
Substitution Patterns of the English Voiced Interdental Fricative by L1 Costa Rican Spanish Speakers

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Received: 30-10-2022
Accepted: 16-02-2024
Published: 11-04-2024

How to cite: Fonseca Quesada, Felix. 2024. Substitution Patterns of the English Voiced Interdental Fricative by L1 Costa Rican Spanish Speakers. RLLT 21, eds. Grant Armstrong, Roberta D'Alessandro & M.Carmen Parafita Couto. Special Issue of *Isogloss. Open Journal of Romance Linguistics* 10(2)/1, 1-10.
DOI: <https://doi.org/10.5565/rev/isogloss.284>

Abstract

L1 Spanish speakers learning English struggle to produce the English voiced interdental fricative [ð]. This is surprising as [ð] occurs naturally in Spanish as an intervocalic allophone of /d/. To investigate Spanish speakers' production of [ð] in English, I conducted a study with ten L1 Costa Rican Spanish/L2 English speakers. The results show that English voiced interdental fricatives were produced with target pronunciation 43.4% (214/494) of the time and were substituted in the remaining 56.6% (280/494). It was determined that target-sound substitution patterns depend on the phonological contexts in which the target sound occurs (word-initial vs. intervocalic), and the type of speaking task (reading vs. spontaneous). I interpret these results as partially due to phonological transfer: L1 allophonic information affects L2 speech production. The results also show that the realization of the segments is affected by the different experimental tasks: speakers

have more target-like production in tasks where there is an opportunity for more careful pronunciation (reading task) than in more spontaneous ones. Finally, I argue that the unexpected appearance of the alveolar tap [ɾ] is due to an interaction between the English /d/ tapping allophone rule and the status of [d] and [ð] in the learner's interlanguage.

Keywords: L2 English production, sound substitution, voiced interdental fricative, Costa Rican Spanish.

1. Introduction

Many characteristics of L2 phonology have been attributed to the transfer of phonological knowledge from L1 to L2 (e.g., Major 2008; Zampini 1994). One common case in which transfer is hypothesized involves substitution, whereby an L2 segment is replaced by a different L1 segment. Substitution can occur because the L2 segment is missing from the L1's phoneme inventory, or because of a different allophonic distribution in the interlanguage (Eckman et al. 2001, 2003; Zampini 1994). An example of this is the English voiced interdental fricative [ð], which represents a challenge for many English language learners. This segment is typologically rare, present in only 5% of the world's languages, according to the Phoible website (Moran et al. 2019), and is often substituted by other sounds in the L2 English of speakers of Dutch (Hanulíková & Weber 2011; Wester et al. 2007), German (Hanulíková & Weber 2011), and Spanish (Zampini 1996).

The Spanish case is particularly surprising since [ð] is present in the Spanish inventory and we might therefore expect Spanish speakers to produce it without issue. However, [ð] has a different distribution and phonemic status in the two languages. In English, the voiced interdental fricative /ð/ is a phoneme on its own and is contrastive with the stop /d/, (e.g., [ðeɪ] 'they' and [deɪ] 'day'). In Spanish, [ð] is an allophonic variant of /d/. The Spanish phoneme /d/ is realized as a stop [d] in certain contexts (e.g., after a nasal: *in[d]icar* 'to indicate'), and it undergoes spirantization to become the fricative¹ [ð] in other contexts (e.g., post-vocalic position: *pre[ð]icar* 'to preach'). The exact distribution of Spanish /d/, however, depends on dialect. To illustrate, Fernandez (1982) found that Costa Rican Spanish speakers prefer the occlusive variant [d] in most contexts, restricting [ð] to post-vocalic positions only; a similar distribution had been proposed in Chavarria-Aguilar (1951). In a more recent acoustic study, Carrasco et al. (2012) confirmed that in the Costa Rican dialect of Spanish, the occlusive allophone [d] – in addition to occurring in post-pausal position – is frequent in all post-consonantal environments, including glides (e.g. [dewda] 'debt'). Carrasco et al. (2012) propose that in Costa Rican Spanish, the cognitive relation between /d/ allophones is of a different nature compared to other Spanish dialects.

¹ It has been argued that the allophone [ð] is not a fricative but rather an approximant (Hualde et al. 2011). Since this is not a central question involved in this project, I will continue referring to it as a fricative sound.

These differences in the distribution of the sounds in their L1 and their target language posit an important challenge for L2 speakers. Based on the Speech Learning Model (SLM) proposed by Flege (1995), L2 speakers establish the new L2 phonetic categories according to the phonetic similarities that sounds have to existing L1 sound categories, and sounds are perceptually related at a position-sensitive allophone level rather than at a phonemic level. Following this line of thinking, Spanish learners of English are expected to associate the target phoneme /ð/ to intervocalic positions, where Spanish intervocalic /d/ surfaces as an approximant [ð]. The association of English /ð/ to an intervocalic context by Spanish speakers predicts greater production accuracy of the English fricative /ð/ in this context, compared to other contexts like word-initial position. This pattern has been demonstrated in previous studies where L1 Spanish speakers produce a stop [d] word-initially for English /ð/, but are more successful in producing the fricative/approximant [ð] in intervocalic contexts (e.g., Eckman et al. 2003; Zampini 1996). Consequently, when faced with the English distribution pattern, the learners in question must redistribute or split the allophones [d] and [ð] in their L1 and map them onto separate phonemes in the L2. Eckman et. al. (2003) defines allophonic split as sounds which are allophones of one phoneme in the learner's L1, but which constitute separate phonemes in the target language.

Prior research has addressed the substitution of the English voiced interdental fricative by a stop [d] by Spanish learners of English (Eckman et. al. 2003; Zampini 1996). In this paper, I expand on that research and investigate the substitution of the English voiced interdental fricative by L1 Costa Rican Spanish speakers, to examine (1) the frequency with which English /ð/ is substituted, (2) the common preferred sounds in the speaker's productions, and (3) the contexts in which such substitutions are most likely to occur. Although it has been proposed that Costa Rican Spanish speakers have a different cognitive realization for /d/ (Carrasco et al. 2012), it is still predicted that the results will pattern like those of previous studies, where target English /ð/ is realized as a stop word-initially and more accurately as [ð] in intervocalic position, given that the stop is the allophone realized in word initial position, and the approximant is realized in post-vocalic position in this dialect of Spanish. This paper is organized as follows. Section 2 describes the pilot experiment I conducted to probe these issues, including information regarding the participants, as well as materials and the procedure of the experiment. Section 3 presents the results from the experiment according to a) the sounds produced for the target segment, and b) the phonological contexts in which the substitutions occurred. And finally, a discussion of the results is provided in section 4, emphasizing the role of the L1 phonology in the production of the target productions, and examining the use of the alveolar tap [ɾ] as a substitute for intervocalic /ð/, which poses an important question about the speakers' representation of the critical phones.

2. Methodology

2.1. Participants

The participants for this study were 10 first-year students (seven females, three males) from the English Teaching as a Foreign Language program at the University

of Costa Rica-Western Campus. The participants were recruited through an electronic flyer shared through WhatsApp groups, and participated voluntarily in the study. All of them were native Spanish speakers from Costa Rica aged between 19 and 24 years old (mean age 21.5), who currently resided in the western region of the Central Valley of the country. The participants were enrolled in their second semester of the required English class series (English Oral Communication II, English Oral Communication Lab II, English Written Communication II). In addition, the students had not taken the Phonetics course, which is part of the third semester coursework. In the Phonetics class, not only do students learn the theoretical fundamentals of English speech sounds, but they also receive training to improve their English pronunciation. It was important to look at the students' production prior to receiving phonetics training as it would be more consistent with other English L2 learners who never receive explicit training in phonetics. It would also avoid more careful and planned articulation of the sounds. In addition, the participants were asked a set of questions to describe their English learning process. All the participants had studied English in the public education system of Costa Rica, both in primary and secondary school; this means that participants had a minimum of eleven years of English instruction. Even though the proficiency of the participants was not measured, the level of the participants was sufficient to complete the different tasks assigned.

2.2. Materials and Procedure

The experiment consisted of two tasks. One was a reading task. A short text was used from the internet, and eight additional sentences were created, with a total of 35 tokens of the target English voiced interdental fricative in different phonological contexts. In addition, to compare a more spontaneous production of [ð] with the possible careful articulation in the reading tasks, there was a second task that included an open-ended question intended to encourage participants to produce spontaneous speech (see the Appendix.) Due to the lack of a lab and the unexpected Covid 19 pandemic, participants were asked to record themselves using a voice recorder in their phones, and to find a quiet place to avoid background noise. Participants were asked to read and talk at a comfortable and natural speaking rate.

The pronunciation of the target segment was transcribed impressionistically by the author. While there were no transcription checks, the author had training in phonetics and both English and Spanish experience. The sounds were classified in two main categories: (1) as the target production (i. e., [ð]), or (2) as a substitution. The substitutions were further categorized according to the segment that was used (as a stop [d] or tap [r]). All the data from the reading tasks were analyzed together, while those from the open question were analyzed separately.

3. Results

The data from the 10 speakers formed a corpus of 494 tokens of the target sound. A total of 350 tokens were part of the reading tasks, and the remaining 144 resulted from the spontaneous speech task. Overall, the voiced interdental fricative [ð] was

produced in 43.4% (214) of the cases, and it was substituted with [d] in 49.3% (244 times), and surprisingly with the alveolar tap [ɾ] in 7.3% (36 times).

3.1. Target-[ð] Production by Context

The most frequent substitute for the voiced interdental fricative was [d]. Out of the 244 tokens produced with a stop, 87.2% (213) appeared in word-initial position (e.g., the words *there* and *though* were pronounced as [dɛɪ] and [doʊ]), while the remaining 12.7% (31) occurred in intervocalic position (e.g., the words *smoother* and *mother* were pronounced [ˈsmudə] and [ˈmʌdə]). The voiced interdental fricative was produced as a fricative in 214 tokens: in word-initial position (88 tokens) and in intervocalic position (126 tokens). In the case of the tap [ɾ], it was used as a substitution 36 times, and 100% (36) of these substitutions appeared in intervocalic position (e.g., the words *together*, *weather* and *another* were pronounced as [təˈgɛɾə], [ˈweɾə] and [əˈnʌɾə]).

Table 1. Percentages of [ð] substitutions per context (number of tokens in brackets).

[ð] realization	Word-Initial (301)	Intervocalic Position (193)
[ð] (214)	41.1% (88)	58.9% (126)
[d] (244)	87.3% (213)	12.7% (31)
[ɾ] (36)	0%	100% (36)

The target [ð] was substituted much more frequently in word-initial position (213 tokens, or 76.07% of the cases) than in intervocalic position (67 tokens, or 23.92% of the cases). In other words, the target [ð] was realized more frequently in intervocalic position than in word-initial position.

3.2. Target-[ð] Production by Task

In terms of the production of the target [ð] by experimental task, out of the 350 repetitions in the reading tasks, [ð] was pronounced 176 times (50.28% of the cases), while [d] was used 143 times (40.85% of the cases), and [ɾ] 31 times (8.85% of the cases).

Table 2. Percentages of [ð] substitutions in reading tasks (number of tokens in brackets).

Target [ð] realizations	Reading Tasks (350 tokens)
[ð]	50.2% (176)
[d]	40.9% (143)
[ɾ]	8.9% (31)

In the free speaking task, which created a corpus of 144 words, [ð] was produced correctly 38 times (26.39%); it was substituted with [d] 101 times (70.14%), and with the tap [ɾ] only 5 times (3.47%).

Table 3. Percentages of [ð] substitutions in spontaneous speech (number of tokens in brackets).

Target [ð] realizations	Open-ended Question (144 tokens)
[ð]	26.39% (38)
[d]	70.14% (101)
[ɾ]	3.47% (5)

4. Discussion

Given the frequency with which the English voiced interdental fricative [ð] was substituted, the results confirm that this segment is a consistent challenge for Spanish native speakers, even when the same sound (or a similar one) exists in their L1. The main findings of this study are discussed below.

First, in the spontaneous speech task, the voiced interdental fricative [ð] was substituted in the majority of cases (73.61%), while in the reading tasks it was produced accurately more than half of the time (50.28%). This suggests that there is a higher accuracy when speakers have the chance to produce more careful speech as compared to spontaneous speech.

Second, the fact that the voiced interdental fricative was realized more frequently in intervocalic position (58.88% of the cases) than in word-initial position (41.12% of the cases) suggests that the allophonic relationship in the learners' L1 – whereby the [ð] allophone is realized intervocalically – has a role in their L2 English production (Eckman et al. 2001). Furthermore, the substitution of the target sound with [d] was much more prevalent in word-initial position (87.29%) than in intervocalic position (12.7%). This also reflects transfer from the speakers' L1 in which the stop is possible in word-initially, but not intervocalically, and confirms that L1 allophonic patterns have a strong effect in the L2 forms.

Perhaps the most surprising finding concerns the alveolar tap [r], which was used as a substitute for the English voiced interdental fricative sound in 7.6% of the cases (36 tokens) and appeared in the speech of 6 of the 10 speakers². All cases of this substitution were in intervocalic position and never in initial position, which corresponds to the distribution of tap in Spanish: tap is possible in intervocalic position, but not in absolute word-initial position (Hualde 2014).

In each of the cases discussed above, the dominant pattern reflects the phonology of the L1: (1) the target is realized more frequently as a fricative or a tap intervocalically than word-initially, and in the L1 the voiced interdental fricative and tap are permitted intervocalically but not word-initially; (2) the target is realized more frequently as a stop word-initially than intervocalically, and in the L1 the stop is realized word-initially but not intervocalically. These production patterns appear to match the predictions of the SLM, which proposes that the association of the L2 sounds is context-sensitive according to similarity between L1 and L2 sounds.

However, the appearance of the tap in L2 English productions of /ð/ shows that the situation is more complex. As schematized in Figure 1, in Spanish, the alveolar tap [r] is a phoneme on its own. In Spanish, it contrasts with [ð] in intervocalic position as in [toðo] 'all' vs. [toro] 'bull'. In North American English, the tap is an allophone of the voiced alveolar stop /d/ (as well as /t/) in intervocalic position³. The fricative [ð] and the tap [r] also contrast in English intervocalically, one example being ['hɛðə] *heather* versus ['hɛrə] *header*.

² Each of the six speakers produced between three and nine taps as substitutions of the target /ð/.

³ The distribution of allophones in English is slightly more complex: the tap is realized in intervocalic position before an unstressed vowel.

Figure 1. Distribution of the Sounds in Spanish and English

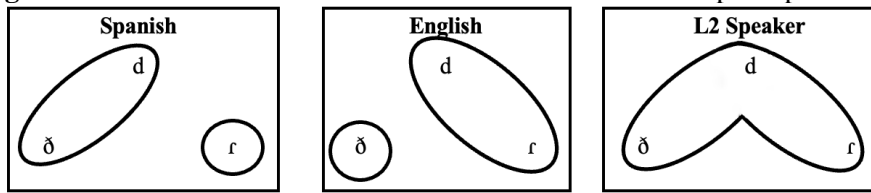
	/d/		/ð/		/d/		/r/
English	/	\		Spanish	/	\	
	[d]	[r]	[ð]		[d]	[ð]	[r]

So why would Spanish speakers substitute the English fricative with the tap in intervocalic position regardless of their contrastive status in both their L1 and the target language? First, it cannot be because of perception, as it has been demonstrated that both Spanish and English speakers are able to discriminate the sounds [ð] and [r] perceptually. Boomershine et al. (2008) tested discrimination between the three phones [d], [ð] and [r] by L1 English speakers, as well as L1 Spanish speakers from different dialects; English speakers outperformed Spanish speakers when asked to discriminate between [d] and [ð], due to the fact that these sounds have contrastive status in English but not in Spanish. In contrast, Spanish speakers were more successful at discriminating between [d] and [r] than English speakers, due to the allophonic status of these sounds in the English speakers' L1. Additionally, both groups were equally successful in discriminating [ð] from [r], given the contrastive nature of the sounds in the two languages. The discrimination patterns of the Spanish speakers reported in Boomershine et al. (2008) are also reported for Costa Rican Spanish speakers specifically, as demonstrated by Chappell (2017). Furthermore, Costa Rican Spanish speakers also show lower levels of discrimination between the allophones [d] and [ð] but are more successful at discriminating between [ð] and [r].

We could also think of an articulatory explanation. Since the stop [d] is the most frequent realization of the target fricative, but the stop [d] is not an accepted realization in intervocalic position in the L1, speakers might use the articulatorily similar tap (Hualde 2014). However, the segments have different places of articulation: the Spanish stop [d] is dental (the English stop is alveolar), while in both languages the tap is alveolar, and the fricative is interdental. Therefore, an articulatory hypothesis is unlikely in part because the differences in place of articulation do not seem to predict why they choose the alveolar tap as a substitute of the interdental fricative. Furthermore, although the appearance of the tap was found in fewer tokens, the tap was more consistent in the reading tasks, where speakers are generally able to produce sounds more carefully, suggesting that the use of the tap is not necessarily a matter of confusion in articulation or attempt at ease of articulation.

Another possibility is that there is a phonological connection among all three sounds in the speakers' interlanguage. If these speakers are acquiring the English tapping rule, whereby [r] is an intervocalic allophone of /d/ and have not learned to split the allophonic status of the segments in their production of English, the three sounds could be associated as elements of one phoneme, as shown in Figure 2.

Figure 2. Distribution of the sounds. Each enclosed shape represents a phoneme



On the other hand, each phone in this L2 speakers' productions is realized most frequently in the environment that reflects its usage in the L1. This suggests that the Spanish phonology is still playing a role.

5. Conclusions

The results of this study show how the L1 allophonic distribution of sounds can affect L2 production, how the blending of the allophonic relationships in L1 and L2 can influence substitution patterns, and how different tasks (reading vs. spontaneous speech) can impact the realization of segments. Additionally, these results suggest that the association of L2 sounds in the speakers' interlanguage occurs at a context-sensitive level, based on the phonetic similarities to existing L1 sounds, as discussed in SLM (Flege 1995) and SLM-r (Flege & Bohn 2021). The additional importance of the English /d/ tapping rule, an optional and subtle one, was a particularly interesting result.

While these results show interesting patterns in L2 sound learning, it is important to point out some considerations for both the interpretation of these results and future research. First, data from a larger number of participants, as well as more tokens per condition is needed to more strongly establish the results found here. Second, in order to better explain the extent to which the three sounds ([d], [ð] and [r]) merge as part of the same mental representation as hypothesized in this paper, we need more accurate measures on speakers' proficiency in the target language, given that interlanguages change and more experienced L2 speakers tend to be more successful at approximating accurate phonetic realizations of the target sounds (Flege 1987; Shea & Curtin 2011).

The results in this paper emphasize how the L2 sound learning goes beyond the question of how familiar/different the L2 sounds are to L1 existing sounds, and they highlight the possible benefits of introducing allophonic awareness into the instruction in English as an L2. It is clear that these Spanish native speakers learning English as an L2 do not make an English-like phonological distinction among the segments analyzed in this pilot study. Although the concept of native-like productions in L2 speakers may be controversial, helping learners achieve more accurate communication, is a valuable goal, and our results suggest that learners will benefit from understanding the phonological relationship among the sounds in the language they are learning.

Acknowledgments

I want to thank my undergraduate instructors at the University of Costa Rica-Western Campus for always helping me in many ways even after I left the program – in particular, I want to thank José Miguel Vargas Vásquez for helping me recruit the participants. I also want to thank my professors at Stony Brook University – particularly Lori Repetti and Marie Huffman – with whom I had excellent discussions and who provided feedback when writing the paper. Finally, I have also benefited greatly from the anonymous reviewers and their helpful comments.

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