



# The production of Estonian quantity degrees by Spanish L1 speakers

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## Abstract

This paper analyses the production of Estonian quantity degrees by Spanish learners. Estonian has an intricate three-way quantity system that combines durational and tonal features. It has been shown to be challenging for Estonian L2 learners to master this system and in particular the distinction between the long (Q2) and overlong (Q3) quantity degrees.

This study is based on data from 22 native speakers of Spanish who participated in a reading task. The reading task consisted of 81 sentences including CV(:)CV structured test words. The analysis focused on vowel duration, syllable ratios and F0. The effect of length of residence was taken into account while interpreting the results.

The results show that Spanish L1 speakers have two rather than three categories. Most striking in their production is the overlap of Q2 and Q3 degrees. The results of this study support previous findings of Estonian L2 production and are in line with the Feature Hypothesis which suggests that contrasts that are not present in L1 are difficult to produce in L2.

**Index Terms:** quantity, production, L2, Estonian, Spanish

## 1. Introduction

This paper focuses on the production of Estonian quantity degrees by native speakers of Spanish. Unlike Spanish, Estonian is a quantity language. The complex three-way quantity system of Estonian combines both durational and tonal features, while in Spanish there is no phonological length opposition [1], [2].

As numerous studies have shown, the Estonian three-way quantity system consists of short (Q1), long (Q2) and overlong (Q3) quantity degrees which operate over a disyllabic sequence. The quantity contrast is carried by the vowel of the stressed syllable or by the intervocalic consonant [3]–[11]. This paper focuses on words where the contrast is based on the duration of vowels, e.g. *sada* Q1 [sata], *saada* Q2 [sa:ta], *saada* Q3 [sa::ta] (for the translation and gloss see Table 1).

The Estonian quantity system can be characterised by syllable ratios. Due to foot isochrony the duration of stressed syllable vowel increases with quantity degree and the duration of unstressed syllable decreases. Both changes contribute to establishing the difference in the ratio between the syllables. The syllable ratio in Q1 is 2/3, in Q2 3/2 and in Q3 2/1 [4] (for a more detailed overview see Table 4.1 in [12]).

In addition to temporal differences the pitch is a decisive factor in distinguishing between Q2 and Q3. In general, Q2 and Q3 have similar temporal patterns, but in Q3 words the F0 starts to fall early during the first syllable, while in Q1 and Q2, the fall takes place between the end of the first syllable nucleus and the beginning of the second syllable [3], [7], [10].

The majority of L2 acquisition theories (e.g. Speech Learning Model [13], Perceptual Assimilation Model [14]) explain the difficulties in acquiring L2 speech sounds assuming that perception precedes production. The Feature Hypothesis [15] (first implied in [13]), on the other hand, focuses on the acquisition of phonological contrasts and suggests that “L2 features not used to signal phonological contrast in L1 will be difficult to perceive for the L2 learner and this difficulty will be reflected in the learner’s production of the contrast based on this feature” (p 230). A Swedish quantity distinction study with Spanish, English and Estonian speakers was conducted to test the Feature Hypothesis. The results confirmed the hypothesis, as the Estonian L1 speakers’ performance was similar to that of the Swedish speakers while the Spanish and English speakers differed from the Swedish speakers. Thus, it was concluded that the participants’ L1 interferes with the acquisition of L2 and the success depends on the role of duration in L1 [15].

Few studies have focused on the production of Estonian quantity degrees by non-native speakers. Most of the L2 studies have described the L2 speakers’ production based on the temporal patterns. The results show that Russian L1 speakers cannot distinguish Q2 from Q3, and produce Q2 and Q3 with a similar duration which is closer to the Estonian Q2 temporal patterns. Finnish L1 speakers were also unable to distinguish Q2 from Q3, but in their production the temporal patterns were more similar to the Estonian Q3 [16]. Also, the Latvian L1 speakers failed to produce the distinction between Q2 and Q3 and produced a rather similar temporal pattern to the Estonian Q3 [17]. A similar tendency can be seen in the case of Japanese L1 speakers who were unable to produce the vocalic quantity distinction between Q2 and Q3, and instead produced a temporal pattern in-between Estonian Q2 and Q3 [18]. It seems to be challenging for Estonian L2 speakers to master the Estonian quantity system, especially the distinction between vocalic Q2 and Q3.

As in case of vocalic quantity contrast the Q2 and Q3 words are not distinguished orthographically (e.g. *saada* Q2 [sa:ta] and *saada* Q3 [sa::ta]) the effect of orthography on the Q2 and Q3 production has been studied. The results show that L2 speakers do not distinguish between the vocalic Q2 and Q3 temporal patterns while in words where the orthography indicates the quantity the distinction is also made in the temporal patterns. However, Russian L1 and Japanese L1 speakers were capable of distinguishing Q2 and Q3 also in consonantal quantity contrast where orthography did not indicate the quantity while Finnish L1 speakers did not make this distinction [18], [19].

Previous studies have to some extent taken into account the L2 speakers’ language background. The age of acquisition [19] and L2 use [17] have shown to have a positive effect on the quantity production. In this paper, in addition to temporal patterns the pitch contours are analysed and the participants’ length of residence (LOR) is taken into account.

Based on previous findings [16]–[19] it is expected that Spanish L1 speakers are unable to produce the temporal patterns and pitch contours characteristic of Q2 and Q3. The length of residence is expected to have a positive effect on the production.

## 2. Materials and method

### 2.1. Materials

In order to test the production of Estonian quantity degrees by Spanish learners a reading task was constructed. The task consisted of sentences that each contained a CV(:)CV structured test word. There were in total 81 sentences (9 vowels x 3 quantity degrees x 3 test words for each category); all test words formed triplets of vowel and quantity (see Table 1 for examples).

Table 1: *An example of the sentences presented to the participants in the reading task.*

Test word	Sentence
<i>sada</i> [sata] ‘hundred’ nom	<i>Mehel on sada eurot.</i> ‘The man has a hundred euros’
<i>saada</i> [sa:ta] ‘to send’ 2sg, imp	<i>Palun saada talle sõnum.</i> ‘Please send him/her a message’
<i>saada</i> [sa::ta] ‘to become’ inf	<i>Tüdruk tahab saada politseinikuks.</i> ‘The girl wants to become a police officer’

### 2.2. Participants

The participants were 22 native speakers of Spanish (11 males, 11 females) from different Spanish-speaking countries (Spain (11), Colombia (5), Mexico (4), Honduras (2)). The participants were between 20 and 46 years old (mean 30.45). Due to the relatively small number of Spanish learners of Estonian in Tartu it was impossible to control for the participants’ country of origin, length of residence and language background. These factors have been considered in the analysis and have shown to have little or no effect at all (for more details see the Results section).

All the participants were exposed to Estonian, but they differed in the length of residence (mean 3.2 years, max 16 years, min 1 month) and duration of studies (mean 1.9 years, max 16 years, min 1 month). All the participants conducted a self-reported questionnaire about their study of Estonian. Some of the participants had participated or were participating in Estonian classes and some participants had studied Estonian individually. Most of the participants reported not using Estonian in their daily activities.

As a control group 10 native speakers of Estonian (5 males, 5 females) were recorded. The Estonian speakers were between 23 and 55 years old (mean 29.5) and spoke standard Estonian. None of the participants reported hearing or speech problems.

### 2.3. Procedure

The reading task was conducted with SpeechRecorder software [20] in the soundproof recording-booth at the University of Tartu. All participants were instructed to read sentences from a computer screen, the sentences were presented in a random order and all participants read the same sentences.

The reading task was part of a larger experiment that included several perception tasks and a picture description task. The results of the vowel production are reported in [21] and the perception of quantity in [22].

### 2.4. Data analysis

The duration of stressed (V1) and unstressed (V2) syllable vowels was measured and syllable ratios (V1/V2) were calculated. The fundamental frequency (F0) was measured from 50 equidistant points over the test word and the F0 contour was smoothed and interpolated using Praat [23]. Only test words with H\*+L intonation pattern were included in the analysis. For instance, all instances of rises were excluded as it has been shown that there are no quantity-dependent tonal differences in the case of rising intonation [24]. In total 1001 tokens were analysed (511 tokens produced by Spanish L1 speakers, 490 by Estonian L1 speakers). A linear mixed-effects model was fitted in R [25] using the lme4 package [26] to evaluate the effect of L1, quantity degree and LOR on the acoustic features of quantity (V1 and V2 duration, V1/V2 ratio, F0 turning point). The test word and subject were added as random intercepts and the intercept of the models corresponds to Spanish L1 and Q2.

## 3. Results

### 3.1. Vowel duration and syllable ratio

The Spanish L1 speakers produce all Estonian vowels with a longer duration compared to native speakers (see Figure 1). The Spanish L1 speakers’ Q2 and Q3 vowels have a similar duration while in Estonian L1 speakers’ production, Q2 and Q3 differ clearly in duration: the mean values for the Spanish L1 group are 190 and 201 ms vs. 134 and 158 ms in the Estonian group.

All the unstressed syllable vowels produced by Spanish L1 speakers have a similar duration (mean values: Q1 109 ms, Q2 110 ms, Q3 116 ms), while in Estonian L1 production the duration of the unstressed vowel shortens with the quantity (mean values: Q1 97 ms, Q2 76 ms, Q3 56 ms).

V1/V2 ratio was calculated for each quantity (see Table 2). The speaker’s L1 and the quantity degree were both statistically significant factors.

Table 2: *V1/V2 mean ratios grouped by L1 and quantity.*

	Estonian L1	Spanish L1
<b>Q1</b>	0.8	1.14
<b>Q2</b>	1.86	1.94
<b>Q3</b>	3.07	1.99

According to the linear mixed-effects model the Spanish L1 speakers’ Q1 ratio differs significantly from Q2 ( $\beta = -0.8$ ,  $t = -7.18$ ,  $p < 0.001$ ), but the difference between Q2 and Q3 ratios is not significant. The interaction of L1 and quantity is also significant: the V1/V2 ratios of Q1 ( $\beta = -0.24$ ,  $t = -2.2$ ,  $p < 0.05$ ) and Q3 ( $\beta = 1.17$ ,  $t = 11.03$ ,  $p < 0.001$ ) of Spanish L1 speakers differ significantly from those of the Estonian L1 group. In case of Q2 the difference between L2 and L1 speakers is not significant. The Q2 and Q3 produced by the Spanish L1 speakers are similar to the Q2 as produced by the Estonian speakers.

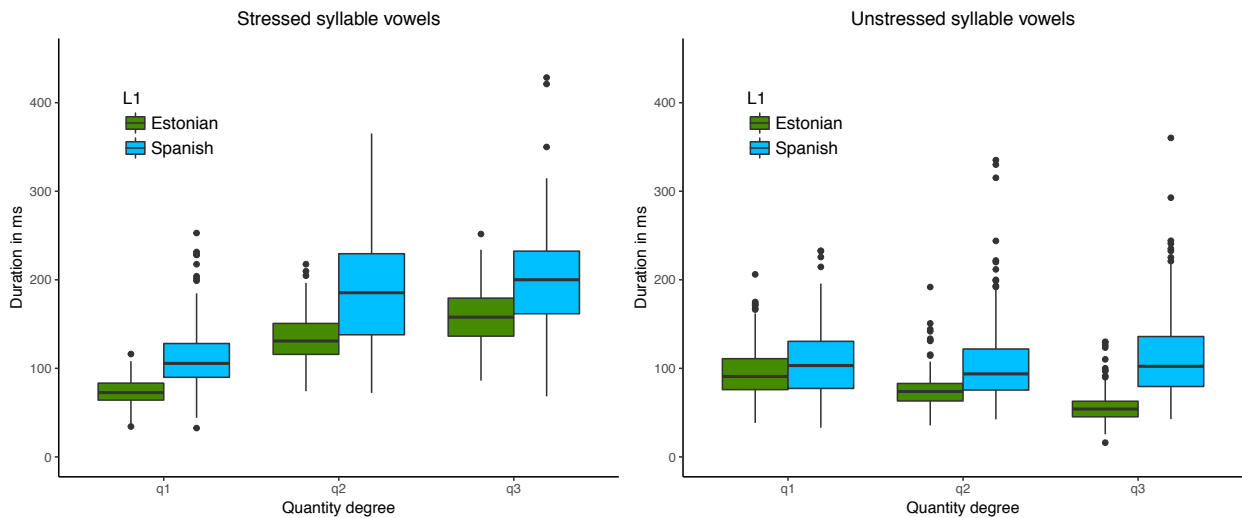


Figure 1: The duration of stressed and unstressed syllable vowels in ms by quantity degrees and L1.

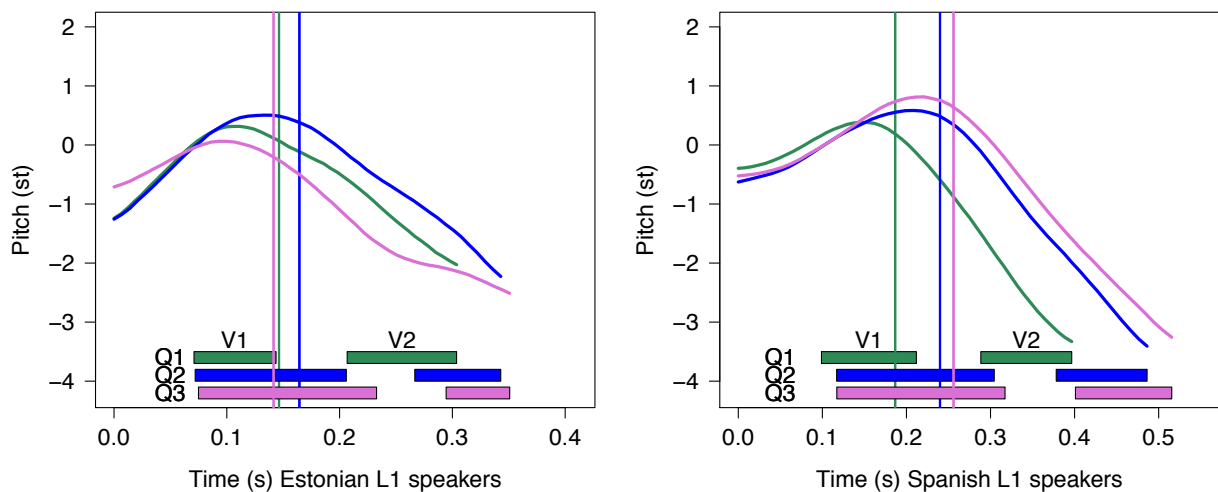


Figure 2: F0 contours annotated over 50 points of the test word in semitones and the duration of stressed (V1) and unstressed (V2) syllable vowels in seconds by quantity degrees (green – Q1, blue – Q2, violet – Q3). Vertical lines mark the F0 turning point (TP); the colour of the line indicates the quantity degree.

The participants' length of residence (LOR) was tested in order to analyse the effect of language experience on L2 production. LOR does not have an effect on V1 duration, but the effect on V2 duration is statistically significant ( $\beta = -0.0004$ ,  $t = -3.04$ ,  $p < 0.01$ ): the participants who have lived in Estonia for a longer period produce shorter V2 vowels. In case of V2 duration the interaction of LOR and Q1 is significant ( $\beta = 0.0003$ ,  $t = -2.38$ ,  $p < 0.05$ ). In case of V1/V2 ratios LOR as a main factor is statistically not significant; however, the interaction on Q1 and LOR is significant ( $\beta = -0.08$ ,  $t = -3.77$ ,  $p < 0.001$ ).

### 3.2. Fundamental frequency

As discussed above, in addition to vowel duration the F0 is an important feature in distinguishing Q2 from Q3. The F0 values were annotated from 50 points over the test word and a turning

point (TP) was calculated for each quantity to compare the F0 contours. The F0 TP was defined as the time from the beginning of V1 to the point after F0 maximum where the F0 was 5% lower than the F0 range in each word.

The F0 contours produced by Spanish L1 and Estonian L1 speakers are presented in Figure 2. The F0 TP in the data of Spanish L1 participants differs significantly from that of the Estonian L1 speakers in all quantity degrees ( $\beta = -0.08$ ,  $t = -4.28$ ,  $p < 0.001$ ). In Spanish L1 production, the F0 contours of Q2 and Q3 words are overlapping, and the TP occurs in the middle of the stressed syllable vowel or later. The difference between the TP in Q2 and Q3 is not statistically significant. In Estonian L1 production, there is a clear difference: in Q3 words the F0 starts to fall in the first part of the stressed syllable vowel and in Q2 the fall takes place later.

Interestingly, the participants' LOR has a statistically significant effect on the TP ( $\beta = -0.0009$ ,  $t = -3.72$ ,  $p < 0.01$ ): the longer the participants' LOR the earlier the TP.

#### 4. Discussion

Previous studies [16]–[19] have shown that the Estonian quantity system poses a challenge for the L2 learners of Estonian regardless of their mother tongue, and especially difficult is the distinction between the vocalic Q2 and Q3. In line with these findings, the results of the current study show that the Spanish L1 speakers have developed two categories of vowel length in their production of Estonian: short and long. In the native Estonian production, V1 and V2 durations differ in the three quantity degrees: V1 is the shortest in Q1 and the longest in Q3, and V2 is the longest in Q1 and the shortest in Q3. Spanish L1 speakers do not produce such temporal patterns; in their Estonian production V1 duration in Q2 and Q3 is almost identical and V2 duration is not affected by the quantity degree. Additionally, all the segments produced by Spanish L1 speakers have longer durations. Similar patterns in L2 production have been found in previous studies as well.

The Estonian quantity system is characterised by the stressed and unstressed syllable durations, and the syllable ratios. As in Spanish L1 production of Estonian, the duration of V1 is binary (short vs. long) and the duration V2 does not change over the quantity degrees, the Spanish L1 speakers' V1/V2 ratios differ significantly from those of the L1 speakers. In Q1 produced by the Spanish L1 speakers the ratio is greater, in Q2 the ratio is similar, and in Q3 the ratio is smaller. The Q2 and Q3 ratios in Spanish learners' speech are close to the Q2 ratio in Estonian L1, which has also been shown in earlier studies, e.g. Russian L1 [16] speakers were found to produce Q2 and Q3 ratios similar to Q2 temporal patterns, and Japanese L1 speakers [18] produced a pattern that was in-between Q2 and Q3.

The F0 is a secondary cue distinguishing Q2 from Q3: in the case of Q3 the F0 TP takes place earlier than in Q2. In Estonian L2 quantity production studies, F0 has not been studied before. The present results show that in Spanish L1 production of Estonian, the Q2 and Q3 F0 contours and TPs are almost overlapping while in Estonian L1 production in Q3 the F0 starts to fall early in V1. It seems that Spanish L1 speakers do not use F0 to distinguish Q2 from Q3, although LOR has a statistically significant effect on TP.

In general, LOR does not seem to affect the results and the effect of LOR is limited. LOR influences V2 duration and F0 TP but does not have an effect on V1 duration and V1/V2 ratios. In this study the participants' LOR varied from 1 month to 16 years, while most of the participants have studied Estonian from 6 months to 3 years. This means that there were very few participants with long LOR (e.g. one speaker had lived in Estonia for 10 years and another for 16 years) and distribution of LOR is therefore rather skewed, not capturing the higher end of the scale with many data points. Due to the limited number Spanish L1 learners of Estonian it was impossible to control the participants' LOR.

This paper focused on the production of vocalic quantity contrasts which might be problematic for L2 speakers due to the orthography: the Q2 and Q3 vocalic contrasts are written identically (e.g. *saada* Q2 [sa:ta] and *saada* Q3 [sa::ta]). In order to know how to pronounce the vocalic Q2 or Q3 word the speaker needs to know the meaning of the word and understand

the whole context. All this requires high proficiency considering that the quantity indicates grammatical information such as genitive, partitive or illative case (e.g. *kooli kõrval* Q2 GEN 'next to school', *vaatab kooli* Q3 PART 'he/she looks at school', *läheb kooli* Q3 ILL 'he/she goes to school').

The Speech Learning Model [13] and the Perceptual Assimilation Model [14] suggest that in the L2 acquisition process perception precedes production. A quantity perception study [22] conducted with the same participants showed that Spanish L1 speakers cannot distinguish Q2 from Q3 perceptually. A previous L2 perception study [27] has shown that L2 learners in general tend to find it hard to distinguish between Q2 and Q3.

The results of this study confirm the Feature Hypothesis [15] which suggests that the acquisition of an L2 feature depends on the similarity of L1 and L2. As Spanish does not have a phonological length opposition the acquisition of the intricacies of the Estonian vocalic quantity is a challenge for Spanish learners of Estonian.

#### 5. Conclusions

This paper studied the production of Estonian quantity degrees by Spanish L1 speakers. The results show that Spanish L1 speakers have developed two categories (short and long) instead of three (short, long and overlong). The Spanish L1 speakers do not distinguish between Q2 and Q3: in their production the Q2 and Q3 vowels have similar durations, V1/V2 ratios, F0 contours and TPs. In other words, Spanish L1 speakers do not use vowel duration and F0 to differentiate the Estonian Q2 from Q3. Participants' LOR had a positive effect on V2 durations and TPs.

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#### 7. References

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