communication* 5: 17–34.
- Frota, Sonia, & Marina Vigário. 2001. On the correlates of rhythmic distinctions: The European/Brazilian Portuguese case. *Probus* 13: 247–275.
- Ghai, Ved K. 1980. Contributions to Dogri phonetics and phonology. *Annual report of the Institute of Phonetics* 14: 31–94.
- Ghazli, Salem, Hamdi, Rym, & Melissa Barkat. 2002. Speech Rhythm Variation in Arabic Dialects. In B. Bel (ed.) *1st International Conference on Speech Prosody 2002*, 331–334. Aix-en-Provence: Université de Provence.
- Gordon, Matthew K., & Timo B. Roettger. 2017. Acoustic correlates of word stress: A cross-linguistic study. *Linguistics Vanguard* 3(1): 1–11.
- Han, Mieko S. 1964. *Studies in the phonology of Asian languages 2: Duration of Korean vowels*. Los Angeles: University of Southern California.
- Kaisse, Ellen M. 1999. Resyllabification Precedes all Segmental Rules: Evidence from Argentinian Spanish. In J.-M. Authier, B. E. Bullock & L. A. Reed (eds.) *Formal perspectives on Romance Languages (LSRL XVIII)*, 197–210. Amsterdam, Philadelphia: John Benjamins.
- Katz, Jonah. 2012. Compression Effects in English. *Journal of Phonetics* 40: 390–402.



- 
- Lipski, John. 1990. Aspects of Ecuadorian Vowel Reduction. *Hispanic Linguistics* 4: 1–19.
- Lipski, John. 1991. The Many Faces of Spanish /s/-Weakening: (Re)alignment and Ambisyllabicity. In J. Gutiérrez-Rexach & F. Martínez-Gil (ed.), *Advances in Hispanic Linguistics*, 198 – 213. Somerville, MA: Cascadilla Press.
- Lope Blanch, Juan M. 1967. En torno a las vocales caedizas del español mexicano. *Nueva Revista de la Filología Hispánica* 17: 1–19.
- Maddieson, Ian. 1985. Phonetic Cues for Syllabification. In V. A. Fromkin (ed.), *Phonetic Linguistics: Essays in honor of Peter Ladefoged*. 203–221. New York, NY: Academic Press.
- McAuliffe, Michael, Socolof, Michaela, Mihuc, Sarah, Wagner, Michael, & Morgan Sonderegger. 2017. Montreal Forced Aligner: Trainable Text-Speech Alignment Using Kaldi. *Proc. Interspeech*, 498–502.
- Melgar-Martínez, Antonia. 1994. El vocalismo del andaluz oriental. *Estudios de fonética experimental* 6: 11–64.
- Munhall, Kevin, Fowler, Carol, Hawkins, Sarah & Elliot Saltzman. 1992. “Compensatory shortening” in monosyllables of spoken English. *Journal of Phonetics* 20: 225–239.
- Myers, Scott. 1987. Vowel Shortening in English. *Natural Language & Linguistic Theory* 5(4): 485–518.
- Ortega-Llebaria, Marta. 2006. Phonetic Cues to Stress and Accent in Spanish. In M. Díaz-Campos (ed.) *Selected Proceedings of the 2nd Conference on Laboratory Approaches to Spanish Phonetics and Phonology*, 104–118. Somerville, MA: Cascadilla Proceedings Project.
- Ortega-Llebaria, Marta, & Pilar Prieto. 2010. Acoustic Correlates of Stress in Central Catalan and Castilian Spanish. *Language and Speech* 54(1): 73–97.
- Peters, Sandra, & Felicitas Kleber. 2014. Articulatory mechanisms underlying incremental compensatory vowel shortening in German. *Institute of Phonetics and Speech Processing, Ludwig-Maximilians-University, Munich: Germany*. [https://www.phonetik.uni-muenchen.de/personen/mitarbeiter/kleber\\_felicitas/publikationen/peters\\_kleber14\\_issp.pdf](https://www.phonetik.uni-muenchen.de/personen/mitarbeiter/kleber_felicitas/publikationen/peters_kleber14_issp.pdf)
- Pike, Kenneth L. 1945. *The Intonation of American English*. Ann Arbor: University of Michigan Press.
- Pointon, Graham E. 1980. Is Spanish really syllable-timed? *Journal of Phonetics* 8(3): 293–304.

- 
- R Core Team. 2020. R: A Language and environment for statistical computing [Computer program].
- Ramsammy, Michael. 2013. Word-final nasal velarisation in Spanish. *Journal of Linguistics* 49: 215–255.
- Ramsammy, Michael. 2021. Contextual reduction of word-final /l/ in Spanish: an EPG study. *Journal of the International Phonetic Association*, FirstView online: 1–28. DOI: <https://doi.org/10.1017/S0025100321000128>.
- Robinson, Kimball. 2012. The dialectology of syllabification: A review of variation in the Ecuadorian Highlands. *Romance Philology* 66: 115–145.
- Rojo, Guillermo. 1991. Frecuencia de fonemas en español actual. In M. Brea & F. Fernández Rei (ed.), *Homenaje ó Profesor Constantino García*, 451–467. Santiago de Compostela: Universidad de Santiago de Compostela.
- Schmitz, Dominic, Niemann, Henrik, & Hae-Eun Cho. 2018. Vowel shortening in German as a function of syllable structure. *Conference on Phonetics & Phonology in German-speaking countries (P&P13, Berlin)*.
- Schuh, Russell G. 1978. Bade/Ngizim vowels and syllable structure. *Studies in African Linguistics* 9: 247–274.
- Shattuck-Hufnagel, Stephanie & Alice Turk. 2013. What is speech rhythm? A commentary inspired by Arvaniti & Rodriquez, Krivokapi, and Goswami & Leong. *Laboratory Phonology* 4(1): 93–118.
- Smith, Rachel H. & Tamara V. Rathcke. 2020. Dialectal phonology constrains the phonetics of prominence. *Journal of Phonetics* 78: 1–17.
- Steriade, Donca. 1999. Alternatives to syllable-based accounts of consonantal phonotactics. In O. Fujimura, B. Joseph, and B. Palek (eds), *Proceedings of the 1998 Linguistics and Phonetics Conference*, 205–242. Prague: Karolinum Press.
- Strycharczuk, Patrycja & Martin Kohlberger. 2016. Resyllabification Reconsidered: On the Durational Properties Word-final /s/ in Spanish. *Laboratory Phonology* 7(1): 1–24.
- Turk, Alice, Nakai, Satsuki, & Mariko Suagahara. 2006. Acoustic Segment Duration in Prosodic Research: A Practical Guide. In S. Sudhoff, D. Lenertova, R. Meyer, S. Pappert, P. Augurzy, I. Mleinek, N. Richter & J. Schließer (eds.). *Methods in Empirical Prosody Research*, 1–28. Berlin: Mouton De Gruyter.
- Wiik, Kaj. 1965. *Finnish and English vowels*. Turku: University of Turku.

## 6. Appendices

### 6.1 Reading passage

Una vez José y sus amigos visitaron la feria del alfreñique. Todos jugaron para el equipo escolar de fútbol y José fue el ariete. Era el mejor, aunque era humilde. Después de la feria, eligieron pasar por el campo. Sus padres les prepararon comida para llevar, incluyó arroz, merengues, crepas dulces y galletas para el postre. Una vez que habían checado que habían abrochado correctamente las tapas de los tupperes, comenzaron a ir en la dirección de los bosques, el lago y las cascadas. Los acompañaron algunos chavos de la escuela mientras que hablaban de todos tipos de cosas: los escapes valientes de los personajes de ficción y sus ataques contra villanos, las pruebas pasadas en clase, sobre todo el hecho de que el maestro había incluido una pega, el rumor de que dos de los chicos estaban encaprichados con la misma chava, y los precios baratos de los dulces en Mercado Morelos. Siguieron las curvas del sendero construido desde hace décadas, escuchando los sonidos creados cuando las patas de las aves pegaban el suelo frío. También miraban las rocas, sobre toda la capa, notaron que en las montañas ya había nieve. Todos gritaron y se volvieron hacia ellos sus ecos, reflejándose las paredes de los enclaves. A un lado, no muy lejos de ellos, había un albergue, quizás fue una finca. Enfrente había una gata, estaba cazando un ratón que se escondió debajo de una colección de monumentos, calculando su escape. El tema de discusión había avanzado a los horóscopos, como obtener la paz mundial y la leyenda de los mengues que vivían en las montañas. José comenzó hablar con su amigo de los códigos de fútbol, intentando evitar asuntos negativos.

Pasó un momento, de repente se encontraron enfrente de un hueco. Se dieron cuenta de que se bloqueó el camino y se volvieron secas sus bocas. Alguien empujó a José al frente del grupo con una coz. Mirando por enfrente y, con toda la fuerza del cuerpo, saltó por encima del hueco.

Por fin, llegaron al lago. Pequeños golpes de agua tocaron a José en la cabeza mientras que comía una nuez que había recolectado de un árbol en el camino. Cuando el sol comenzó a ponerse, sabían que tenían que regresar a sus pueblos y ciudades. Después de los saludos cordiales, a pesar del frío, José se sintió caliente y positivo. Llegó a su hogar y pudo oír a los residentes del barrio hablando. Se quitó los botes en la entrada. Entró y olió tacos de albóndigas, su favorito.

*6.2 Tokens***Table 4.** Number of tokens per speaker

<b>Speakers</b>	<b>Tokens (initial number)</b>	<b>Tokens (after trimming)</b>
<b>S1</b>	190	184
<b>S2</b>	209	208
<b>S3</b>	204	204
<b>S4</b>	203	198
<b>S5</b>	206	203
<b>S6</b>	208	200
<b>Total</b>	1220	1197