# Who's motivated to trill?
## A sociolinguistic study on the acquisition of Spanish trills in heterosyllabic sequences

*Santiago Arróniz and Mackenzie Coulter-Kern*

**Indiana University**

**Abstract**

This study aims to investigate the acquisition of trills in heterosyllabic sequences by speakers of Spanish as a second language (L2) and heritage speakers. To this end, we presented participants with three oral production tasks designed to elicit instances of trills, accompanied by a motivation questionnaire and a background questionnaire. The results obtained by means of acoustic analysis of the productions together with the answers to the motivation questionnaire show clear acquisitional patterns in L2 learners of Spanish at varying levels of proficiency, as well as variation in native speakers' production of the trill in heterosyllabic sequences. This paper also raises some pedagogical implications, pointing out that instructors should more explicitly teach and illustrate examples of trills in heterosyllabic sequences at all levels, since this phenomenon is neither orthographically salient nor frequent in speech.

## 1. Introduction

Our study investigates the acquisition and production of trills in heterosyllabic sequences (e.g., *honrar* 'to honor') in Spanish by advanced and intermediate Spanish learners (i.e., graduate and undergraduate students, respectively), heritage speakers (HSs), and native speakers (NSs). The present study employs a variationist approach to investigate the social and individual factors that may affect the acquisition of the trill in heterosyllabic sequences, a cluster which has been

described in previous studies simply as a trill, even though it is not orthographically written with two <r>'s, as in *carro* 'car'. We analyzed learners' and NSs' production of Spanish trills using both formal (i.e., monitored) and informal (i.e., less monitored, more spontaneous) production tasks. We investigated learners' motivation using the framework and the operationalizations of Ought-to self and L2 context used by Dörnyei and Ushioda (2009). Our study investigates the impact of social and individual factors, such as L2-context-oriented motivation (e.g., motivation to be part of a Spanish speaking community or the speakers of a specific Spanish speaking context) vs. Ought-to-self-oriented motivation (i.e., motivation to speak Spanish for class/work purposes or because one feels they ought to be able to), as well as social variables (e.g., time spent abroad) on the acquisition of the trill in heterosyllabic sequences.

## 2. Previous Literature

### 2.1 Trills in Spanish

Previous studies that have investigated trills in Spanish have looked at acoustic characteristics and dialectal variation of rhotics (Hualde, 2013). The Spanish phonetic system has two rhotic phonemes, a rhotic with one occlusion or tap (e.g., *pero* 'but'), and a rhotic with two or more occlusions or trill (e.g., *perro* 'dog') (Hualde, 2013). Both are normally voiced and alveolar, but alternative productions are attested in different dialects. The trill is not just a succession of taps but requires a more precise articulatory gesture involving the coarticulation of these segments (Recasens, 1991; Racasens y Pallarè, 1999). Trills and taps phonemically contrast only in intervocalic position and within a word: this is where we find minimal pairs such as *perro* vs. *pero*. Outside of the intervocalic context, however, there is no phonemic contrast between the two sounds. The trill can be found either in word-initial position or after a heterosyllabic consonant. On the contrary, the tap is only possible in consonant groups in onset position (Hualde, 2013).

Heterosyllabic sequences consist of two consonants that belong to two different syllables as in *alrededor* (***al-re***-*de-dor*) 'around', as opposed to tautosyllabic sequences in which both consonants belong to the same syllable, as in *broma* (***bro***-*ma*) 'joke'. There are only three heterosyllabic contexts in Spanish, namely, consonant clusters /lr/ (e.g., ***al-re***-*de-dor*), /nr/ (e.g., ***en-re***-*do*), and /sr/ (e.g., ***Is-ra***-*el*). Of the three clusters, /lr/ and /nr/ are reduced less often than /sr/ (Solè, 2002). The /sr/ cluster tends to be elided and the rhotic in this context is sometimes produced as an approximant, as in Costa Rican Spanish (Blecua, 2001; Hammond, 1999). This approximant has been described as similar to English rhotic /ɹ/ (Hualde, 2013). In addition, depending on the dialect, the /sr/ cluster may be pronounced as a sibilant, as it happens in the Spanish varieties spoken in Central Mexico, Guatemala, Costa Rica, Paraguay, and northern Argentina (Moreno de Alba, 1994). The Spanish rhotic system clearly contrasts with the English one (Alwan et al., 1997; Ladefoged & Maddieson, 1996), where rhotics are typically associated with retroflex articulation (e.g., 'red' [ɻɛd]) or bunched articulation (e.g., 'red' [ɪ̈ɛd]). Since there is no change in meaning between retroflex and bunched rhotics, L1 English speakers assign different articulations to the same category (Olsen, 2012).

## 2.2. The role of motivation in L2 Acquisition of trills

Two studies have investigated the role of motivation in L2 acquisition of trills: Reeder (1998) in Spanish, and Nance et al. (2016) in Gaelic. In general, they found that motivation affects acquisition of trills and/or accentedness in the L2. Reeder (1998) investigated the acquisition of the trill in learners of L2 Spanish at four different proficiency levels and attempted to acoustically define learners' path of acquisition. Nance et al. (2016) investigated the acquisition of rhotics among adult learners of L2 Gaelic from a sociocultural perspective similar to the present study. They also employed Dörnyei and Ushioda's (2009) model of motivation to analyze the narratives

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of learners qualitatively, and found that learners' Ideal L2 self[1] affected their acquisition of the Gaelic rhotic.

Nagle (2018) investigated the interaction between motivation and accent of immigrants residing in Spain, who were near-native speakers of L2 Spanish, comparable to the graduate students recruited for the present study. These participants, just like our study's participants, had primarily received implicit instruction. Nagle found a correlation between motivation and L2 learners' accentedness in Spanish.

While Dörnyei and Ushioda's (2009) model of motivation has been used to investigate the impact of motivation on the acquisition of the trill in Gaelic, it has not been used to investigate the acquisition of the trill in Spanish. The present study aims to fill this gap by applying Dörnyei and Ushioda's (2009) operationalization of motivation as part of the L2-self system to the acquisition of trills in Spanish and it investigates the acquisition of the trill in L2 learners, HSs, and NSs from a variationist perspective.

Face (2018) investigated the acquisition of rhotics by L2 learners of Spanish that had immigrated to Spain. He described them as very advanced learners (similar to the graduate students recruited for the present study) who had lived abroad for an extensive amount of time. Despite their high proficiency, not all learners approximated NSs' production of the trill. The author classified the learners' production into five different categories of articulation: trill, tap, tap+, approximate, and assibilated[2].

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[1] The ideal L2 self is a term used to describe a learner's projected identity in an L2. This term is part of self-system described by Dörnyei and Ushioda (2009).

[2] A trill typically includes two or more occlusions. A tap typically includes one occlusion. A tap+ is a tap followed by an approximant or assibilated sound. An approximate does not have a complete occlusion. An assibilated sound is when there is frication without a full closure or occlusion.

## 3. The Study

### 3.1 Research questions and hypotheses

The present study adopts the operationalization of motivation as part of the Ideal L2-self system by Dörnyei and Ushioda (2009) as done in previous studies investigating the relation between acquisition of the trill and motivation (Nance et al., 2016; Nagle, 2018). In particular, we focused on two facets of the L2-self motivational system: the Ought-to self and the L2 context. In the present study the motivational variable Ought-to self is operationalized as qualities that an individual feels they ought to possess to avoid negative interactions (Dörnyei & Ushioda 2009). The L2 context is operationalized as situations in which learners' motivation is mediated or influenced by their immediate learning context and experience in that context (Dörnyei & Ushioda, 2009). In order to fill the gaps identified in the existing literature we propose a study guided by the following research questions:

1) How can we describe the acquisition of the Spanish trill in heterosyllabic sequences?
    a. If learners do not produce a tap or a trill, what are the alternative productions?
    b. At what point do L2 speakers begin to produce target-like variants?
    c. What is the frequency of trill production in heterosyllabic sequences across participants?
2) What are the social and linguistic variables that predict the production of the trill in heterosyllabic sequences?
3) Within the Ideal L2-Self system, which of the two factors (i.e., Ought-to self and L2 context) correlates more with the acquisition of the Spanish trill in heterosyllabic sequences?

We propose the following hypotheses:

H1) Regarding the acquisition of the trill in heterosyllabic sequences, we hypothesize that (a) if learners do not produce a tap or trill, they will produce the closest English equivalent, i.e., the retroflex /ɹ/. With respect to points (b) and (c), we hypothesize that trill production will start among intermediate-level learners; its frequency will increase among (intermediate-level) HS and advanced learners (i.e., graduate students), who, having spent a significant amount of time abroad and/or possessing high motivation, may show native-like production patterns. We hypothesize that trill production will increase with proficiency and that, due to the low frequency of trills in heterosyllabic sequences in the input and to their opaque orthographic representation (i.e., with a single <r>), acquisition of trills in heterosyllabic sequences will occur starting from the intermediate level. We did not include beginners in our study because of the little exposure they would have had to this sound. The choice of recruiting learners starting from the intermediate level was also motivated by previous research such as Reeder (1998), who found that the Spanish trill was a phonetic category often noticed only by learners at more advanced proficiency levels.

H2) Assuming that learners were exposed to input containing trills, motivation and time spent abroad will be significant predictors of trill production in heterosyllabic sequences.

H3) We hypothesize that learners who want to be part of a Spanish-speaking community or who had more contact with NSs will show more native-like tendencies to produce trills in these consonant clusters (again, assuming that they were exposed to relevant input).

## 3.2 Participants

A total of 19 participants were included in the study. Six learners were recruited from an intermediate (i.e., 300-level) undergraduate course at a large Midwestern university. Two HSs were recruited from the same course; they identified themselves as HSs as they grew up in the U.S. in a Spanish-speaking household. Students from this course were selected because they had not

received explicit instruction on trill production. Eight graduate students, advanced L2 Spanish learners enrolled in the Hispanic Linguistics program at the same university, were also recruited, along with three Spanish NSs (one from Venezuela and two from Spain) who were included as controls to compare the learners' production. The original number of tokens analyzed was 758 which included intervocalic taps and trills, as well as trills in heterosyllabic sequences. For the present study, we only considered trills in heterosyllabic sequences. However, we used the productions of intervocalic taps and trills to determine if students had acquired taps and trills in the most common orthographic contexts.

### 3.3 Materials

Our study used three different oral production tasks as well as two questionnaire investigating motivation and linguistic background. Tasks and questionnaires were administered to all participants remotely through Qualtrics (Qualtrics, Provo, UT).

The three oral tasks differed with respect to language formality. The first task (Appendix A) was a contextualized story that included 12 words containing a trill in a heterosyllabic sequence, with four words for each of the sequences (i.e., /lr/, /nr/, and /sr/). Participants were asked to read the story out loud.

The second task (Appendix B) featured a list of 25 words, each presented in a short sentence (e.g., *Digo **alrededor** para ti*, 'I say *alrededor* for you'). The 25 words were divided as follows: five words contained the sequence /lr/, five the sequence /nr/, and five the sequence /sr/; distractors included five words containing an intervocalic tap, four containing an intervocalic trill, and one containing a trill in word initial position. These distractors allowed us to ensure that participants were able to produce taps and trills in prototypical contexts. Participants were asked to read the sentences out loud.

The third task consisted of two oral discourse completion tasks (DCTs), in which participants were presented with a context featuring trills in heterosyllabic sequences and had to respond to questions relative to the DCT using the same vocabulary as that included in the prompt (Appendix C), even if they did not know the meaning of a word. Critical words were pseudo-randomized throughout the task.

The motivational questionnaire (Appendix D) was modeled after Dörnyei and Ushioda (2009) and contained five questions related to motivation and Ought-to self, and five questions related to motivation and L2 experience. Participants were asked to answer each question using a 6-point Likert scale. Additionally, a background questionnaire was used to gather data on participants' previous language experience, e.g., Spanish courses taken, time spent abroad, etc. The background questionnaire helped us to identify heritage speakers as well as participants who had spent previous time abroad in a Spanish speaking country.

### 3.4 Procedure

All participants completed the tasks in the same order. Twelve participants completed the task in a controlled laboratory setting. Due to laboratory restrictions imposed by Covid-19, seven participants had to complete the task on their home computer. Regardless of the testing location, all the participants' responses were recorded using the acoustic analysis software Praat (Boersma & Weenink, 2018) while they completed the oral tasks and data were collected via Qualtrics. Participants who completed the tasks at home were instructed on how to use Praat to record and save audio files.

## 4. Data Analysis

### 4.1 Coding

The dependent variables considered were tap /ɾ/ (one occlusion), trill /r̃/ (two or more occlusions), and other target-like productions (zero occlusions). The independent variables were categorized as linguistic or extralinguistic variables. The linguistic independent variable was the preceding segment (/l/ vs. /n/ vs. /s/). We also checked the duration of the preceding segment in milliseconds to help with the identification of taps and trills, but we did not include this as an independent variable in the statistical analysis because, in the end, it was not relevant to any of our research questions and only aided in the spectrographic identification of taps and trills. The extralinguistic independent variables included task type (story, list, oral DCT), group (intermediate Spanish learners, HSs, advanced Spanish learners, and NSs), motivation (Ought-to self vs. L2 Experience), and previous experience, binarily coded as 'experience' or 'no experience'. For this study we conducted a multivariate regression analysis in Rbrul, which allowed us to analyze multiple independent variables in order to see which variables (if any) predicted the production of the trill at each level.

### 4.2 Acoustic analysis in Praat

First, each possible context for a trill in heterosyllabic sequences was individuated and analyzed spectrographically for the acoustic correlates, using the same analysis methods as Amengual (2016). We coded the number of occlusions for each possible context as "0", "1", and "2 or more" (see Figures 1, 2, and 3). The duration of each trill was also measured using a Praat script (Henriksen, personal blog[3]) which helped to qualify potentially ambiguous consonants as trills.

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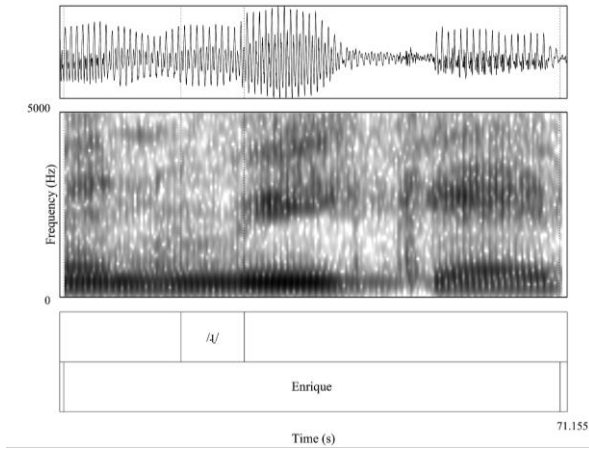[3] http://www-personal.umich.edu/~nhenriks/spanish410/ad/2/

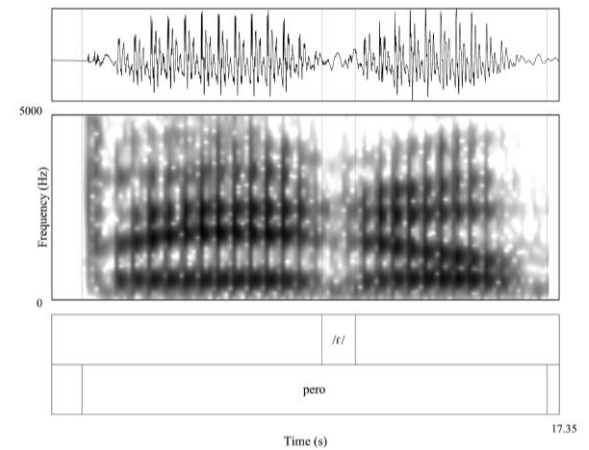Figure 1. Example of zero occlusions as produced by an intermediate learner



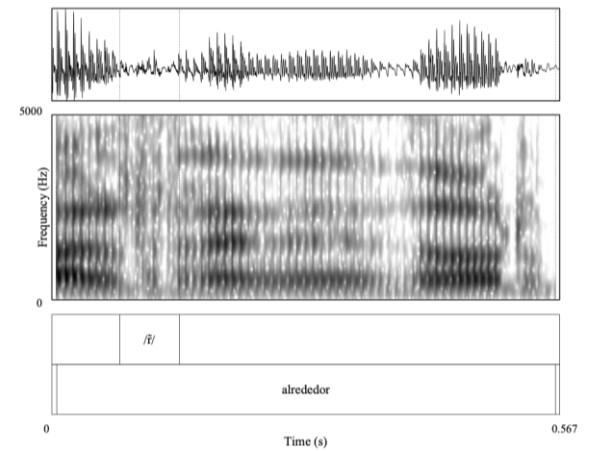Figure 2. Example of one occlusion (i.e., tap) as produced by a NS



Figure 3. Example of two or more occlusions (i.e., trill) as produced by a NS

*4.3 Motivation*

The scores obtained from the participants' answers to the motivation questionnaire were averaged for each respondent and rounded up to the nearest whole number; participants were then divided into the following seven categories: native speaker (N/A), very low (mean score = 1), low (mean score = 2), medium (mean score = 3), medium high (mean score = 4), high (mean score = 5), very high motivation (mean score = 6). This method is meant to provide insight into the validity of Hypothesis 2, according to which the Ideal L2 self is a social variable related to identity, and very high motivation of the Ought-to self would correlate with increased native-like production of the trill.

## 5. Results

The results are presented arranged by research question.

### 5.1 RQ1: How can we describe the acquisition of the Spanish trill in heterosyllabic sequences?

*1a) If learners do not produce a tap or a trill, what are the alternative productions?*

*1b) At what point do L2 speakers begin to produce target-like variants?*

*1c) What is the frequency of trill production in heterosyllabic sequences across participants?*

The participants in the present study produced taps, trills, and additional variations that were neither taps nor trills, classified as 'other'. Production varied based on group (i.e., intermediate, advanced, HSs, NSs). Figures 4 through 7 display the most frequent productions for each participant group. For example, the intermediate group tended to produce the 'other' variant more than taps or trills, and Figure 4 shows, in fact, a retroflex rhotic that was neither a tap nor a trill. Advanced learners produced more trills than the other two learner groups, but less than the NSs. Figure 5 is an illustration of a trill with four occlusions and Figure 6 is an example of a trill with preceded by a long pause, as produced by advanced learners. The HSs tended to produce more

taps (Figure 7) with only some instances of trills, and the NSs in this study were an excellent example of dialectal variation in the sense that they favored the production of trills in most, but crucially not all, contexts which (prescriptively) would require a trill.
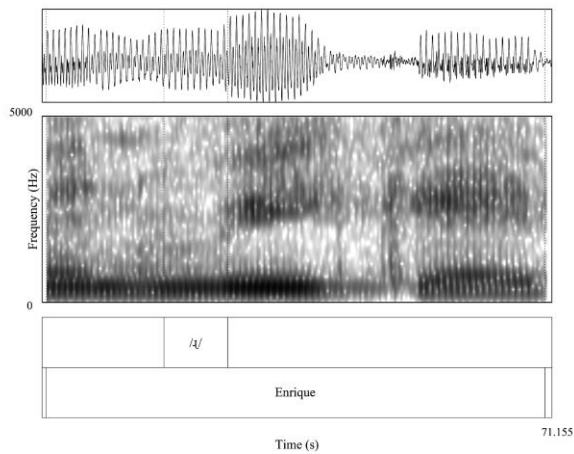


Figure 4. Example of "other" (retroflex) as produced by an intermediate learner
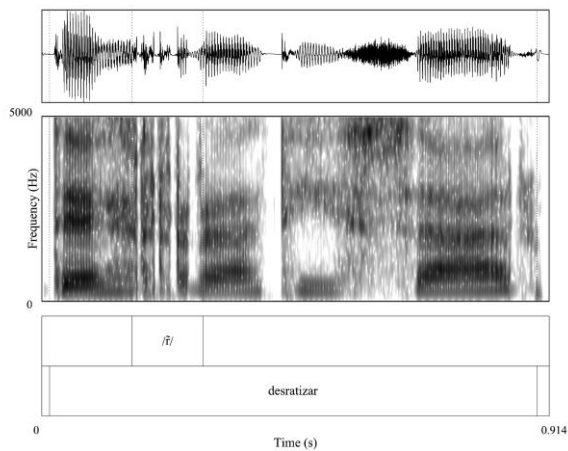


Figure 5. Example of trill (four occlusions) as produced by an advanced learner
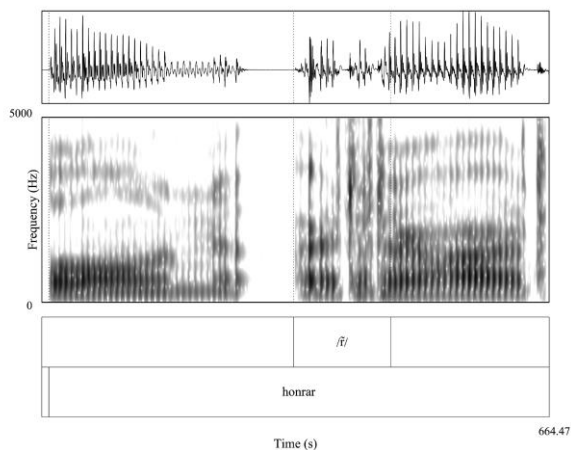
Figure 6. Example of trill (with a preceding pause) as produced by an advanced learner
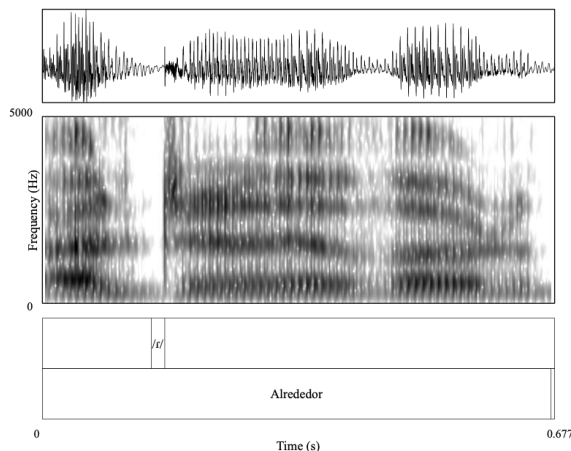


Figure 7. Example of tap as produced by a HS

With respect to questions 1b and 1c, Figure 8 below shows the frequency in tap and trill production in heterosyllabic sequences across the various groups. As shown by the figure, each group varied in their production of rhotic variants. The most frequently variant produced by the intermediate learners was 'other' (52% of the time); the HSs mainly produced taps (85%); both advanced learners and NSs mainly produced trills, although at different frequencies (49% and 76% of the time, respectively). While there was variation in the production of trills across all participants, a developmental trend observed was that trill production positively correlated with

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length of exposure to the target language (i.e., the longer participants were exposed to Spanish the more trills the produced in general).


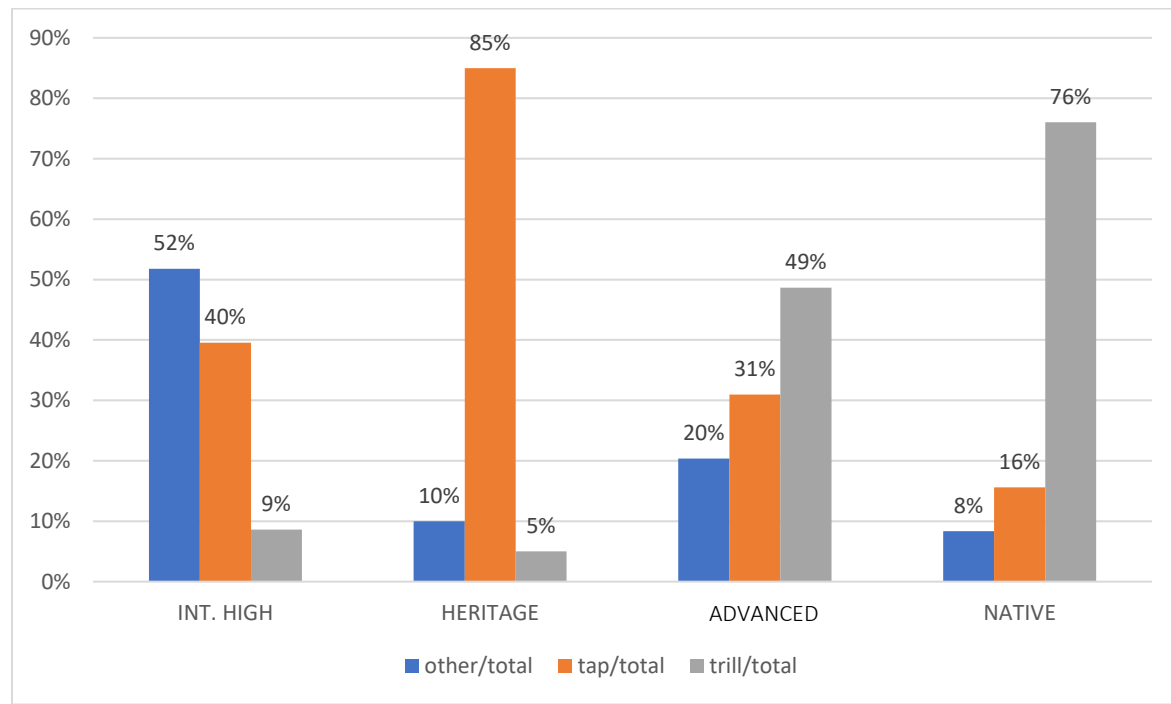
Figure 8. Participant productions of 'other', tap, and trill in heterosyllabic sequences.

*5.2 RQ2: What are the social and linguistic variables that predict the production of the trill in heterosyllabic sequences?*

   *RQ3: Which of the two motivation facets correlate more with the acquisition of the Spanish trill in heterosyllabic sequences?*

To understand the effect of the social and linguistic variables and of the motivational self-system on the production of the trill in heterosyllabic sequences, we conducted a multivariate analysis which consisted of multiple regressions performed using the statistical software, Rbrul. The non-linguistic (socially oriented) independent variables that were significant in this analysis were both types of motivation (i.e., Ought-to self vs. L2 context motivation), previous experience abroad,

and proficiency level. The linguistic variable that was significant in the regression analysis in predicting the production of the trill was preceding segments (i.e., /l/, /n/, and /s/). As indicated in Table 1, preceding segment /l/ prompted more trill production than the other two preceding segments, i.e., /n/ and /s/.

Table 1. Multivariate analysis of significant linguistic and extra-linguistics variables

| | Logodd | Factor weight | % | N |
|---|---|---|---|---|
| Log likelihood | | | | -157.102 |
| AIC | | | | 334.204 |
| Total N | | | | 458 |
| | | | | |
| **Motivation: Ought-to self** | | | | |
| Very high | 1.864 | .866 | .763 | 73/97 |
| Medium | -0.755 | .32 | .152 | 22/151 |
| High | -1.109 | .248 | .214 | 45/210 |
| *Range* | | 62 | | |
| **Motivation: L2 Context** | | | | |
| High | 6.685 | .99 | .23 | 51/214 |
| Very high | 4.869 | .99 | .45 | 88/196 |
| Medium | -11.553 | <.001 | .00 | 0/48 |
| *Range* | | 99 | | |
| **Level** | | | | |
| Grad. Stud. | 1.332 | .79 | .49 | 117/262 |
| Intermediate level | 0.837 | .69 | .088 | 11/136 |
| Heritage | -2.170 | .10 | .05 | 3/60 |
| *Range* | | 69 | | |
| **Experience Abroad** | | | | |
| Yes | 9.299 | .99 | .35 | 140/400 |
| No | -9.299 | .00 | .00 | 0/59 |
| *Range* | | 99 | | |
| **Previous Context** | | | | |
| /l/ | 0.604 | .65 | .37 | 56/151 |
| /n/ | -0.042 | .49 | .30 | 43/143 |
| /s/ | -0.562 | .36 | .25 | 41/164 |
| *Range* | | 29 | | |

*p < .05

Figure 9 illustrates the distribution of preceding segments across each level of proficiency and types of productions. Segment /l/ triggered the overall largest number of target-like

productions. However, even with the preceding segment /l/, nearly all intermediate-level participants produced "other", whereas the heritage learners mainly produced taps.
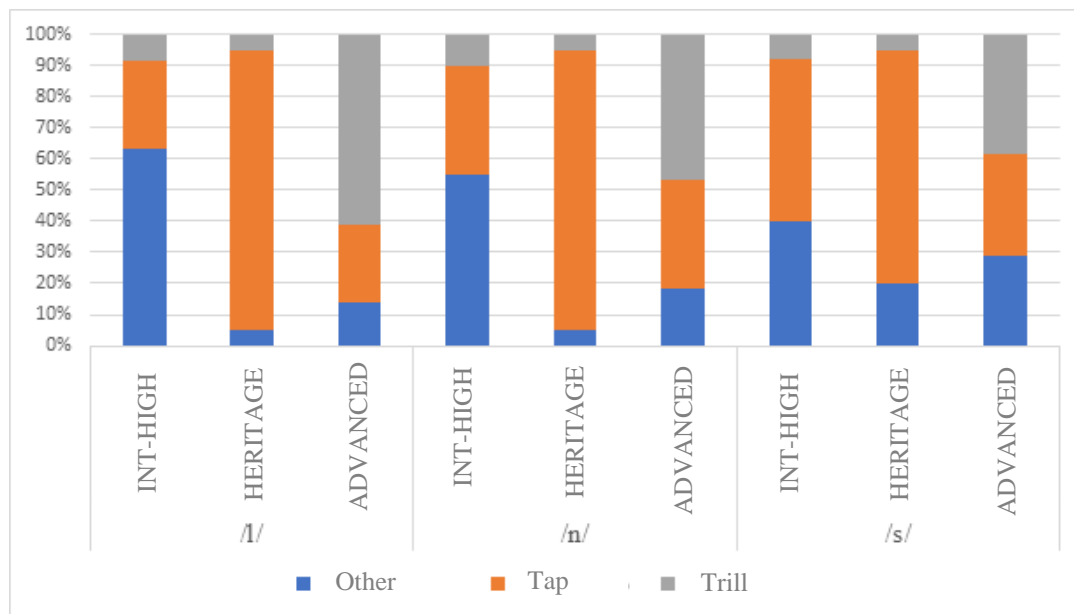


Figure 9. Relationship between previous context and production at each level

With respect to RQ3, regarding the differences between the two types of motivation, both turned out to be predictive of production of trills in heterosyllabic sequences but, in contrast to what we had hypothesized, the motivation oriented towards the Ought-to self was slightly more significant in the statistical model.

**6. Discussion**

In reference to RQ1 in general, we can describe the acquisition of the trill as slow to develop across L2 learners and occurring at later levels of proficiency based on the number of tokens that each participant in each group produced. For example, we found that the number of tokens produced by each participant gradually increased from the intermediate group through the advanced group. We can see that the trills are acquired first in intervocalic position by participants in the intermediate group, and HSs (at the intermediate-high level), and by all but one speaker at the advanced level.

The production of the trill in intervocalic position occurs first, followed by the production of the trill in heterosyllabic sequences. While advanced learners produced target-like trills in heterosyllabic sequences quite consistently, they also used trills where trills were not required, and sometimes produced several occlusions (as many as four occlusions) within those contexts. They also made long pauses prior to trills (cf. Fig. 7, p. 13), unlike NSs. Our results regarding the acquisition of the trill echo those of Reeder (1998) in that learners at different proficiency levels showed slightly different production patterns. Similar to NSs, advanced learners tended to favor trills, but they still showed some non-native-like behaviors, e.g., the above-mentioned pause preceding the trill. More studies involving acoustic analysis of advanced learners' trill production are recommended.

We also saw opposite preference patterns in intermediate and advanced learners, in that the former mostly produced "other" variants, whereas the latter mostly produced (and, occasionally, even overproduced) trills; HSs were somewhere in between with respect to production of "other", taps, and trills.

While this study focuses on the production of the trill in heterosyllabic sequences, we still think it is important to spend a few words on the "other" variants produced. Some of them were retroflex and/or bunched rhotics (referred to as "English rhotics" in previous studies) and assibilated rhotics. As seen in Figure 8, the intermediate-level learners primarily produced the "other" variant (52% of the time) and also produced a sustained amount of taps (40%), but only very few trills (8%). However, upon closer analysis of the specific cases of trill production in contexts other than heterosyllabic sequences, we found that only one intermediate-level learner produced the trill in intervocalic position. From this, we can infer that 8% of the trill productions in heterosyllabic position were produced by this speaker. It is reasonable to assume that if a speaker

does not produce a trill in intervocalic position, they will not produce it in heterosyllabic sequences either, because, in these contexts, trills are less frequent and not orthographically transparent (i.e., these words are always spelled with only one 'r').

While there were only two HSs among our participants, which makes it difficult to draw any reliable generalization, one pattern that we noticed between these two participants was that they only produced trills 5% of the time, and instead preferred taps (85%), proving that they were in fact able to produce the tap systematically. Additionally, they were able to distinguish between the Spanish tap and English bunched/retroflex rhotic, a variant they rarely produced, as the analysis revealed. Both HSs proved able to produce the trill in intervocalic position, but for some reason did not consistently produce it in heterosyllabic sequences.

Compared to the other two learner groups (i.e., HSs and intermediate group), the advanced group showed a marked increase in taps and trills in heterosyllabic sequences and a decrease in the production of "other" variants, to which they resorted only when unable to produce a trill. The 20% of "other" productions by advanced learners were not retroflex or bunched rhotics but were instead a more target-like version of "other" productions of the trill, such as assibilated or approximant productions. In other words, we could see that these advanced learners, for the most part, understood trills and attempted to produce them when required. Of them, seven were able to produce a trill in intervocalic position.

While we recruited native controls as term of comparison for the learners' production and to validate the task materials, their production unveiled interesting patterns that could further the understanding of trill production: for instance, we observe a certain variation in the production of trills in heterosyllabic sequences even among NSs.

Our results support those of Nagle (2018) in that we found motivation to correlate with target-like production of L2 Spanish. More specifically, while Nagle found that motivation correlated with accentedness in L2 learners, we found that motivation correlated with acquisition of the Spanish trill. Unlike previous studies, we investigated two types of motivation included in Dörnyei and Ushioda's (2009) L2-system operationalization of motivation. While we hypothesized that motivation oriented towards the L2 context would have more predictive power on the production of the trill compared to the Ought-to self, we found the opposite. One possible reason why the Ought-to self appeared to be a stronger predictor of trill production was because all participants rated themselves as having high or very high Ought-to-self-oriented motivation, leaving no probabilistic possibility for the other motivational variable. Another possible reason for this result could have been how the instrument used in the present study was designed. With more examples of Ought-to-self-oriented motivation and more examples of L2-Context-oriented motivation, one of the variables might have resulted more significant.

Lastly, we confirmed that time spent abroad was also significantly positively correlated with the production of the trill in heterosyllabic sequences because this sound is not necessarily salient or frequent in classroom input, and learners who produce it have likely had greater social contact with NSs in naturalistic settings.

As mentioned in the results section, an /l/ preceding the trill was a stronger predictor of trill production compared to /n/ and /s/. Hualde's (2013) suggested reason for this asymmetry is that /l/ and rhotics are both liquids and their shared articulatory characteristics are more similar than those shared by the rhotic and /s/ or /n/. Therefore, it seems safe to assume that due to their shared articulatory traits, it was easier for participants to coarticulate sounds /l/ and /r/ than sounds /s/ or /n/ and /r/.

**7. Conclusion**

This study found that motivation plays a role in the acquisition of trills in heterosyllabic sequences by intermediate and advanced L2 learners of Spanish as well as heritage speakers. Our results highlight that proficiency and trill production are positively correlated, so, the pedagogical implication that can be drawn from the present study is that instructors should more explicitly teach and exemplify the trill in heterosyllabic sequences at all levels, since it is neither salient orthographically nor frequent in speech.

One of the limitations of our study is the small sample size. We had originally planned to include an additional level of participants (from an advanced-low undergraduate class), but due to testing restrictions imposed by Covid19, we were unable to recruit more participants. We suggest two ideas for future research to develop. One is to more closely analyze the acoustic productions of L2 learners for additional patterns (e.g., elongated pauses before a trill). The second is to conduct a study with learners with more varied proficiency levels and who have received explicit instruction or treatment sessions regarding the production of the trill in heterosyllabic sequences to see how treatment as well as proficiency may affect the acquisition of the trill in this specific phonological environment.

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# Appendix A

**Story (Spanish version):**

Un día, Enrique, el hijo de una pareja famosa en España celebró una gran fiesta para honrar a sus padres, ya que era su aniversario de bodas. La fiesta fue en la casa de la familia, pero tuvieron que desroñar todo el jardín que estaba alrededor de la mansión. Por suerte, se dieron cuenta a tiempo de que había ratas en la cocina, y gracias a esto pudieron desratizar toda la zona. La pobre criada fue la que lo tuvo que limpiar todo, por lo que terminó desriñonada. Mientras un perro ladraba en el jardín. Todos empezaron a llegar a la fiesta en sus carros. Vinieron todo tipo de gente. Algunas chicas llegaron en vestidos de milrayas, y otras chicas, sin embargo, con enredos en el pelo. Para el final de la fiesta, el aire estaba enrarecido. Fue un poco alrevesado el sacar a la gente cuando esta terminó. Una vez que todos se habían ido, Enrique se dio cuenta de que los invitados habían malrotado toda la hacienda. Habían desreglado por completo toda la casa y estaba hecha un desastre.

**Story (English version):**

One day, Enrique, the son of a famous Spanish couple, threw a grand party to honor his parents' anniversary. The party took place in the house of the family, but they had to clear out the entire garden that was next to the mansion. Luckily, they realized in time that there were rats in the kitchen. Thankfully they were able to get rid of all of the rats in the entire place. The poor son was the one who had to clean everything and when he finished, he was very dizzy. Meanwhile, the dog was messing up the garden. Everyone started to arrive at the party in their cars. There were all types of people. Some girls arrived in striped dress while others arrived with curls in their hair. Towards the end of the party, the air was starting to feel congested. It was a little difficult to get rid of all of the people once the party was over. Once everyone had left, Enrique realized that the invites had ruined the entire *hacienda*. They had completely ruined the house and it looked like a disaster.

| | Word | Word in Context |
|---|---|---|
| **/lr/** | *Alrededor* 'around' | *Digo* **alrededor** *para ti* 'I say *alrededor* for you' |
| | *Alrevesado* | *Digo* **alrevesado** *para ti* 'I say *alrevesado* for you' |
| | *Malrotar* | *Digo* **malrotar** *para ti* 'I say *malrotar* for you' |
| | *Milrayas* | *Digo* **milrayas** *para ti* 'I say *milrayas* for you' |
| | *Alrota* | *Digo* **alrota** *para ti* 'I say *alrota* for you' |
| **/nr/** | *Enrique* | *Digo* **Enrique** *para ti* 'I say *Enrique* for you' |
| | *Enredo* | *Digo* **enredo** *para ti* 'I say *enredo* for you' |
| | *Honrar* | *Digo* **honrar** *para ti* 'I say *honrar* for you' |
| | *Desenrollar* | *Digo* **desenrollar** *para ti* 'I say *desenrollar* for you' |
| | *Enrarecer* | *Digo* **enrarecer** *para ti* 'I say *enrarecer* for you' |
| **/sr/** | *Desraspado* | *Digo* **desraspado** *para ti* 'I say *desraspado* for you' |
| | *Desroñar* | *Digo* **desroñar** *para ti* 'I say *desroñar* for you' |
| | *Desriñonar* | *Digo* **desriñonar** *para ti* 'I say *desriñonar* for you' |
| | *Desreglar* | *Digo* **desreglar** *para ti* 'I say *desreglar* for you' |
| | *Desratizar* | *Digo* **desratizar** *para ti* 'I say *desratizar* for you' |
| **Intervocalic /r/** | *Pero* | *Digo* **pero** *para ti* 'I say *pero* for you' |
| | *Cero* | *Digo* **cero** *para ti* 'I say *cero* for you' |
| | *Tara* | *Digo* **tara** *para ti* 'I say *tara* for you' |
| | *Para* | *Digo* **para** *para ti* 'I say *para* for you' |
| | *Caro* | *Digo* **caro** *para ti* 'I say *caro* for you' |
| **Other** | *Carro* | *Digo* **carro** *para ti* 'I say *carro* for you' |
| | *Parra* | *Digo* **parra** *para ti* 'I say *parra* for you' |
| | *Jarra* | *Digo* **jarra** *para ti* 'I say *jarra* for you' |
| | *Perro* | *Digo* **perro** *para ti* 'I say *perro* for you' |
| | *Rueda* | *Digo* **rueda** *para ti* 'I say *rueda* for you' |

## DCT 1
**Please read the context below aloud and then respond to the question aloud. (If you have any questions about what a word means, please ask the researcher) and do not skip the question.**

*Juan está pensando hacerle un regalo para **Enrique** y otro regalo para Ana, pero no sabe qué cosa comprar. Al final, decidió comprar un **carro** barato para **Enrique** y una nueva computadora para Ana.*
Juan is thinking about getting a present for **Enrique** and another for Ana, but does not know what to buy. In the end, he decides to buy a cheap **car** for **Enrique** and a new computer for Ana.

*¿Qué va a regalar Juan y para quién?*
What is Juan giving and to whom?
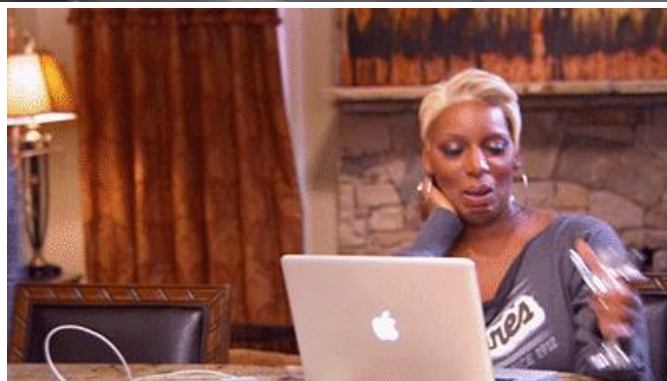
...

**Please read the context below aloud and then respond to the question aloud. (If you have any questions about what a word means, please ask the researcher and do not skip the question.)**

*Pepper es un **perro** que juega **alrededor** de **Tara**, y Salt es un gato que duerme todo el día.*
Pepper is a **dog** that plays **around Tara**, and Salt is a cat that sleeps all day.

*¿Es Pepper un gato que duerme todo el día?*
Is Pepper a cat that sleeps all day?
...
*Juan tiene que **desraspar** la nieve de la **rueda** desde **cero**, y Ana tiene que cortar el césped.*
Juan has to **scrape** the snow **off** the **wheel**, and Ana has to cut the grass.

*¿Qué tiene que hacer Juan?*
What does Juan have to do?
...
*Ana quiere **desreglar** la mesa con la **jarra** que se rompió, **pero** no tiene tiempo porque tiene mucho trabajo atrasado.*
Ana wants to **remove** the **jar** that broke from the table **but** she doesn't have time because she has a lot of backlog work.

*¿Qué quiere hacer Ana y por qué no puede hacerlo?*
What does Ana want to do and why can't she do it?
...
*Ana se ha comprado una camiseta de **milrayas** muy **cara** en la tienda "Esports **Parra**".*
 Ana has bought an **expensive** shirt with **pin-stripes** in the store "Esports **Parra**".

*¿Qué ha comprado Ana y dónde lo ha comprado?*
What did Ana buy and from where did she buy it?
...
*Juan va a comprar un **carro** nuevo **para** su abuelo para **honrarle** por la dedicación que siempre ha tenido por su familia.*
Juan is going to buy a new **car for** his grandpa to **honor** him for the dedication that he has always had to his family.

*¿Qué va a hacer Juan y para qué?*
What is Juan going to do and for whom?

**Motivation questionnaire** *(Please rate the sentences on the Likert scale 1-6, 1=strongly disagree, 6=strongly agree).*

1. I'm studying Spanish because I'm very interested in the values and customs of Spanish speaking cultures.

2. Studying Spanish is important to me because I think it will someday be useful in getting a good job.

3. I'm studying Spanish because close friends of mine think it is important, or I want to speak with Spanish speakers.

4. Studying Spanish is important to me to get a good grade or for academic reasons.

5. Studying Spanish is important to me because I would like to spend a period living abroad.

6. Studying Spanish is important to me because I would like to work abroad.

7. I study Spanish because I enjoy Spanish and Hispanic cultures.

8. I'm studying Spanish to fulfill a graduation requirement.

9. I'm studying Spanish because I want to get to know Spanish speakers and culture.

10. I'm studying Spanish to be able to travel more efficiently.