Roll your R! Speech therapy techniques to improve L2 Spanish pronunciation

Belén Reyes Morente
Universidad de Málaga
Irene Checa García
University of Wyomin
Francisco José Manjón Pozas (Corresponding Author)
Universidad de Granada

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ABSTRACT: A proficient pronunciation in an L2 can not only improve communication success but also enhance learners' confidence and proficiency perception. However, L2 phonemes very different from L1 ones are usually challenging. For Spanish /r/, difficult sometimes also for native speakers, speech pathologists have developed intervention techniques potentially applicable to L2 Spanish. This study looked at the effect of transferring these techniques into three groups: beginning, advanced, and study abroad immersion learners. Learners' /r/ pronunciations in three different phonic contexts were recorded before, immediately after, and a few weeks after an adapted speech therapy treatment. For each recording, the number of vibrations and milliseconds per vibration (fluency) were recorded. Repeated measures ANOVA indicate that the effect was significant in all groups and remained stable for number of vibrations but was significant only in the immersion group for fluency. Differences according to r position were also found.
Keywords: L2 pronunciation, Speech Therapy, Spanish phonetics, vibrant phonemes, articulatory instruction

From Hollywood to the classroom: The adaptation of film titles into Spanish and their pedagogical potential in teaching Spanish as a For-eign Languagel

RESUMEN: Una pronunciación competente en una segunda lengua (L2) no solo puede mejorar el éxito comunicativo, sino también aumentar la confianza de los estudiantes y su percepción de competencia. Sin embargo, los fonemas de la L2 que son muy diferentes de los de la lengua materna (L1) suelen ser difíciles. En el caso de la /r/ en español —a veces difícil incluso para hablantes nativos—, los logopedas han desarrollado técnicas de intervención que podrían aplicarse al aprendizaje del español como L2. Este estudio analizó el efecto de transferir estas técnicas en tres grupos: estudiantes principiantes, avanzados y en inmersión en el extranjero. Se grabaron las pronunciaciones de la /r/ en tres contextos fónicos distintos antes, inmediatamente después y semanas después de un tratamiento adaptado de terapia del habla. En cada grabación se registraron el número de vibraciones y los milisegundos por vibración (fluidez). Un ANOVA de medidas repetidas indica que el efecto fue significativo en todos los grupos y se mantuvo estable en cuanto al número de vibraciones, pero solo fue significativo en el grupo de inmersión en cuanto a la fluidez. También se encontraron diferencias según la posición de la /r/.
Palabras clave: pronunciación en L2, terapia del habla, fonética del español, fonemas vibrantes, instrucción articulatoria.

1. Introduction

In L2 instruction, the emphasis on communication often results in other aspects, deemed less important, being overlooked. Pronunciation teaching, for example, is less explored and frequently utilized just for corrective feedback, not incorporated into lesson plans (Foote, et al., 2011; Foote et al., 2016). Nevertheless, recent research indicates its potential benefits on L2 pronunciation, learners' linguistic confidence, and self-perception, influencing peer and native speaker perspectives. Various techniques, including those from fields like speech therapy (ST) and communication disorders, have been employed in numerous languages, often with success. However, ST methods have rarely been applied or evaluated in Spanish as L2. In this study, ST methods were used to teach a commonly difficult Spanish phoneme for L2 learners, and their effects were assessed across beginner, advanced at home, and advanced abroad levels to determine their effectiveness and optimal usage context.

The subsequent section outlines several justifications for teaching L2 pronunciation. It reviews perceived difficulties in pronunciation teaching and discusses the significance of explicit instruction and success in this area. The potential of one explicit method, ST techniques, is introduced. The research questions of this study are detailed in section 4, followed by a methods section. Section 6 presents and analyzes the results. The final section proposes conclusions, especially concerning teaching implications, current study limitations, and recommendations for future research.

2. The Role of Pronunciation in L2 Instruction

With the shift in language teaching from accuracy to communication effectiveness, pronunciation was sidelined unless it obstructed comprehension (Celce-Murcia et al., 1996; Derwing & Munro, 2009; Iruela, 2004; Olson, 2014). It led to the 60s and 70s neglecting phonetics, considering pronunciation teaching as impractical and insignificant (Usó Viciedo, 2008). This led to beliefs concerning pronunciation as being complex, unimprovable, and demotivating (Busto, 2010; Derwing & Munro, 2009), thus it was rarely taught compared to grammar or vocabulary. This remains largely true today, despite recent research suggesting other reasons for teaching pronunciation.

In spite of a shift in paradigm in regards to "nativeness" as the benchmark for high proficiency in pronunciation (as stated in the CEFR Companion Volume, 2020, pp. 133-136), several studies have shown that self-perceived pronunciation accuracy influences confidence and motivation in L2 learning (Zarrinabadi & Khodarahmi, 2017; Aiello & Mongibello, 2019), with accent strength impacting willingness to communicate and affecting perceptions of linguistic and intellectual abilities. L2 speakers with "native-like" accents are also more accepted when using dialectal expressions, associating them with language proficiency (Ruivivar & Collins, 2018; George, 2017).

Reducing a foreign accent can therefore improve self-perception, boost confidence, and enhance native speakers' perceptions, regardless of actual communicative skills. Pronunciation contributes to a speaker's identity, affecting their participation in language usage and learning.

Despite being considered difficult, teaching pronunciation is possible and beneficial. Recent studies show improvements can be made (Lee, Jang & Plonski, 2014) and being

metalinguistically aware aids in the process (Ramírez Verdugo, 2006; Kennedy and Trofimovich, 2010; Mitrofanova, 2012). The effectiveness varies based on factors like instruction duration, features taught, or assessments procedures, but can be significant (Saito, 2012; Lee et al., 2014; Thomson & Derwing, 2015).

3. How to Teach Pronunciation: Challenges, Questions, and Potential Solutions

3.1. Barriers to Teaching Pronunciation

Teachers opting to teach pronunciation confront three challenges: methodological, psychological, and resource-related (Busto, 2010). Methodological challenges arise from pedagogical approaches such as natural and communicative ones that favor practice over explicit training. Additionally, Spanish phonetic system is thought to demand less focus compared to other languages due to its average amount of phonemes[1]. Psychological barriers come from the belief that phonetics expertise is essential for teaching pronunciation, which can intimidate many (Burguess & Spencer, 2000; Derwing, 2010; Foote et al., 2011). Resource-related challenges relate to the inaccessibility of specialized pronunciation manuals for L2 classrooms and the monotony of available resources, leading to pronunciation teaching's general rejection (Deng et al., 2009; Olson, 2014; Leather, 2000; Lord, 2005).

When pronunciation is taught, proposed activities vary. Communicative approaches emphasize task-based activities with the target phoneme, prioritizing communication rather than explicit pronunciation instruction. Explicit methodologies, as outlined by Saito (2012), include "FonFS" (drill activities emphasizing sound repetition) and "FonF" (communicative activities with explicit pronunciation focus). Saito's study found only explicit methods improved pronunciation. However, available materials to implement these methods are limited, with textbooks rarely featuring explicit pronunciation activities, except for standalone pronunciation courses (Derwing, et al., 2012).

3.2. Speech Therapy as an Explicit Method for Pronunciation Training

The concept of applying Speech Therapy (ST) techniques to L2 pronunciation teaching was first proposed by Yúfera Gómez (1993) for Spanish. ST starts with problem awareness and provides tools for correction, which Yúfera Gómez suggested could apply to L2 pronunciation. Unfortunately, this idea wasn't widely adopted, and no teaching resources were created.

Recently, technological tools have been developed for identification and immediate feedback, initially aiding native speakers with speech issues (Bernhard, Gick, Bacsfalvi & Adler-Bock 2005, cited by Antolik et al., 2019). These tools were later successfully used for L2 pronunciation in various languages (Badin et al., 2010 for French; Carey, 2004 and Gick et al. 2008 for English; Duan et al., 2017 for Chinese; Nicolaidis et al., 2015 for

[1] Spanish has an average amount of vowels and consonants and average proportion of the two, and only one variant of Spanish exhibits a rare phoneme, the interdental fricative /θ/ (Maddieson, 2013a; Maddieson, 2013b; Maddieson, 2013c).

Greek). New tools now use verbal suggestions (Duan et al. 2017) or visual articulation presentations (Bliss et al., 2018), showing promise in improving pronunciation (Noguchi et al., 2015; Nicolaidis et al., 2015).

Though computer-assisted tools for ST in Spanish L1 exist (Saz et al., 2009), they haven't been applied to L2. These tools could benefit individual learning and diverse L1 classrooms. However, most Computer Aided Pronunciation Training (CAPT) literature focuses on visual feedback without explicit articulatory information, unlike traditional ST approaches (Badin et al., 2010). These ST approaches aim to enhance linguistic awareness, which is beneficial for pronunciation instruction.

3.2.1. What could speech therapy be useful for in L2 Spanish and when?

Most Speech Therapy (ST) techniques focus on common difficulties in Spanish L1, like the multiple vibrant /r/. This complex phoneme involves rapid, repeated tongue and alveoli contact, with native speakers averaging 3 contacts (Quilis, 1999). However, this number can range from 2 to 10 (Harris, 1983) and duration averages 0.85 milliseconds (Bradley, 2001). L2 learners often struggle with these repetitions, substituting /r/ for simpler sounds. Figure 1 depicts a spectrogram of the word "perro" spoken by a native Spanish speaker, with three columns each corresponding to a tongue-alveoli contact.

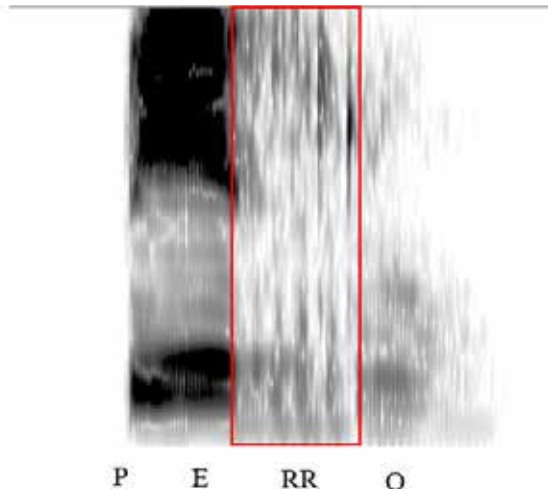

Figure 1. *Spectrogram of word "perro" by Spanish native speaker*

Even native speakers find this phoneme challenging (Carballo and Mendoza, 2000; Flege 1995, cited by Antolik, Pillot-Loiseau & Kamiyama, 2019), often replacing it with an easier sound like /l/ (Andrae, Pérez, Sandi, Vildoso, & Orellana, 2014). Consequently, this phoneme frequently requires ST. English speakers learning Spanish also struggle with /r/, due to its articulatory complexity and significant differences from the English equivalent /ɹ/, often substituting it with the familiar English phoneme.

3.2.1.1. Speech therapy techniques for Spanish /r/.

Dyslalia, a disorder marked by incorrect phoneme pronunciation (Planas, 2015; Pascual, 2012), is similar to pronunciation issues in L2 learners who, like functional dyslalia patients, lack physiological speech impediments[2]. This study examines functional dyslalia, particularly with the challenging /r/ phoneme (Pascual, 2012). Speech Therapy (ST) techniques aiding native speakers' /r/ pronunciation have proven effective (Díaz-Caneiro & Gestal-Couso, 2017; Hotham & Oriol, 2000), suggesting similar techniques could benefit L2 learners. These techniques enhance awareness and provide explicit phoneme instruction, characteristics of successful pronunciation methods. ST treatment involves extensive sessions incorporating both indirect (e.g., breathing exercises, relaxation) and direct treatments. Adapting ST techniques for the L2 classroom, however, requires consideration of time constraints and the group education context, versus individual clinical settings. Further details on adapting ST techniques are discussed in the methods section.

4. Research Questions

This study focused on the effects of ST techniques used to improve the pronunciation of Spanish /r/ in the L2 classroom. In addition, it sought to find out if there is a level in L2 development when teaching pronunciation is more effective and if it is more effective in a study abroad vs. at home instruction. The research questions are thus the following:

(i) Does the use of ST techniques for the difficult phoneme /r/ in Spanish have a significant effect on improving the pronunciation of this phoneme in English L1 learners of Spanish L2?
(ii) Does the effect only work short-term or does it last?
And (iii) does the effect varies for level and context of learning?

5. Methodology

5.1. Participants

The study included three participant groups: immersion, beginner, and advanced L2 Spanish learners, according to method of acquisition (at home vs. abroad) and years of instruction for the groups at home. Immersion students, studying abroad at a Spanish university for four months, numbered 10. Fourteen beginners were enrolled in a first-semester Spanish class at an American public university. The advanced group, with 11 participants, were third-year Spanish students focusing on conversational proficiency. All participants signed consent forms following respective institutional guidelines.

[2] There could be indeed L2 learners who also have a physiological disfunction in any of their speech production or reception organs, but this population was not considered in this study.

5.2. Procedure

Participants initially recorded themselves saying specific words to provide initial, intervocalic, and postconsonantal /r/ samples. After applying the treatments described in 5.3, they repeated the same words. Non-immersion groups also recorded themselves 2-3 weeks of post-treatment to assess if improvements were temporary or long-lasting. Unfortunately, access to the immersion group was limited to one session so the delayed post-treatment test was not possible (we discuss the impact of this in interpreting our results later on).

5.3. Treatment

The selection of ST techniques was guided by time constraints considerations as well as the general principles for any ST intervention: awareness of articulation and the development and application of specifically designed exercises to practice the articulation gestures required for the target phoneme. From the wide spectrum of techniques presented in Pascual (2012), the selected ones were: breathing techniques, auditory discrimination and articulation awareness, orofacial exercises, and phoneme-specific articulatory exercises.

The first exercise comprised a short and straightforward explanation of the anatomical process of pronunciation, the overall process of pronunciation and which organs are involved, in order to make the process understandable and to enable students to consciously use their organs in the later exercises.

After this brief explanation, students were shown some breathing exercises. They practiced breathing by blowing a balloon up in the following way: first, they were asked to blow up one balloon as much as they could and to count how many expirations they needed to blow it up. After that, students were indicated to blow another balloon up as much as they could with a single expiration. The purpose was to observe the difference in size between the two balloons and how their expirations had worked to understand breathing patterns' importance.

The third exercise consisted of an explanation of how to pronounce the multiple vibrant. At this point, a specifically directed explanation that detailed the articulatory organs involved in the production of the target sound was provided. As visual support, the University of Iowa (2014) resource *Sounds of Speech* (version 2.2.10 https://soundsofspeech.uiowa.edu/home) was used because it allows students to visualize how the organs move in the articulation of a phoneme. The visual support supplemented the verbal explanation and later would make it easier to imitate this sound. In addition, to continue facilitating the application of the visuals, students were given a little portion of chewing gum to put against their alveoli, to help them check if they were actually using those organs where /r/ articulation is rendered (tongue and alveoli).

The fourth exercise consisted of practicing /r/ to get the students to apply what they had learned, and to check their articulatory skills progress and the difficulties they were facing, following Cervera & Ygual (1994). In order to have them practice but also get some feedback, they worked in pairs. Each member of the pair took turns pronouncing

the phoneme in isolation -after being asked to pay attention to tongue placement and movement as shown previously-, doing several repetitions. Then they pronounced it within a syllable, such as *ra*.

Then, they were asked to do several repetitions lengthening the sound as much as possible and to repeat the same process but with the reverse syllable "ar", with the goal of practicing various positions. In the case of the immersion group, the class period was longer and allowed for two indirect treatment extra exercises more focused on perception rather than production. In the first exercise, students were shown minimal pairs for the phoneme (examples from Gil, 2007). The goal was to enhance phoneme perception and auditory discrimination to help students recognize sounds and differentiate words. The other exercise had students recording themselves while pronouncing a word with the phoneme and later being shown their spectrograms and the spectrograms of native speakers for them to compare. The ultimate aim was to engage students in their own "before" and "after" treatment awareness. The possible impact of these extra exercises for this group is later discussed in section 7.1.

5.4. Measurements and Statistical Analysis

As mentioned previously, English-speaking learners of Spanish tend to replace the multiple vibrant for phonemes with a different mode of pronunciation, and therefore no vibration or sometimes only one, as the Spanish /ɾ/. Hence, to measure effectiveness of the treatment, the number of vibrations were counted by noting columns of the spectrogram representing tongue touches (repetitions measure). In addition, a fluency measure was calculated by dividing the total duration into milliseconds by the number of repetitions.

A generalized linear model tested for significance with ANOVA (repeated measures ANOVA, packet *nlme* in R) for each group. For those variables which did not meet the test assumptions (normality, homoscedasticity or sphericity) a rank transformation was applied. Effect sizes were measured with Partial Eta Squared (calculated with the *sjstats* packet in R). Only size effects of significant differences are reported since, as expected, non-significant size effects were extremely low.

6. Results

Figures 2 and 3 give us a summary, through the means, of repetitions and fluency/speed respectively. They show how each of these measures behave in each of the positions for each of the groups. The colored columns indicate the time: pre-treatment, post-treatment, and post-treatment with delay.

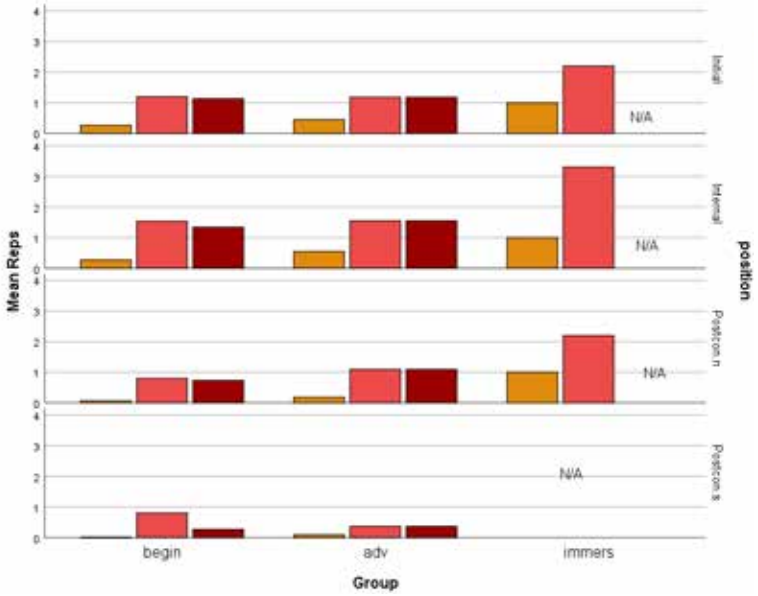

Figure 2. *Mean repetitions per group and position at each time*

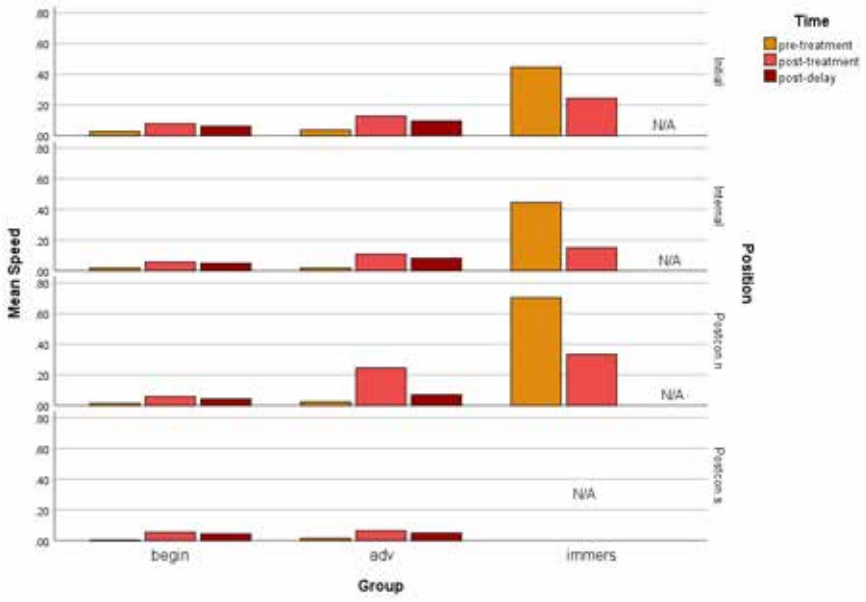

Figure 3. *Mean speed of each repetition per group and position at each time*

As a general trend, repetitions do increase over time, an increase that is usually maintained, regardless of position. In contrast, fluency only increases for the immersion group (more milliseconds per repetitions, taller bar, means less fluency), again regardless of position. The increases do look higher for initial and intervocalic than position at first glance. The next sections test for significance of differences for each group.

6.1. Beginners Group

In Table 1, descriptive values of repetitions are presented, by position and within the position by time.

Table 1. *Repetitions by position and time in beginners' group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	0.27	0	0.704	0	2
	Post-treatment	1.2	1	1.014	0	3
	Post-delay	1.13	1	1.06	0	3
	Total	0.87	0	1.014	0	3
Intervocalic	Pre-treatment	0.27	0	0.704	0	2
	Post-treatment	1.53	2	1.457	0	4
	Post-delay	1.33	1	1.345	0	4
	Total	1.04	0	1.313	0	4
Postcon.n	Pre-treatment	0.07	0	0.258	0	1
	Post-treatment	0.8	0	0.941	0	2
	Post-delay	0.73	0	0.884	0	2
	Total	0.53	0	0.815	0	2
Postcon.s	Pre-treatment	0	0	0	0	0
	Post-treatment	0.8	0	1.082	0	3
	Post-delay	0.27	0	0.458	0	1
	Total	0.36	0	0.743	0	3

These descriptive values show more repetitions in Intervocalic position, followed by initial, post-consonantal *n* and finally post-consonantal *s*. However, the median shows that there are some extremely rare values, and in fact most of the values is zero repetitions, because a majority of the beginners never rolled their /r/ in post-consonantal positions and not often pre-treatment in the other two positions.

Table 2 presents the same descriptive values for the duration of each repetition.

Table 2. *Fluency of repetitions by position and time in beginners' group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	0.0274	0	0.07236	0	0.22
	Post-treatment	0.0787	0.098	0.06157	0	0.18
	Post-delay	0.0613	0.073	0.05843	0	0.18
	Total	0.0558	0	0.06651	0	0.22
Intervocalic	Pre-treatment	0.0169	0	0.04535	0	0.15
	Post-treatment	0.0562	0.0763	0.05136	0	0.16
	Post-delay	0.048	0.0555	0.04324	0	0.1
	Total	0.0404	0	0.04881	0	0.16
Postcon.N	Pre-treatment	0.0147	0	0.0568	0	0.22
	Post-treatment	0.0584	0	0.0689	0	0.18
	Post-delay	0.0429	0	0.0487	0	0.1
	Total	0.0387	0	0.06023	0	0.22
Postcon.S	Pre-treatment	0	0	0	0	0
	Post-treatment	0.0534	0	0.07344	0	0.23
	Post-delay	0.0435	0	0.07739	0	0.2
	Total	0.0323	0	0.06459	0	0.23

The speed values present a very similar picture, with lots of zeros, since there is no duration if there are no repetitions. Once again post-consonantal positions present the lowest values, with the peculiarity that any time there is an average above the most common score zero, the treatment elongates the duration of each tongue touch. However, this could be due to more people producing such touches after the treatment while not being so agile at it.

The next sections present the significance of differences for each of these values by time, positions, and both time and position.

6.1.1. Differences by time

The differences observed in Figures 2 and 3 and tables 1 and 2 resulted significant ($F=34.25324$, $p<.0001$) for repetitions, Partial Eta= 0.34, medium to low. The pre-treatment measurement differed significantly from the two post-treatment measurements ($p=0.0000007$ for post-treatment, $p=0.0001585$ for post-delay. However, the delay measurement was not statistically significant from that in the post-treatment ($p=0.424651$), so there was no significant decrease of the effect of the treatment with time.

As for the fluency in rolling, the differences among measurements in time were again highly significant (16.844514, $p<.0001$) and, also, only for the pre-test vs. the post-test and delay ($p=0.0038343$ and $p=0.0000410$ respectively), with no difference between post-test and delay values ($p=0.4462866$). However, the size effect was small (Partial Eta=0.19).

6.1.2. Differences by position

Figure 2 suggests that post-consonantal position gets less benefit from the instruction than the others and it is also lower to begin with in all groups. Figure 3, which shows the speed, does not give away such a clear impression. The test for level differences in the position variable indicated that it is significant for repetitions ($F=34.2532$, $p<.0001$), but not for fluency ($F=2.125343$, $p=0.0993$). However, within the positions, the only significant difference occurred between the post-consonantal position following -n and the intervocalic position ($p=0.0067902$), where Intervocalic position showed more repetitions than the rest of the positions. Perhaps due to this, the effect size was fairly low (Partial Eta = 0.16).

6.1.3. Interaction between position and time

The interesting piece of information concerning positions is their interaction with time: are there positions that benefit more from instruction and/or are more resilient in keeping the instruction effect? Neither in number of repetitions nor in how fast they can occur were there significant differences by position. Thus, the effect of the treatment seems similar regardless of the position in the beginners group.

6.2. Advanced Group

As with the Beginners Group, the first descriptive measures of repetitions are displayed in Table 3 and then of fluency in Table 4, classified according to the two within group variables, position and time, as well as their interaction.

Table 3. *Repetitions by position and time in Advanced group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	0.45	0	0.82	0	2
	Post-treatment	1.18	1	0.751	0	2
	Post-delay	1.18	1	0.751	0	2
	Total	0.94	1	0.827	0	2
Intervocalic	Pre-treatment	0.55	0	1.214	0	3
	Post-treatment	1.55	1	1.128	0	3
	Post-delay	1.55	1	1.128	0	3
	Total	1.21	1	1.219	0	3
Postcon.N	Pre-treatment	0.18	0	0.405	0	1
	Post-treatment	1.09	1	0.701	0	2
	Post-delay	1.09	1	0.831	0	2
	Total	0.79	1	0.781	0	2
Postcon.N	Pre-treatment	0.09	0	0.302	0	1
	Post-treatment	0.36	0	0.505	0	1
	Post-delay	0.36	0	0.505	0	1
	Total	0.27	0	0.452	0	1

Results are very similar to the beginners' group, with the same ranking for repetitions by position. The maximum values are similar or even lower than the beginners. As happened with the beginners' group, there were many zeros and some extreme values.

Table 4. *Speed of repetitions by position and time in Advanced group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	0.0274	0	0.07236	0	0.22
	Post-treatment	0.0787	0.098	0.06157	0	0.18
	Post-delay	0.0613	0.073	0.05843	0	0.18
	Total	0.0558	0	0.06651	0	0.22
Intervocalic	Pre-treatment	0.0169	0	0.04535	0	0.15
	Post-treatment	0.0562	0.0763	0.05136	0	0.16
	Post-delay	0.048	0.0555	0.04324	0	0.1
	Total	0.0404	0	0.04881	0	0.16
Postcon.n	Pre-treatment	0.0147	0	0.0568	0	0.22
	Post-treatment	0.0584	0	0.0689	0	0.18
	Post-delay	0.0429	0	0.0487	0	0.1
	Total	0.0387	0	0.06023	0	0.22
Postcon.s	Pre-treatment	0	0	0	0	0
	Post-treatment	0.0534	0	0.07344	0	0.23
	Post-delay	0.0435	0	0.07739	0	0.2
	Total	0.0323	0	0.06459	0	0.23

The maximum speed, as with repetitions, was higher in the beginners group. Otherwise, the tendencies were very similar to those in the beginners' group, with frequent zeros and same ordering in terms of speed as the one in the beginners' group, and with pre-treatment values that were not zero being faster than post-treatment values.

6.2.1. Differences by time

Time was a significant factor in repetitions ($F=26.317757$, $p<.0001$) with a medium size effect (Partial Eta = 0.42), as well as speed ($F=8.376035$, $p=0.0004$), though this later with a smaller size effect (Partial Eta = 0.2). As for repetitions, the differences were significant between pre-treatment and post-treatment ($p=0.0003508$), and between pre-treatment and

delayed measurement (p=0.0003508), but not between post-treatment and delay (p=1), indicating that the gain after the treatment was not lost in the subsequent weeks. As for speed, the treatment did render an effect, and pre and post-test measurements were significantly different (p= 0.0005011) but neither pre- nor post-treatment values differed significantly from those of the delayed time (p=0.1932228 and p=0.0883327 respectively), indicating that the delayed measurements lay somewhere in between, and therefore some loss of the previous gain has occurred, not enough to be statistically significant, but sufficient to be closer to the initial levels.

6.2.2. Differences by position

The number of repetitions was the only variable affected meaningfully by position (F=17.442368, p<.0001), unlike speed (F=1.751714, p=0.1607). The statistically significant differences were found between post-consonantal s and initial (p=0.0112891), and also between post-consonantal s and intervocalic (p=0.0001222), indicating that post-consonantal position after /s/ was particularly difficult in general for the advanced group, which started at a higher number of repetitions in non-post-consonantal positions than the beginners' group, but still struggled with post-consonantal position following /s/.[3] The effect size here was medium-low (Partial Eta = 0.33).

6.2.3. Interaction of time and position

For the advanced group, neither in speed nor in rolling times there were any interactions between time and position. Therefore, it seems that although the post-consonantal *s* position was a little harder (or rather the other was easier according to the descriptive measures in Tables 3 and 4), it did not interact with the effect of the treatment, which was significant for both speed and repetitions, and lasting for the latter only.

6.3. Immersion group

In the case of the immersion group, there are only measures for pre- and post-treatment, no delay measure, and only for one measure of the post-consonantal positions, the one after /n/. Table 5 below presents descriptive measures for this group.

[3] It may be worth noting that, even though not statistically significant, the probability for it between the two post-consonantal positions was the next lowest one at 0.07, and not those of post-consonantal n and the initial and intervocalic positions.

Table 5. *Repetitions by position and time in Immersion group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	1	1	0	1	1
	Post-treatment	2.2	2	0.422	2	3
	Total	1.6	1.5	0.681	1	3
Intervocalic	Pre-treatment	1	1	0	1	1
	Post-treatment	3.3	3	0.483	3	4
	Total	2.15	2	1.226	1	4
Postcon.n	Pre-treatment	1	1	0	1	1
	Post-treatment	2.2	2	0.422	2	3
	Total	1.6	1.5	0.681	1	3

Immersion group produced more repetitions to begin with, like the number of post-treatment repetitions in the at-home groups. Mean and median were fairly close, suggesting that there were not many extreme values. The most defining difference with respect to the previous groups, though, is that minimum values were systematically higher, that is, at least one point over zero. Table 6 below shows speed/fluency values.

Table 6. *Speed of repetitions by position and time in Immersion group*

Position	Time	Mean	Median	Std. Deviation	Min.	Max.
Initial	Pre-treatment	0.4466	0.4495	0.02057	0.41	0.48
	Post-treatment	0.244	0.246	0.0396	0.17	0.3
	Total	0.3453	0.3562	0.10836	0.17	0.48
Intervocalic	Pre-treatment	0.4445	0.444	0.00295	0.44	0.45
	Post-treatment	0.1495	0.1583	0.01869	0.12	0.17
	Total	0.297	0.3042	0.15188	0.12	0.45
Postcon.n	Pre-treatment	0.7037	0.698	0.04098	0.63	0.76
	Post-treatment	0.3329	0.354	0.05197	0.23	0.37
	Total	0.5183	0.4983	0.19558	0.23	0.76

As with repetitions, minimum values were commonly above zero, maximum values were very high, and there did not seem to be as many extreme values distorting the mean, very similar to the median. The slowest pronunciations corresponded to post-consonantal > initial > intervocalic, consistent with the previously observed results.

6.3.1. Differences by time

Looking at Figures 2 and 3 it becomes clear that the immersion group is very different from the other two groups, and their pre-treatment levels are similar to post-treatment and delay levels in the other two groups. However, they benefited from the instruction as well, and they showed a significant improvement in terms of repetitions ($F=504.5950$, $p<.0001$) with an extremely high size effect (Partial Eta = 0.95) and speed ($F=1120.337$, $p<.0001$), also with an extremely high size effect (Partial Eta = 0.96).

6.3.2. Differences by position

The immersion group also showed differences in terms of the position for both repetitions ($F=27.6397$, $p<.0001$) with a medium-high size effect (Partial Eta = 0.56) and fluency of repetitions ($F=241.429$, $p<.0001$) with an extremely high size effect (Partial Eta = 0.91). Regarding repetitions, all positions were significantly different, with intervocalic being the easiest (most repetitions) and post-consonantal, in this case only /n/, being the most difficult (for all $p<.001$). As for the fluency, the results were also all extremely significant ($F=241.4$, $p<.0001$). The fluency was highest in intervocalic position, closely followed by initial, while it was lowest in post-consonantal position. A separate question, though, perhaps more interesting, is whether these differences varied in interaction with time, that is, whether there are positions that benefited more from the instruction than others.

6.3.3. Interaction of time and position

The immersion group was the only group showing significant interactions between position and time in both repetitions ($F=27.63$, $p<.0001$) and fluency/speed ($F=31.6$, $p<.0001$). In both cases the size effects were medium-high, Partial Eta was 0.56 for repetitions and 0.48 for speed. Here, in the case of fluency, all combinations were significantly different except for before the treatment between initial and intervocalic, where both were quite high.

The interactions with repetitions were a little more complex. All contrasts between pre-treatment positions were not significant. That is, before the treatment, the number of repetitions was not different for the different positions. Within the post-treatment contrast, post-consonantal /n/ and initial were not significantly different, but the rest of combinations were. When it came to the contrast between pre- and post-treatment in between positions, regardless of the position, the post-treatment values were always significantly higher.

7. Discussion

7.1. Treatment Efficacy

Does the treatment work? And if it does, when and where is it best applied? The results strongly suggest that the treatment applied worked. However, it did not work equally at every level, nor for repetitions number vs. fluency. In all levels, the repetitions increased, and for beginning and advanced learners this effect was maintained. However, in the case

of these two groups, this came at the cost of fluency, with beginners never increasing the speed, and advanced learners starting to increase it, although not significantly so, in the delay measurement. In both groups, most of the participants did not have repetitions at all or very little before treatment, so a significant increase was achieved at the price of slower vibrations, which is preferable to almost no repetitions. Only the immersion group increased fluency, and it did so even though they also were able to increase the number of repetitions significantly.

All across the three groups and the different times in the case of the immersion group, the intervocalic position seemed the easiest, already in the pre-treatment, followed by the initial, while post-consonantal, particularly after /s/, was the hardest.

These results indicate that intervention is effective in both the beginners and the more advanced learners, as well as in an immersion situation abroad. The best effects are obtained in the advanced group and the immersion one in terms of repetitions. It may still valuable to use these ST methods since early on if there is time for it in the instruction, as there are effects and students enjoyed them. It is possible that a later repetition at the advanced level could build upon those results to see final values more similar to those of the immersion group. The position after a consonant needs the most practice for all the groups and levels. As for speed, effects probably will not be seen till very late in the development, although, starting earlier and building up upon those initial increases of repetitions even at the cost of speed, may have a positive later effect in fluency at a third point in the development, as the immersion group started high and was finally able to show an increase in fluency. That said whether the immersion effect would last or not cannot be predicted given the design of the study, and as it could also be due to exposure to more techniques/longer session used with this group.

7.2. Suggestions for Future Research

Only future research can clarify if the effects found in the immersion group are durable. The sharp contrast between the advanced at home and the immersion group needs further investigation, making sure the treatment is exactly the same. Another question for longitudinal testing is the possibility that instruction in basic levels could help to achieve in the classroom the levels seen in immersion, or at least closer, at the advanced courses.

Finally, testing how much of training is desirable, as the immersion group had more time to explore more of these ST activities than the other groups, could render interesting results. However, immersion group did start at a better place, so it is not possible from this study to separate the effect of starting point and more instruction, and this also is left to future studies.

8. Conclusions

This study has explored the potential benefits of interdisciplinarity by applying ST techniques for L1 speakers to the L2 pronunciation classroom. Results are encouraging and indicate that ST techniques are successful in improving L2 segmental features, although possibly more so at higher levels. Further research is needed to clarify the most effective amount and type of ST techniques, as well as publications focused on adapting ST techniques for Spanish L2 that can serve as applicable and more approachable resources for teaching Spanish L2 pronunciations that all instructors can use.

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