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Mirror Phonological Distributions in L1–L2 Mappings: [d ð ɾ] in L1 Spanish Learners of General American English

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Abstract: The three phones [d ð ɾ] exist in both Spanish and some varieties of English (e.g., General American English). However, their phonological status differs across the two languages, creating a challenge for L1 Spanish learners of L2 English. This study examines the development of allophonic union and allophonic split involving these three phones. In allophonic split, the L1 allophones of /d/ ([d] and [ð]) must be mapped onto separate L2 phonemes (/d/ and /ð/), whereas in allophonic union, the L1 phonemes /d/ and /ɾ/ must be mapped as allophones of a single L2 phoneme (/d/). Ten Costa Rican Spanish speakers completed a production task targeting English /ð/ in word-initial and intervocalic contexts and English /d/ in intervocalic context. The results reveal a complex distribution of the three phones in the learners' interlanguage, reflecting persistent L1 influence, emerging target-like patterns, and productive phonological processes that cannot be explained solely by either L1 transfer or L2 input.
Keywords: L2 phonology; allophonic split; allophonic union; L1 Spanish-L2 English; interlanguage

ES Distribuciones fonológicas espejo en correspondencias L1-L2: [d ð ɾ] en hablantes de español como L1 aprendiendo inglés estadounidense general

Resumen: Los tres sonidos [d ð ɾ] existen tanto en español como en algunas variedades del inglés (p. ej., el inglés estadounidense general). Sin embargo, su estatus fonológico difiere entre ambas lenguas, lo que representa un desafío para los aprendices hispanohablantes de inglés como L2. Este estudio examina el desarrollo de la unión alofónica y la escisión alofónica que involucran estos tres sonidos. En la escisión alofónica, los alófonos de la L1 correspondientes a /d/ ([d] y [ð]) deben reorganizarse como fonemas separados en la L2 (/d/ y /ð/), mientras que en la unión alofónica, los fonemas /d/ y /ɾ/ de la L1 deben reorganizarse como alófonos de un mismo fonema en la L2 (/d/). Diez hablantes de español costarricense completaron una tarea de producción dirigida a /ð/ del inglés en contextos iniciales de palabra e intervocálicos, así como a /d/ del inglés en contexto intervocálico. Los resultados revelan una distribución compleja de los tres sonidos en la interlengua de los participantes, que refleja una influencia persistente de la L1, la aparición de patrones más cercanos a la lengua meta y procesos fonológicos productivos que no pueden explicarse únicamente ni por la transferencia de la L1 ni por el input de la L2.
Palabras clave: fonología en L2; escisión fonológica; unión fonológica; Español L1 – Inglés L2; interlengua

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1. Introduction

The process of learning a new language involves categorizing new and familiar phones. In other words, it involves acquiring phones that are not present in the speaker's L1, but it also involves reorganizing phones that exist in the L1 into different phonemic categories. One of the most complex processes in L2 phonological

development is that of an *allophonic split*, whereby two allophones of the same phoneme in the L1 constitute separate phonemes in the L2 (e.g., Eckman et al. 2003). For example, L1 Spanish learners of English must learn that their L1 allophones of /d/, [d] and [ð], are separate phonemes in the L2. It has been documented that, when acquiring the English phoneme /ð/, L1 Spanish speakers transfer the phonological distribution of /d/ from their L1, producing a stop [d] in word-initial positions, and a fricative/approximant[1] in intervocalic contexts (e.g., Fonseca Quesada 2024; Zampini 1996). Another known process in the L2 phonological development is coalescence – or *allophonic union* – whereby two L1 phonemes become allophones of the same phoneme in the target language (Barrios et al. 2016). Considering again L1 Spanish learners of L2 General American English (GAE), the L1 phonemes /d/ and /ɾ/ constitute allophones of a single English phoneme /d/, such that [d] occurs in, for instance, word-initial contexts, and [ɾ] occurs in some intervocalic positions.

In this article, I examine the transitional stages of both processes – allophonic split and allophonic union – in the L2 GAE phonological development of L1 Costa Rican Spanish speakers. While both processes – allophonic split and allophonic union – have been widely studied, to the best of my knowledge there is no study that investigates how the two processes happen at the same time involving the same phones. Analyses of the L2 production data obtained from the L1 Costa Rican Spanish (CRS) speakers of L2 GAE will be used to investigate the acquisition of the allophonic relations among the phones [d], [ð], and [ɾ], which map onto different underlying phonological representations in the speaker's native language and target language. An experiment was designed to elicit read English production data from L1 Costa Rican Spanish speakers, containing multiple tokens of the English phonemes /d/ and /ð/ produced in different phonological contexts. Speakers' production of the two target phones presents evidence of progress towards both allophonic split and allophonic union happening simultaneously: on the one hand, speakers demonstrate acquisition of both target English phonemes by producing correct context allophones. On the other hand, speakers also alternate their allophonic productions, producing on-target realization of the phonemes, as well as incorrect phone substitutions.

2. Background

When attempting to produce English /ð/, L1 Spanish speakers transfer the phonological distribution of Spanish /d/, which leads them to produce a stop [d] in a word-initial position, and a fricative/approximant [ð] in intervocalic position (Eckman et al. 2003; Fonseca Quesada 2024; Zampini 1996). The phonological distribution of [d] and [ð] in English represents a challenge for Spanish speakers; in Spanish L1, [ð] and [d] are allophones of the phoneme /d/, but in the target language (English), [d] and [ð] represent different phonemic categories (/d/ and /ð/). Fonseca Quesada (2024) looked at the production patterns of English [ð] by Costa Rican Spanish speakers in reading and spontaneous tasks; the participants in the study produced the target phone [ð] more faithfully in intervocalic positions, while word-initially, it was substituted with a stop [d] in most cases. The study confirmed that the speakers' Spanish phonology played a role in the speakers' production patterns. However, one surprising finding was that six out of ten speakers realized English intervocalic /ð/ as an alveolar tap [ɾ]; this substitution for the target phone is surprising because Spanish speakers should encounter no difficulties when producing [ð] in intervocalic positions, as this is what happens in their L1 /d/ intervocalic realization, which again, seemed to be playing a role in the speakers' L2 production. In addition, both in Spanish and in some varieties of English (e.g., North American English varieties), the phones [ð] and [ɾ] are part of different phonemic categories; in Spanish, [ð] is an allophone of /d/, and the tap represents a different phoneme /ɾ/. In GAE, /ð/ is a phoneme on its own, and the tap is an intervocalic allophone of /d/. The fricative/approximant and the tap are contrastive at the surface level in both the speakers' L1 and the target language. Fonseca Quesada (2024) hypothesized that one possible explanation for this phenomenon – [ɾ] resulting as an intervocalic substitution of English /ð/ – might be due to the acquisition of the GAE tapping rule, whereby GAE /d/ surfaces as an alveolar tap [ɾ] in intervocalic position. Such a rule, when acquired by a Spanish L1 learner of GAE may further give rise to an association between the phones [d], [ð] and [ɾ] in the speakers' interlanguage (the grammar that is neither identical to the native nor the target language (e.g., Selinker 1972). This substitution pattern raises important questions about the mapping of phones during L2 phonological acquisition, and therefore, the hypothesis provided in Fonseca Quesada (2024) must be examined further.

2.1. Distribution of the phones in GAE and Spanish

In most varieties of Spanish, the phoneme /d/ is produced as an alveolar stop in post-pausal contexts like word-initial positions (e.g., [dar] 'to give') and after the alveolar consonants [l] (e.g., [aldea] 'village') and [n] (e.g., [kondena] 'sentence'), (e.g., Hualde 2014). The spirant version [ð] is present in the remaining contexts; this includes post-vocalic positions within the word (e.g., [aðemas] 'also'), word-initial positions in connected speech (e.g., [la ðjosa] 'the goddess'), and word-final positions, as well as after certain consonants like [ɾ] (e.g., [berðað] 'truth') and glides (e.g., [dewða] 'debt'). The exact distribution of Spanish /d/, however, depends on each 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 Chavarría-Aguilar (1951). In a more recent acoustic study by Carrasco et al. (2012), it was confirmed that the Costa Rican dialect of Spanish maintains a different allophonic distribution for /d/, in which the occlusive allophone is frequent in post-pausal contexts, as well as all post-consonantal environments, including glides (e.g., [dewda]

[1] The Spanish allophone [ð] is an approximant (e.g., Hualde et al., 2011). In that sense, when referring to what is produced by L1 Spanish L2 English speakers, I will refer to [ð] as a fricative/approximant, as I am not examining what exactly is being produced at the phonetic level. Please see section 2.2. for additional comments on this matter.

'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. In English, however, /d/ and /ð/ constitute different phoneme categories and are contrastive, as in the pairs [ðeɪ] 'they' and [deɪ] 'day.' This means that the voiced interdental fricative [ð] is present in both English and Spanish but maintains a different phonemic distribution in each of these languages: [ð] presents an allophone of /d/ in Spanish, but a contrastive phoneme in English /ð/.

The alveolar tap [ɾ], which appeared as a substitution for English intervocalic /ð/ by the L1 Spanish speakers in Fonseca Quesada (2024), is also present in both languages in question. In GAE, [ɾ] is used as an allophone of /d/, as well as of /t/, in intervocalic positions after a stressed vowel (e.g., Eddington and Elzinga 2008; Herd et al. 2010; Turk 1992), as well as between the retroflex approximant [ɹ] and a following vowel (e.g., [stɑɹəd] "started"). In Spanish, however, /ɾ/ has a phonemic status, and appears in intervocalic positions (e.g., [ka.ɾa] 'face'), in consonant cluster onsets (e.g., [tra.er] 'to bring') and word-finally (e.g., [ko.reɾ] 'to run') (e.g., Bradley 2019). Figure 1 shows the distribution of the phones of interest in Spanish and GAE. I refer to this difference in distribution as "a mirror case."

GAE			CRS		
/d/		/ð/	/d/		/ɾ/
/	\	|	/	\	|
[d]	[ɾ]	[ð]	[d]	[ð]	[ɾ]

Figure 1. Distribution of the phones [d], [ð] and [ɾ] in CRS and GAE.

In both languages, [ð] and [ɾ] are contrastive at the surface level. Consider Spanish words [toðo] 'all' and [toɾo] 'bull', which differ on the phones [ð] and [ɾ], suggesting that both phones form part of different phonemic representations. A similar relationship is observed in GAE; the words 'heather' [hɛðɚ] and 'header' [hɛɾɚ] also differ on the same phone. This suggests that the Spanish speakers in Fonseca Quesada (2024) were substituting a phoneme with a phone that maintains a contrastive status in both the speakers' L1 and the L2, which raises questions about the nature of this substitution pattern.

2.2. Acquiring Target L2 [d ð ɾ] Phones

Different L2 acquisition models have been proposed to account for how L2 speakers develop phone categories in the target language involving new and familiar phones. Examples of these models are the Speech Learning Model (SLM) proposed by Flege (1995) and its revised version SLM-r (Flege and Bohn 2021), and the Perceptual Assimilation Model L2 (Best and Tyler 2007). These models predict L2-phone-learning based on how the L2 learners *perceive* the target phones; they propose that the L2 speakers first filter the L2 phonetic phones through their native phonology and then map the phones according to how similar/different they are to L1 phones and their corresponding phonological categories. For the purposes of this paper, I will focus on PAM-L2, which proposes that once the phones have been filtered through the L1 phonological grammar, there are three options on how L2 phones are categorized: a) as a Categorized Exemplar, when the target phone is perceived phonetically similar to an L1 phone, and therefore it is mapped into an L1 category (e.g., English [m] is mapped into the speakers' Spanish /m/), b) as an Uncategorized Exemplar, when the L2 phone is perceived sufficiently different to any existing L1 category, so it is categorized outside any L1 phonological category (e.g., an L1 English speaker learns Spanish and encounters the alveolar trill [r], which is phonetically different to all English phones, so [r] is not categorized into any of the speakers' phonological categories), and c) the phone is not perceived as a speech phone in the first place, which is then a Unassimilable Nonspeech case (e.g., an L1 English learner of Zulu encounters clicks, which are perceived as non-speech phones). PAM-L2 also predicts how the speakers perceive phone contrasts in the target language. For example, if two phones are categorized into the same L1 phonological category (Single Category Assimilation), poor discrimination is expected since the phones do not represent a contrast in the L1 in the first place. If the two phones are categorized into two separate L1 categories (Two Category Assimilation), discrimination is expected to be excellent, as there is a contrast in the speakers' L1.

In that sense, PAM-L2 makes good predictions for how L1 Spanish speakers learn English [d ð ɾ] and their corresponding phonological distributions. First, since the three phones exist in the speakers L1, it is expected that the three phones will be mapped into the corresponding L1 categories; in other words, the three phones will be Categorized Exemplars. Furthermore, when the speakers encounter English [ð], the PAM-L2 prediction is that the phone is perceptually assimilated to the closest L1 phone, which is the Spanish allophone of /d/ ([ð]); therefore, the L2 speakers map English [ð] into their Spanish /d/ category. It is important to point out that there is a phonetic difference in the realization of [ð] in both languages; in Spanish, [ð] is an approximant, while in English, the phone in question corresponds to a fricative. In that sense, the Spanish phonological category for /d/ ranges from a stop [d] to an approximant [ð] at the phonetic level, which in turn suggests that a fricative constriction (as that of the English [ð]) falls in between both allophones in terms of degree of constriction, denoting a variation at the gradient level. Consequently, PAM-L2 successfully accounts for the approximant/fricative distinction in both languages, and therefore it indeed predicts that the English fricative phone [ð] will be perceptually assimilated to the Spanish /d/ phonological category.

PAM-L2 also predicts how the Spanish speakers will discriminate the English target sounds. The prediction suggests that the speakers will show poor discrimination for the English /d/ and /ð/ contrast, as this

represents a Single Category Assimilation (two sounds – [d] and [ð] – are mapped as part of the same L1 phonological category /d/). In the case of English [ɾ], the PAM-L2 prediction is that the phone will be assimilated to the Spanish [ɾ], so it will be mapped into the Spanish /ɾ/ phonological category. Because the phones [d ð] are mapped into a different category than [ɾ], the speakers are expected to successfully discriminate [ɾ] from both [d] and [ð], as this is a Two Category Assimilation.

Support for these predictions come from different experiments testing discrimination rates for these three phones in both Spanish and English speakers. In both Barrios et al. (2016) and Boomershine et al., (2008), discrimination between the three phones [d], [ð] and [ɾ] by L1 English speakers, as well as L1 Spanish speakers was tested; the results showed that English speakers outperformed Spanish speakers when asked to discriminate between [d] and [ð], due to the fact that these phones have contrastive status in English but not in Spanish. On the contrary, Spanish speakers were more successful at discriminating between [d] and [ɾ] than English speakers, due to the allophonic status of these phones in the English speakers' L1. In the case of [ð] and [ɾ], both groups showed similar levels of good discrimination; this result was expected because the two phones are phonologically distinct in both languages. The discrimination patterns of the Spanish speakers in Boomershine et al. (2008) and Barrios et al. (2016) are also reported for Costa Rican Spanish speakers specifically, as demonstrated by Chappell (2017). Costa Rican Spanish speakers also show lower levels of discrimination between the allophones [d] and [ð] given that both are part of the same L1 phonological category (/ð/) but are more successful at discriminating between [ð] and [ɾ], as these phones form part of different phonological categories.

In that sense, L1 Spanish L2 GAE learners encounter an important acquisition challenge that requires the speakers establish new phonological associations for these three phones. In order to meet this challenge, the learners in question must *redistribute* or *split the allophones* [d] and [ð] and map them onto separate phonemes in the L2, as they constitute different phonemes in English. Eckman et al (2003) defines allophonic split as follows:

> *a. Allophonic split:* "Sounds which are allophones of one phoneme in the learner's native language constitute separate phonemes in the target language." (Eckman et al. 2003).

An incomplete allophonic split may be challenging for L2 speakers due to persistent L1 influence, and it may lead to realizations of the target phone that resemble the phonological distribution of that phone in the L1. In other words, categorizing both L1 allophones ([d] and [ð]) as separate phonemes in the L2 (/d/ and /ð/) will be difficult for learners, since the contrast is not perceived in the early stages of acquisition, as predicted by PAM-L2. As a result, oral realizations of target English /ð/ are expected to resemble the distribution of Spanish /d/, with the stop occurring word-initially and the approximant/fricative [ð] occurring intervocalically. Once again, this has been illustrated by production studies of English /ð/ by L1 Spanish speakers, showing the influence of phonological transfer from the L1 (Eckman et al. 2003; Fonseca Quesada 2024; Zampini 1996). Adhering to this claim also predicts that Spanish speakers will produce English /d/ as a fricative or approximant in intervocalic position, yielding patterns similar to those observed for target /ð/. That is, in intervocalic contexts, L1 Spanish speakers are expected to produce a fricative/approximant, mirroring both their L1 distribution and their realizations of target English /ð/. This has been attested in previous studies as well (e.g., Flege, J. E., and Davidian, R. D. 1984).

Nonetheless, if L1 Spanish speakers are exposed to GAE, they might have learned that intervocalic English /d/ is also realized as a tap [ɾ]. The phones [d] and [ɾ] belong to separate phoneme categories in Spanish (the L1), but coalesce into a single phonemic category in the L2 (/d/), giving rise to a process known as *allophonic union,* which is defined as follows:

> *b. Allophonic union*: Two L1 phonemes become part of one single phoneme category in the L2. (Barrios et al. 2016)[2].

Therefore, what happens if the L1 Spanish speakers are acquiring the GAE /d/ tapping rule? The production of English intervocalic /d/ by L1 Spanish speakers may be influenced by phonological transfer from Spanish, leading target intervocalic /d/ to be realized as [ð]—denoting an incomplete allophonic split—but the same speakers may also produce the target allophone [ɾ], indicating evidence of allophonic union. Figure 2 clearly illustrates the mirror case and both the allophonic union and allophonic split processes involving these phones.

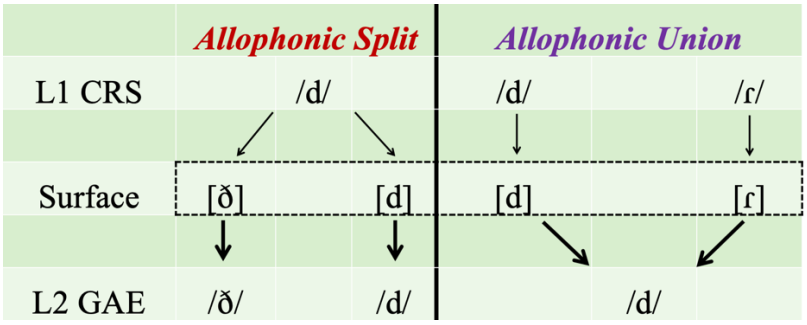

Figure 2. Allophonic split and allophonic union involving the phones.

[2] Barrios et al. (2016) defined allophonic union as "two allophones in the L1 that become part of the same phoneme in the L2," referring to Spanish /d/ and /ɾ/. Since /d/ and /ɾ/ function as phonemes in Spanish, the first author later clarified (personal communication) that the intended definition was "two phonemes in the L1 that become part of the same phoneme in the L2."

2.3. Ease vs Difficulty

Although many predictions derived from contrastive analysis (Lado 1957) fail to account for current findings in L2 speech production, Lado's general insight remains influential: L1 phonological grammar continues to shape L2 speech (Davidson 2011). Under a contrastive analysis approach, Stockwell et al. (1965) proposed a grammatical hierarchy regarding the levels of difficulty in second language acquisition, applicable to both syntactic and phonological features. In this proposal, the authors predicted that a process of split—whereby one item in the L1 becomes two or more in the L2—constitutes one of the most difficult aspects of L2 phonological development. This prediction has since been examined and confirmed in both earlier literature (Hammerly 1982; Hardy 1996) and more recent work on L2 phonological acquisition (Eckman et al., 2013; Major, 2008). Stockwell et al.'s grammatical hierarchy also suggests that coalescence, or allophonic union—where two L1 items merge into a single category in the target language—is an easier process for L2 speakers than allophonic split.

The question of ease vs. difficulty in second language phonology is not an easy one (Archibald 2021). Zampini (1994) looked at the production of Spanish /b d g/ spirantization ([β ð ɣ]) by native speakers of English; the author concluded that the existence of a segment as a phoneme in the speakers' L1 (/ð/) does not necessarily represent a facilitator in the process of L2 learning, and in fact suggested that the phoneme status of an L1 phone may inhibit the production of the target allophone in the L2. In other words, for Zampini (1994), the existence of /ð/ as a phoneme in English did not benefit the speakers in the production of Spanish [ð], which is an intervocalic allophone of /d/. Zampini (1994)'s results suggest that the coalescence of two segments from the L1 as two separate ones in the L2 is not necessarily an easy process for L2 speakers, as is predicted in the grammatical hierarchy proposed by Stockwell et al.

In a more recent study, Vokic (2010) examined the production of L2 Spanish by native speakers of English, focusing on production patterns of similar phones in the L1 and L2. The first hypothesis stated that if an acoustically identical or similar target phone is a phoneme in the L1 and an allophone in the L2, and if it shares the same distributional properties in both languages, the target phone will be relatively easily accessed by the L2 learner and will not pose difficulties in L2 speech production. In this case, according to Vokic's first hypothesis, the production of Spanish intervocalic [ð] by L1 English speakers should not represent a difficult process for the speakers, given that both phones share acoustic similarities, and English /ð/ also surfaces in intervocalic positions. Vokic's second hypothesis stated that if an acoustically identical or similar target phone functions as an allophone in the L1 and as a phoneme in the L2, and if the two share the same distributional properties across languages, the target phone will be relatively easily accessed by the L2 learner and will not represent an obstacle in L2 speech production. That is, the production of Spanish intervocalic /ɾ/ should not represent an obstacle for L1 English speakers, since an acoustically similar allophone in the L1 ([ɾ]) also shares the same distributional context. The results for Vokic's first hypothesis showed that speakers produced the target phone [ð] correctly in 47% of the cases; for the second hypothesis, the speakers produced the target phone [ɾ] accurately in 37% of the cases. These results suggest that the speakers in this study were relatively more successful in accessing the L1 phonemes rather than the L1 allophones. Although this interpretation is not explicitly stated in the paper and the difference is not statistically significant, the results may nonetheless suggest higher levels of allophonic union than of allophonic split, in line with the grammatical hierarchy proposed by Stockwell et al. (1965). While both Zampini (1994) and Vokic (2010) studies suggest that it is not clear whether one process is easier than the other, the evidence shows that L2 speakers do learn new patterns about familiar phones – both allophones and phonemes – and their corresponding categories in the target L2.

3. The Current Study

The present study examines production patterns of target English /ð/ and /d/ by native speakers of CRS, to infer the phonological status of the phones [d ð ɾ] in the speaker's interlanguage, as the phonological distribution of the phones in English does not match that of Spanish; I have denominated this a mirror case. In order to address these phenomena, the research question addressed is the following: how are both *allophonic union* and *allophonic split* evidenced in the production of /d/ and /ð/ phonemes by L1 Costa Rican Spanish learners of General American English?

Based on the PAM-L2 predictions on how speakers map the L2 phones, and the interaction between the L1 and the target L2 representations, we can think of the following scenarios that will provide answer to the research question:

3.1. Predictions for Target /ð/

If speakers have not split the L1 allophones ([ð] and [d]) as separate phonemes, a stop will be produced in word-initial position. Example: 'they' will be pronounced as [**d**eɪ]. If the speakers have split the allophones as separate phonemes, they will produce a fricative/approximant in word-initial position. Example: 'they' will be pronounced as [**ð**eɪ]. In intervocalic position, we expect an accurate production due to positive L1 transfer. Example: 'together' will be pronounced as [tʊˈgɛ**ð**ɚ].

3.2. Predictions for Target /d/

If speakers have not unified the two L1 phonemes (/d/ and /ɾ/) as allophones of the same L2 phoneme /d/, they will produce a fricative/approximant [ð] (from L1 transfer). Example: 'stadium' will be pronounced

as [steɪðɪəm]. If the speakers have unified the L1 phonemes as L2 allophones, they will produce a tap [ɾ]. Example: 'stadium' as [steɪɾɪəm].

4. Methodology

4.1. Participants

Ten adult L1 Spanish learners of English (eight females, two males) participated in this study. The mean age of the speakers was 18.5 (range: 18-21). All participants were native speakers of Costa Rican Spanish. At the time of participation, all speakers were first-year undergraduate students in the English Teaching program at the University of Costa Rica-Western Campus. Only first year students qualified for inclusion in the present study, before completing college-level coursework in English Phonetics and Phonology. Excluding participants who had received explicit instruction in phonetics and phonology was important to not introduce additional sources of variance in participants' performance, as well as to obtain results representative of most L1 Spanish-L2 English speakers. Participants were recruited through an email and an electronic flier. Prior to participation, each participant completed an online questionnaire providing general information about their language background. All speakers indicated that they started learning English between ages six and ten, as all of them had been learning English in the Costa Rican education system for around ten to twelve years. Although the Costa Rican Ministry of Education does not explicitly state whether a particular variety of English is taught in Costa Rican schools, geographical proximity, American tourism, and economic exchanges between Costa Rica and the United States suggest that American English is prevalent in Costa Rica (Brand Fonseca and Segura Arias 2022). This, in turn, suggests that participants have had sufficient direct and indirect exposure to GAE.

All participants reported Spanish to be the language spoken outside of class and in their households. No speaker had ever lived in an English-speaking country, and two speakers reported having knowledge of an additional language (Mandarin Chinese). Each participant provided consent for their participant and received a monetary payment of $14.80 in Costa Rican currency. The speakers' English proficiency was measured objectively (see sections 4.2. and 4.4.1. for a description of the proficiency task); it is important to point out that, qualitatively, nine out of ten speakers were sufficiently proficient to maintain basic conversations and understand instructions provided in English. Data from one speaker, however, (S06) was excluded due to low proficiency score obtained in the proficiency task, which negatively affected performance throughout the experiment. Accordingly, the results reported in Section 5 are based on nine participants.

4.2. Materials

Three tasks were carried out. Task 1 measured the speakers' proficiency. Tasks 2 and 3 elicited productions of target English /ð/ in word-initial and intervocalic positions, as well as intervocalic /d/. A more detailed description of the tasks is provided below:

> *Task 1: Proficiency Task.* Given that discrimination of nonnative contrasts improves with increasing L2 proficiency (e.g., Flege, Munro, and McKay 1995), and that learners acquire L2 allophonic variants with experience (Shea and Curtin 2010; Shea and Curtin 2011), it is therefore important to consider speakers' target-language proficiency. The task carried out in this study was the Elicited Imitation Task originally developed by Ortega et al. (1999). In this task, speakers were presented with a set of thirty audio-recorded sentences, with increasing numbers of morphemes and increasing syntactic complexity. The rationale for this task is that speakers are able to repeat only those sentences that they comprehend and can parse using their developing grammars (Bowden 2016). All thirty sentences were presented in a single audio file, with each sentence followed by a beep and a five-second interval during which speakers were required to repeat the sentence. This design required immediate repetition of each sentence. For this experiment, the most recent version of the English Elicited Imitation Task (EIT B) was used, as suggested by Wu et al. (2022).
>
> *Task 2: Meaningful Sentences.* This task was intended to elicit oral production of target English /ð/ in word-initial and intervocalic positions, as well as intervocalic /d/ and /t/. The task was composed of sixteen meaningful sentences/short paragraphs in English. Each sentence contained on average fifteen words. The distribution of the target phones in this task's materials was as follows: for /ð/, the task materials included eight words (twelve tokens, as some words were repeated) where the phone appeared in word-initial position (e.g., 'therefore'), since this environment shows evidence of weather speakers produce the L1 pattern [d], or whether the speakers show progress towards allophonic split and produce accurate target fricative/approximants. Nine words (ten tokens, as one word was repeated) in which /ð/ appeared in intervocalic position (e.g., '*weather*') were also included. In this environment, speakers are predicted to be successful, given the L1 /d/ pattern, in which the approximant [ð] is realized intervocalically.
> For intervocalic /d/, eight words were included containing the target allophone [ɾ] (e.g., 'study'), as this context would show progress towards allophonic union, but also, evidence from the L1 pattern might be observed (production of [ð]). In addition, eight words containing target /t/ tap realizations (e.g., '*city*') were included to provide additional evidence that (a) speakers show progress toward the acquisition of the tapping rule, which also applies to /d/, and (b) speakers are exposed to GAE, in which this phonological rule is realized. There were words targeting other phones, such as the voiceless interdental fricative phoneme /θ/, although these were not intended to test any of the hypotheses for this experiment

and therefore are not analyzed. For a complete list of the sentences and target words, please see the appendix. An example of the meaningful sentences is the following: "*Maps don't show the real shape of the earth. Some of them make the north look bigger, and others make it look wider. These companies should be more ethical*."

Task 3: Carrier Phrases. This task was intended to elicit the same target words used in the sentences from Task 2. The carrier phrase used was "*I say the word _____ in English.*" Example: "*I say the word another in English.*"

4.3. Data collection

The experiment took place at the Modern Languages Laboratory of the University of Costa Rica-Western Campus. Each participant met individually with the researcher for approximately 25 minutes to carry out all tasks. Speakers sat in a booth for the entire duration of the data collection session. They wore earphones and a head-mounted microphone. The researcher was outside the booth to control the flow of the experiment, and communicated with the participants through the microphone/earphones setting of the laboratory. A brief informal conversation in English was carried out between the speakers and the researcher to place participants in an English-language mode before the experiment tasks. Specific task instructions were then provided in English. The three tasks were completed separately in the following order: participants first completed the Proficiency Task (EIT B), followed by the Sentences task, and finally the Carrier Phrases task.

For the EIT B (Proficiency Task), the audio file suggested in Wu et al. (2022) containing the pre-recorded sentences was played for the speakers, while they were being recorded. After each sentence, the beep would indicate the speakers when it was time for them to repeat the sentence. For the Meaningful Sentences task, each sentence/short paragraph was presented one-at-a-time to speakers on a slide, and speakers read each stimulus as it was presented while being recorded. The Carrier Phrases task followed the same order, as each carrier phrase was also projected on a slide. For each of them, the word was inserted in the carrier phrase (e.g., "*I say the word stadium in English*"). The order of the stimulus presentation was pseudo-randomized to avoid having consecutive words with the same target phone/context. The slides for both tasks were projected on the classroom's board, which was approximately 3.5 meters away from the speakers. The microphone used to record the speakers was a unidirectional Electret condenser, with a frequency response of 40 – 16k Hz. All recordings were automatically saved to a computer hard drive.

4.4. Data Analysis

4.4.1 Proficiency scores: For the EIT B, the present study adopted the scoring procedure proposed in Wu et al. (2022). To score the speakers' responses, the author transcribed each sentence produced by the speakers. Then, a score from 0 to 4 was given to each produced sentence, according to the scoring rubric. Scores ranged from 0 to 4 and depended on the number of morphemes produced and the accuracy of those morphemes relative to the target sentences, which in turn provided evidence of speakers' morphological, syntactic, and phonological processing. For example, a score of 0 represented complete silence or no repetition, the production of a single word, or a completely unintelligible repetition, whereas a score of 4 represented a perfectly clear repetition of the entire sentence. The points for each speaker's sentences were summed up. The sentence repetition accuracy was then calculated for each speaker, where 120 points represents the maximum possible points or 100% accuracy in the task.

4.4.2 Categorization of productions: All target productions were impressionistically transcribed by two raters and then documented in a spreadsheet for each speaker. To reduce the risk of bias in the transcribers' impressionistic judgments, two factors were considered: (a) both transcribers had professional training in phonetics and phonology, which strengthens the possibility of transcribers to perceptually assess acoustic cues relevant to categorize the phone productions and (b) the transcribers differed in their first-language backgrounds, as the phonological status of the phones in their respective languages would be expected to facilitate discrimination of different sound pairs (see Section 2.2). One transcriber was a native speaker of Costa Rican Spanish, and the other one was a native speaker of American English. Both transcribers listened to the speakers' productions and independently transcribed the target phones. For the words containing target /ð/, the transcribers indicated what consonantal phone was produced (e.g., [d], [ð], [ɾ], etc). When it was not clear what phones the speakers produced, the transcribers entered "X". For the words containing a possible target tap production [ɾ] (intervocalic /d/ and /t/), the transcribers gave each production a value of 1 or 0, where 1 represents a tap production, and 0 represents the production of a stop ([d] or [t]), or something else. Later, both transcribers listened to the words that received a value of 0 to determine what phone was produced for each target token.

In the spreadsheets, the transcriptions were compared to determine whether the token productions represented a match or a mismatch for the transcribers. Then, interrater agreement was assessed using Cohen's Kappa (Cohen 1960), which is a statistical measure to determine the level of interrater reliability. To resolve mismatches, the transcribers met to jointly listen to the phones, discuss their decisions, and examine the words in Praat (Boersma & Weenink 2026) in order to identify acoustic cues such as release bursts (e.g., [ð] vs. [d]) and voicing (e.g., [ð] vs. [θ]). Finally, the percentage of the productions were calculated for each speaker per phonological context and then summed across all speakers per context.

5. Results

A paired t-test was conducted to assess whether speakers' accuracy in target productions ([ð] for /ð/ and [ɾ] for /d/) differed significantly across production task types (carrier phrases vs. meaningful sentences). The results show that there is no statistical difference between the tasks neither for /ð/ word-initial position (p = 0.15) nor for the intervocalic cases /ð/ (p = 0.21), and /d/ (p = 0.26). Therefore, the results reported here do not make a distinction between carrier phrases and meaningful sentences. The results are presented as follows: section 5.1. shows target /ð/ productions across all speakers. Section 5.2. provides results on target intervocalic /d/ (and intervocalic /t/) realizations across all speakers as well. Section 5.3. provides results on the proficiency scores per speaker and the correlation measures between accurate productions and speakers' proficiency.

5.1. Target English /ð/ productions

Both transcribers categorized the target /ð/ phones produced word-initially and in intervocalic position. The interrater agreement was k=0.71, considered substantial agreement. Figure 3 reports the realizations of English /ð/ across all nine speakers per phonological context. In total, there were 180 (twenty per speaker) productions of English /ð/ in word-initial positions. In the case of intervocalic contexts, there were 171 tokens in total (nineteen per speaker).

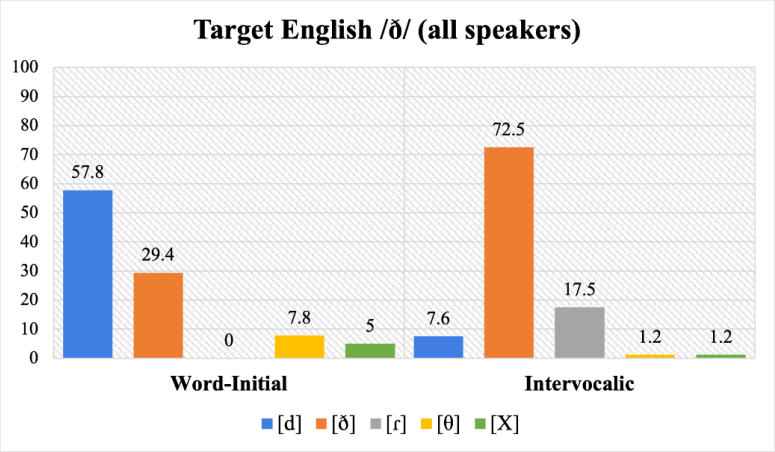

Figure 3. Realizations of target English /ð/ across all speakers per phonological context.

Across all speakers, most of the productions in word-initial positions corresponded to a stop [d] (e.g., 'these' as [diz]), representing 57.8% of the cases, whereas the voiced fricative was produced accurately in 29.4% of the cases (e.g., 'there' as [ðɛɹ]). The remaining productions in word-initial contexts present more substitution variants of the target phoneme /ð/[3]; for example, the voiceless interdental fricative [θ].

In intervocalic position, the fricative/approximant [ð] was realized more frequently, accounting for 72.5% of all instances (e.g., 'mother' as [mʌðə˞]). In the case of the substitution variants, the most persistent realization was an alveolar tap [ɾ], observed in 17.5% of the cases (e.g., 'weather' as [wɛɾə˞]), being more persistent than the stop [d], which occurred in 7.6% of the cases.

5.2. Target English intervocalic /t/ and /d/ productions

As a reminder, sixteen words (eight in carrier phrases and eight in meaningful sentences) that contain target English /t/ allophonic taps [ɾ] were included. The inclusion of these words was to determine whether speakers produced an alveolar tap [ɾ] for /t/, which in turn would suggest two things: a) the speakers are exposed to GAE, and b) speakers are indeed aware, and have acquired, such tapping rule (which applies for /d/ as well). The transcribers determined what phone was produced for each target production (e.g., [ɾ] or [t]); the Cohen's Kappa coefficient for these transcriptions was k=0.66, which corresponds to substantial agreement. The results are summarized in Table 1, which shows the number of tokens produced as a tap [ɾ] by each speaker, as well as the percentage of such production pattern. All speakers evidence acquisition of the English /t/ tapping rule in their production, as 72.91% of the cases were produced as taps across all speakers (exact number varies by speaker as shown in Table 1). All other realizations of /t/ correspond to a voiceless alveolar stop [t]. This allows us to conclude that the participants in this study have indeed sufficient exposure to GAE, as the acquisition of the tapping rule is evidenced in their production.

[3] [X] corresponds to productions that were categorized by the raters as unclear, or productions that seemed accidental.

Table 1. Realizations of intervocalic English /t/ across all speakers (tokens and percentage).

Speaker	Number of tokens produced as taps [ɾ] (16 max)	Percentage of /t/ instances produced as taps [ɾ]
S01	12	75%
S02	8	50%
S03	11	68.75%
S04	9	56.25%
S05	14	87.5%
S07	14	87.5%
S08	14	87.5%
S09	12	75%
S10	11	68.75%
Average	**11.66**	**72.91%**

For target English intervocalic /d/ productions, transcribers determined what phones were produced for each token. The Cohen's Kappa coefficient obtained for these transcriptions was k=0.68, considered to be substantial agreement as well. A summary of the productions for target English intervocalic /d/ across all speakers is provided in Figure 4. Cumulatively, there were 144 token realizations of /d/ in this context across all speakers (sixteen per speaker).

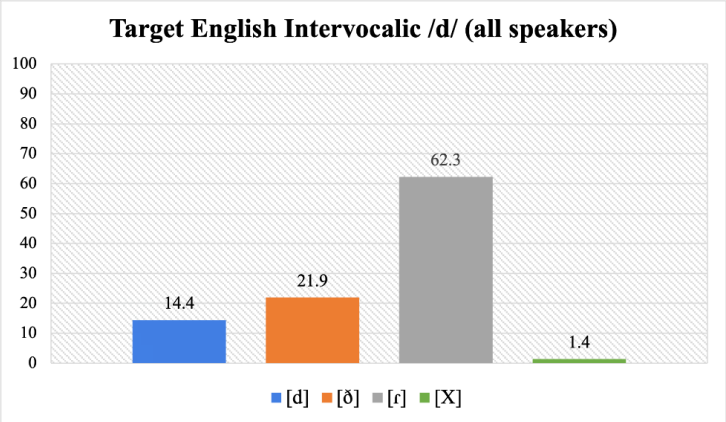

Figure 4. Realizations of intervocalic English /d/ across all speakers.

The most consistent realization for intervocalic /d/ corresponds to the target allophonic tap [ɾ] in 62.3% of the cases (e.g., 'study' as [stʌɾi]). 14.4% of the productions correspond to a stop [d] (e.g., 'video' as [vidɪoʊ]), and 21.9% of the realizations correspond to a fricative/approximant (e.g., 'products' as [pɹɑðəkts]), showing evidence of the L1 allophonic pattern. With the consistent realization of intervocalic /d/ as an alveolar tap [ɾ], we can argue that speakers not only have acquired the /d/ tapping rule, but also that it has become a productive pattern in the speakers' interlanguage.

5.3. Variation across speakers

5.3.1. Target /ð/

All speakers produced at least one realization of English /ð/ as a voiced stop [d] in a word-initial position (e.g., 'those' as [doʊz]; 'therefore' as [dɛɹfoɹ]); the number of such productions varies across speakers. However, seven out of nine speakers produced more stops [d] than fricatives [ð] in the word-initial context, except for speakers S01 and S09, who were more accurate at producing a target fricative than a stop. Figure 5 summarizes the target /ð/ productions per speaker and per phonological context.

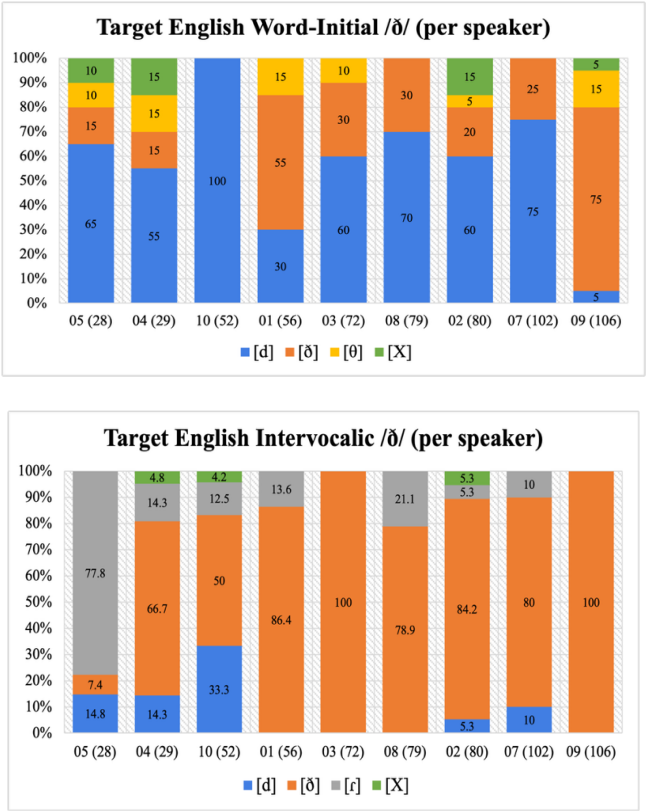

Figure 5. Realizations of target /ð/ per speaker and phonological context (organized by speakers' proficiency score from lowest to highest).

In the intervocalic context, eight out of nine speakers were more successful at producing the fricative/approximant (e.g., 'together' as [tʊgɛðə˞]), which is not surprising as this is the allophonic variant of Spanish /d/ in intervocalic contexts. Two speakers produced a fricative/approximant in 100% of the intervocalic contexts. In addition, seven out of nine speakers produced at least one realization of the English intervocalic /ð/ as a tap [ɾ] (e.g., 'breathing' as [bɹiɾɪŋ]; 'smoothies' as [smuɾis]); the number of such production varies across speakers. Across all nine tested speakers, the tap [ɾ] was restricted to intervocalic positions, which is the allophonic [ɾ] context in English, and one of the contexts of the Spanish tap /ɾ/. The number of substitution variants, as well as the consonantal phones used varies across speakers. In addition to those production patterns discussed above, some speakers realized the target phoneme /ð/ as its voiceless counterpart [θ]; this occurred in word-initial position (e.g., 'though' as [θoʊ]; 'then' as [θɛn]).

5.3.2. Target /d/

All speakers realized English intervocalic /d/ as the target allophonic tap [ɾ] to some extent (e.g., 'products' [pɹʌɾəkts]; 'stadium' [steɪɾɪəm]), being speakers S10 and S02 the speakers with the lowest rate of tap realizations (18.75% of all productions). One of the speakers (S09) produced the tap in 100% of the cases. Six speakers produced a voiced stop [d] in at least one token (e.g., 'audience' [ɔdɪəns]). Eight of the speakers produced a fricative/approximant (e.g., 'studying' [stʌðɪŋ]; 'model' [mɑðəɬ]), resulting from phonological transfer from the L1. Figure 6 shows the intervocalic /d/ realizations per speaker.

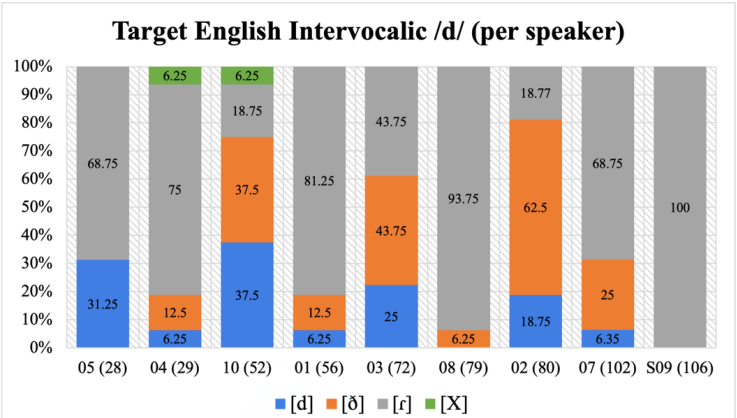

Figure 6. Realizations of intervocalic /d/ per speaker (organized by speakers' proficiency score from lowest to highest).

In sum, for target intervocalic /d/, all speakers showed some evidence of the acquisition of the target allophone [ɾ]. In addition, some speakers also showed evidence of L1 phonological transfer, as the L1 allophone [ð] was produced for the target phoneme /d/. The production patterns showing evidence of the target allophone, as well as evidence from the L1 allophone, vary among all speakers.

5.4. Proficiency-Productions Correlations

Different correlations were tested to determine the role of proficiency in the speakers' productions. All these correlations are discussed in this section. Table 2 summarizes the correlations tested, and the resulting *p* values showing the significance of the results. (a-c) correspond to proficiency vs speakers' accurate realizations, and d-f correspond to proficiency vs speakers' incorrect realizations.

Table 2. Correlations tested to examine the role of proficiency in the speakers' productions.

Correlation Tested	*p* values
a. Proficiency vs accurate [ð] realizations for target /ð/ in word-initial context	*p* = .13
b. Proficiency vs accurate [ð] realizations for target /ð/ in intervocalic context	***p* = .04**
c. Proficiency vs accurate [ɾ] realizations for target /d/ in intervocalic context	*p* = .64
d. Proficiency vs incorrect [d] realizations for target /ð/ in word-initial context	*p* = .44
e. Proficiency vs incorrect [ɾ] realizations for target /ð/ in intervocalic context	*p* = .06
f. Proficiency vs incorrect [ð] realizations for target /d/ in intervocalic context	*p* = .68

Of all correlations tested, only correlation (b) was statistically significant (p = .04), indicating that greater target-language proficiency was associated with greater accuracy in producing intervocalic /ð/. Figure 7 shows the relationship between proficiency (y axis) and accurate intervocalic /ð/ realizations (x axis).

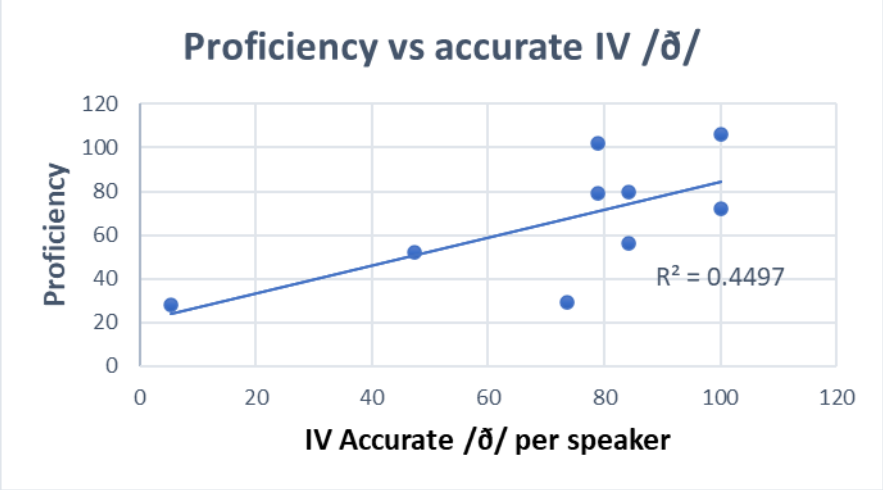

Figure 7. Proficiency vs accurate intervocalic (IV) /ð/ productions in percentages.

While correlation (e) did not reach statistical significance (p > .05), the results suggest a trend whereby realizations of target /ð/ as a tap [ɾ] (i.e., an incorrect target pattern) decrease as speakers' proficiency increases. None of the remaining correlations were statistically significant; however, examination of individual speakers' production patterns offers additional insight into the role of target English proficiency. This is illustrated by the two extremes of the proficiency spectrum: the lowest-proficiency speaker (S05) and the highest-proficiency speaker (S09). S05 exhibited high rates of target /ð/ realization as a stop [d] in word-initial position (65% of tokens) and produced the highest proportion of target /ð/ as an alveolar tap [ɾ], suggesting persistent interlingual transfer from Spanish /d/. By contrast, S09 realized target /ð/ more accurately in both word-initial (75%) and intervocalic (100%) positions, consistent with a more advanced stage of allophonic split. Additionally, S09 produced target intervocalic /d/ as a tap [ɾ] in 100% of cases, indicating substantial progress toward allophonic union.

6. Discussion

The goal of this study was to address the following question: how are both *allophonic union* and *allophonic split* evidenced in the production of /d/ and /ð/ phonemes by L1 Costa Rican Spanish learners of General American English? The processes of allophonic split, in the current study, corresponds to the process in which Spanish speakers separate the L1 /d/ allophones [d] and [ð] as separate phonemes in their L2 English (/d/ and /ð/), and allophonic union corresponds to the process in which speakers map the two L1 phonemes /d/ and /ɾ/ as part of the same phoneme in L2 English (/d/). To do so, we predicted different patterns based on PAM-L2 (Best & Tyler 2007). For example, speakers perceptually associate

English [ð] to the allophonic variant of their L1, mapping the phone to the L1 category (/d/), and the production for both English /d/ and /ð/ could therefore evidence the L1 /d/ production patterns. For the English /d/ allophonic tap [ɾ], speakers should perceptually associate the allophone to the L1 /ɾ/ category, which predicts that the speakers notice the allophonic pattern, and this is possibly reflected in their spoken production as well.

In order to give answer to our question, we can analyze the production patterns for each target phoneme. For target /ð/, the realizations across all speakers show a preference for a stop [d] in word-initial positions, similarly to previous findings (Eckman et al. 2003; Fonseca Quesada 2024; Zampini 1996). This is true for seven out of nine speakers. This result confirms that the production of the target English interdental fricative /ð/ by L1 Spanish speakers is influenced by the Spanish phoneme /d/, evidencing phonological transfer from the L1. This result is also expected as it reflects the L1 /d/ pattern, in which [ð] surfaces allophonically in intervocalic contexts. These production patterns show evidence of an incomplete allophonic split; in other words, the L1 allophones [d] and [ð] have not been fully mapped as two separate phonemes in the L2. For the intervocalic context, eight out of nine speakers were more successful at producing the fricative/approximant [ð]. However, the intervocalic fricative/approximant [ð] was not produced faithfully in all cases, which is surprising as this is the pattern that occurs in the speakers' L1. Seven out nine speakers produced an alveolar tap [ɾ] for intervocalic English /ð/, providing similar results to those in Fonseca Quesada (2024). Across all speakers, the alveolar [ɾ] was the most frequent substitution for intervocalic /ð/ in 17.5% of the cases. The appearance of the tap [ɾ] as a substitute for the English intervocalic /ð/ across all the speaker population suggests that this is neither accidental nor restricted to individual speakers; in fact, it shows that it is a common pattern across L1 Spanish L2 English speakers, at least in this Costa Rican dialect sample population. This production pattern cannot be attributed to poor discrimination for the phones at the perceptual level, since both [ð] and [ɾ] belong to separate phonological categories in the speakers L1 and the L2. As predicted by PAM-L2 and demonstrated in perceptual discrimination experiments (Barrios et al. 2016; Boomershine et al. 2008; Chappell 2017), Spanish speakers should show excellent discrimination between [ð] and [ɾ], as these phones are perceived and mapped onto two distinct phonological categories. In that sense, the consistent appearance of the tap [ɾ] as a realization of target English /ð/ should be further analyzed.

To account for this pattern, it is important to examine the production of target English intervocalic /d/. First, there were instances in which the target phoneme /d/ was realized as a stop [d] (14.4% of cases across all speakers). Although the stop allophone [d] does not typically surface in intervocalic contexts in either the L1 or L2 representation of /d/, this pattern may be explained in two ways. First, as noted in Section 2.1, the stop variant is the most common realization of /d/ in Costa Rican Spanish (Carrasco et al. 2012), suggesting that speakers may be overgeneralizing the use of the stop allophone [d] to other contexts, including the target intervocalic position in their L2 production. Second, the production of a stop [d] may result from careful or hyperarticulated speech. In either case, although the stop allophone [d] does not generally surface in this phonological context, it nonetheless reflects the underlying form of the phoneme /d/, which exists in both the speakers' L1 and L2. Consequently, this realization cannot be considered a fully incorrect production, nor can it be attributed exclusively to either L1 or L2 influence.

Additionally, intervocalic /d/ was produced as an alveolar tap [ɾ] across all speakers (62.3%). This suggests that the speakers are successfully acquiring the English /d/ tapping rule, showing clear evidence of progress towards allophonic union, where both phonemes (/d/ and /ɾ/) from the L1 correspond to allophones of the same phonemic category in the L2 (/d/). Similar to other studies (Flege, J. E., and Davidian, R. D. 1984; Zampini 1996), eight out of nine speakers produced the fricative/approximant [ð] for the English intervocalic /d/, which shows evidence of phonological transfer from the L1. In other words, the speakers produce the L1 /d/ rule, which is a production of [ð] post-vocalically.

The production patterns of both target phonemes, /ð/ and /d/, show that Spanish /d/ is still playing a role in the speakers' interlanguage. Both target phonemes seem to be influenced by the L1 /d/ representation ([ð] is incorrectly treated as an allophone of /d/), and therefore a complete allophonic split has not yet occurred. However, at the same time, there is clear evidence of progress towards learning the target language patterns. For example, the acquisition of the target English /d/ allophonic rule, in which the alveolar tap [ɾ] surfaces as the intervocalic position, is clearly evidenced across all speakers, suggesting allophonic union. These results suggests that both processes – *allophonic split* and *allophonic union* – are occurring at the same time in the speakers' interlanguage. In other words, the two L1 /d/ allophones are not yet be mapped onto two fully separate phonemic categories (due to transfer from the Spanish /d/), but at the same time, there is evidencing that /d/ is acquiring the new target allophonic variant [ɾ]. In other words, in the speakers' interlanguage, both [d] and [ð] (from L1), and also [ɾ] (from target L2) are mapped to /d/, which surfaces as the three allophonic variants [d], [ð] and [ɾ]. This representation is more clear in certain speakers (e.g., S03) who produce the three phones for both target phonemes in the intervocalic context. To illustrate this, figure 8 shows the potential representation of these speakers based on the interaction of the phonological status of the phones in both the L1 (CRS) and the L2 (GAE).

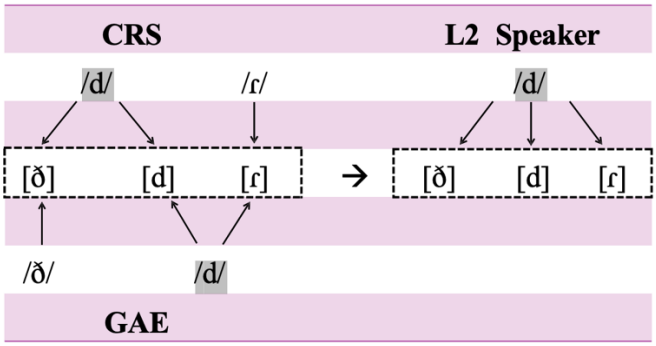

Figure 8. Hypothetic phone distribution when both processes happen simultaneously.

An articulatory explanation for the production patterns observed in this study, particularly in intervocalic contexts, also supports the claims regarding speakers' phonological representations. The production of a stop [d] in word-initial position may be attributed to articulatory difficulty, as speakers are not accustomed to producing a fricative/approximant in this context (unless it occurs post-vocalically across word boundaries). This suggests that producing a fricative/approximant word-initially is articulatorily more demanding, leading speakers to produce the stop [d], which is permitted in the L1. Nevertheless, not all production patterns can be explained in articulatory terms. For example, in intervocalic contexts, speakers are expected to be fully accurate in producing a fricative or approximant for target /ð/, as this realization occurs in the speakers' L1. In other words, speakers are accustomed to producing this phone in this phonological environment, and it therefore poses no articulatory difficulty. Similarly, for intervocalic /d/, where a tap [ɾ] is expected, speakers also produce non-target patterns, such as the L1 [ð] allophone, even though the tap surfaces in this context in the speakers' L1. This suggests that an articulatory explanation is unlikely and instead supports an account based on the cognitive representation of phones in speakers' interlanguage.

Another factor that may influence the production of target phones and provide insight into these production patterns is orthography. It has been argued that orthographic input plays a role in phonological acquisition (e.g., Hayes-Harb and Barrios 2021), and one might therefore attribute the observed production patterns to orthographic influence. To examine this possibility, we consider the spelling conventions of the relevant phones in the speakers' L1 and L2, as illustrated in Table 3.

Table 3. Spelling conventions for the phones in the speakers' L1 and L2.

Phone	GAE Spelling	CRS Spelling
[ð]	<th>	<d>
[d]	<d>	<d>
[ɾ]	<d>	<r>
[θ]	<th>	–[4]

The appearance of the voiceless interdental fricative [θ] as a substitution for /ð/ may be explained by orthography. Speakers may know that the orthographic sequence <th> can be realized as either a voiced or a voiceless interdental fricative, and when speakers are unfamiliar with the words in the stimuli, reliance on orthographic input may provide a reasonable basis for guessing pronunciation. In addition, previous research has shown that orthographic symbols consistent with an L1 allophone can activate that allophone in L2 production (e.g., Shea 2017). In this case, the production of English /d/ may be influenced by the grapheme–phoneme relationship, particularly in the speakers' L1. Specifically, the orthographic representation of /d/ as <d> in Spanish may trigger fricative/approximant realizations in intervocalic positions, consistent with the L1 pattern; in Spanish, /d/ is orthographically represented as <d> both word-initially and intervocalically (e.g., *dedo* à [deðo] 'finger'). Orthography, nonetheless, cannot account for the entire set of results reported in the present study. First, neither in English nor in Spanish is the sound [d] (which appeared as a word-initial substitution for target /ð/) orthographically represented by the letters <th>, suggesting that word initial /ð/ productions as a stop [d] cannot be because of orthographic influence. Second, the Spanish tap is a rhotic sound realized orthographically as <r>, which suggests that the production of the intervocalic /d/ as well as intervocalic /ð/ as an alveolar tap [ɾ] is also not orthographically-driven, but purely a matter of a phonological representation.

While most of the correlations tested between the speakers' proficiency and the production patterns are not statistically significant, it does seem that proficiency plays a role in the oral realization of the target phonemes by the L2 speakers. For intervocalic /ð/, there was significant association between the accurate productions and the speakers' proficiency. Speakers are more successful at producing the target realization as they become more proficient. Interestingly, in this case, the lower proficiency speakers are producing patterns that are less L1-like (as producing [ð] is expected) given the L1 and L2 interaction rules in their interlanguage.

[4] This phone does not exist in Costa Rican Spanish. Therefore, the dash – indicates non-existent.

The speakers are learning a new pattern from the L2, such as the English /d/ allophonic alveolar tap pattern, but transfer it to incorrect target contexts, resulting in production of tap [ɾ] for English /ð/. In addition, evidence from the role of proficiency comes from individual patterns, as exemplified with the speakers of lowest and highest target language proficiency. This is not unexpected, as it has been shown that as adult speakers progress in learning the L2 phones, they become better at approximating the target phonetic and phonemic realizations (Flege 1987; Shea and Curtin 2011).

Finally, the results in this study confirm that the process of allophonic split represents one of the most difficult processes in L2 phonological acquisition, supporting previous claims (Eckman et al. 2003; Eckman et al. 2013; Hammerly 1982; Hardy 1996; Major 2008). While a different study may be needed to confirm that allophonic union is easier than allophonic split, as suggested by Stockwell et al.'s (1965) grammatical hierarchy, the results of the present study suggest that speakers do show evidence of allophonic union—specifically, L1 /d/ and /ɾ/ becoming allophones of /d/ in the L2—prior to a complete L1 allophonic separation, whereby the L1 allophones [d] and [ð] must be reanalyzed as separate L2 phonemes.

7. Conclusions

In this article, I have shown that the phones [d ð ɾ], despite being part of the phonological grammar of Spanish, pose challenges for learners of GAE as an L2 due to their differing phonological distributions. The production patterns observed indicate an interaction between L1 and L2 phonological representations, with learners experiencing difficulty separating the two L1 allophones of /d/ ([d] and [ð]) into distinct phonemes in the target language (/d/ and /ð/). This finding supports previous research on the difficulty of allophonic split in L2 phonological acquisition. At the same time, learners show progress toward allophonic union, unifying the L1 phonemes /d/ and /ɾ/ as allophones of the target-language phoneme /d/. The results also reveal patterns that cannot be explained solely by L1 transfer or L2 input, such as the realization of target intervocalic /ð/ as an alveolar tap [ɾ], providing evidence for productive patterns in learners' interlanguage.

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References

Archibald, John. 2021. "Ease and Difficulty in L2 Phonology: A Mini-Review." *Frontiers in Communication* 6: 626529. https://doi.org/10.3389/fcomm.2021.626529.

Barrios, Shannon L., Anna M. Namyst, Ellen F. Lau, Naomi H. Feldman, and William J. Idsardi. 2016. "Establishing New Mappings between Familiar Phones: Neural and Behavioral Evidence for Early Automatic Processing of Nonnative Contrasts." *Frontiers in Psychology* 7: 1–16. https://doi.org/10.3389/fpsyg.2016.00995.

Beebe, Leslie M. 1980. "Sociolinguistic Variation and Style Shifting in Second Language Acquisition." *Language Learning* 30 (2): 433–45. https://doi.org/10.1111/j.1467-1770.1980.tb00327.x.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In *Language experience in second language speech learning: In honor of James Emil Flege* (pp. 13-34). John Benjamins Publishing Company.

Boersma, Paul & Weenink, David (2026). Praat: doing phonetics by computer [Computer program]. Version 6.4.63, retrieved 4 April 2026 from https://praat.org

Boomershine, Amanda, Kathleen Currie Hall, Elizabeth Hume, and Keith Johnson. 2008. "The Impact of Allophony versus Contrast on Speech Perception." In *Contrast in Phonology*, edited by Peter Avery, Elan Dresher, and Keren Rice, 143–72. Berlin: De Gruyter.

Bowden, Harriet W. 2016. "Assessing Second-Language Oral Proficiency for Research: The Spanish Elicited Imitation Task." *Studies in Second Language Acquisition* 38 (4): 647–75. https://doi.org/10.1017/S0272263115000443.

Bradley, Travis. 2019. "Spanish Rhotics and the Phonetics–Phonology Interface." In *The Routledge Handbook of Spanish Phonology*, 237–58. London: Routledge. https://doi.org/10.4324/9781315228112-13

Brand Fonseca, Kevin and Roger Segura Arias. 2022. "The Importance of English for the Costa Rican Economy and Curriculum." *Letras* 72: 193–218. https://doi.org/10.15359/rl.2-72.8.

Carrasco, Patricio, José Ignacio Hualde, and Miquel Simonet. 2012. "Dialectal Differences in Spanish Voiced Obstruent Allophony: Costa Rican versus Iberian Spanish." *Phonetica* 69 (3): 149–79. https://doi.org/10.1159/000345199.

Chavarría-Aguilar, O. L. 1951. "The Phonemes of Costa Rican Spanish." *Language* 27 (3): 248–53. https://doi.org/10.2307/409754.

Chappell, Whitney. 2017. "Costa Rican Spanish Speakers' Phonetic Discrimination." *Journal of Experimental Phonetics* 26: 13–61. https://doi.org/10.1344/efe-2017-26-13-61.

Cohen, Jacob. 1960. "A Coefficient of Agreement for Nominal Scales." *Educational and Psychological Measurement* 20 (1): 37–46. https://doi.org/10.1177/001316446002000104

Davidson, Lisa. 2011. "Phonetic and Phonological Factors in the Second Language Production of Phonemes and Phonotactics." *Language and Linguistics Compass* 5: 126–39. https://doi.org/10.1111/j.1749-818X.2010.00266.x.

Eckman, Fred R., Abdulla Elreyes, and Gregory K. Iverson. 2003. "Some Principles of Second Language Phonology." *Second Language Research* 19 (3): 169–208. https://doi.org/10.1191/0267658303sr2190a.

Eckman, Fred, and Gregory K. Iverson. 2013. "The Role of Native Language Phonology in the Production of L2 Contrasts." *Studies in Second Language Acquisition* 35 (1): 67–92. https://doi.org/10.1017/S027226311200068X.

Eddington, David, and Dirk Elzinga. 2008. "The Phonetic Context of American English Flapping: Quantitative Evidence." *Language and Speech* 51 (3): 245–66. https://doi.org/10.1177/0023830908098542.

Fernández, J. 1982. "The Allophones of /b, d, g/ in Costa Rican Spanish." *Orbis* 31: 121–46.

Flege, J. E., & Bohn, O. S. (2021). The revised speech learning model (SLM-r) applied. *Second language speech learning: Theoretical and empirical progress*, 84-118.

Flege, James E. 1995. "Second-Language Speech Learning: Theory, Findings, and Problems." In *Speech Perception and Linguistic Experience: Theoretical and Methodological Issues*, edited by Winifred Strange, 229–73. Timonium, MD: York Press.

Flege, James E. 1987. "Effects of Equivalence Classification on the Production of Foreign Language Speech Sounds." In *Sound Patterns in Second Language Acquisition*, 9–39. Dordrecht: Foris.

Flege, James E., Murray J. Munro, and Ian R. A. McKay. 1995. "Effects of Age of Second-Language Learning on the Production of English Consonants." *Speech Communication* 16: 1–26. https://doi.org/10.1016/0167-6393(94)00044-B.

Flege, James E., and R. Davidian. 1984. "Transfer and Developmental Processes in Adult Foreign Language Speech Production." *Applied Psycholinguistics* 5 (4): 323–47. https://doi.org/10.1017/S014271640000521X.

Fonseca Quesada, F. (2024). Substitution Patterns of the English Voiced Interdental Fricative by L1 Costa Rican Spanish Speakers . *Isogloss. Open Journal of Romance Linguistics*, *10*(2), 1–10. https://doi.org/10.5565/rev/isogloss.284

Hammerly, Hector. 1982. "Contrastive Phonology and Error Analysis." *International Review of Applied Linguistics* 20: 17–32.

Hardy, Jane. 1993. "Phonological Learning and Retention in Second Language Acquisition." In *Confluence: Linguistics, L2 Acquisition and Speech Pathology*, edited by Fred Eckman, 235–48. Amsterdam: John Benjamins.

Hayes-Harb, Rachel, and Shannon Barrios. 2021. "The Influence of Orthography in Second Language Phonological Acquisition." *Language Teaching* 54 (3): 297–326. https://doi.org/10.1017/S0261444820000658.

Herd Wendy, Allard Jongman and Joan Sereno. 2010. "An Acoustic and Perceptual Analysis of /t/ and /d/ Flaps in American English." *Journal of Phonetics* 38 (4): 504–16. https://doi.org/10.1016/j.wocn.2010.06.003.

Hualde, José Ignacio. 2014. *Los sonidos del español*. Cambridge: Cambridge University Press.

Hualde, José Ignacio, Ryan Shosted, and Daniel Scarpace. 2011. "Acoustics and Articulation of Spanish /d/ Spirantization." Paper presented at the 17th International Congress of Phonetic Sciences, Hong Kong, August 17–21.

Lado, Robert. 1957. *Linguistics across Cultures: Applied Linguistics for Language Teachers*. Ann Arbor: University of Michigan Press.

Major, Roy. 2008. "Transfer in Second Language Phonology: A Review." In *Phonology and Second Language Acquisition*, edited by Jette Hansen Edwards and Mary Zampini, 63–94. Amsterdam: John Benjamins.

Ortega, Lourdes, Noriko Iwashita, John Norris, and Said Rabie. 2002. "An Investigation of Elicited Imitation Tasks in Crosslinguistic SLA Research." Paper presented at the Second Language Research Forum, Toronto.

Selinker, Larry. 1972. "Interlanguage." *International Review of Applied Linguistics* 10: 219–31.

Shea, Christine E. 2017. "L1 English / L2 Spanish: Orthography–Phonology Activation without Contrasts." *Second Language Research* 33 (2): 207–32. https://doi.org/10.1177/0267658316684905.

Shea, Christine E., and Suzanne Curtin. 2010. "Discovering the Relationship between Context and Allophones in a Second Language." *Studies in Second Language Acquisition* 32 (4): 581–606. https://doi.org/10.1017/S0272263110000276.

Shea, Christine E., and Suzanne Curtin. 2011. "Experience, Representations and the Production of Second Language Allophones." *Second Language Research* 27 (2): 229–50. https://doi.org/10.1177/0267658310375753.

Stockwell, Robert P., Bowen Donald, and Martin John W. 1965. *The Grammatical Structures of English and Spanish*. Chicago: University of Chicago Press.

Turk, Alice. 1992. "The American English Flapping Rule and the Effect of Stress on Stop Consonant Durations." Ithaca, NY: Cornell University Press.

Vokic, Gabriela. 2010. "L1 Allophones in L2 Speech Production: The Case of English Learners of Spanish." *Hispania* 93: 430–52.

Wu, Shu-Ling, Yee Ping Tio, and Lourdes Ortega. 2022. "Elicited Imitation as a Measure of L2 Proficiency: New Insights from a Comparison of Two L2 English Parallel Forms." *Studies in Second Language Acquisition* 44 (1): 271–300. https://doi.org/10.1017/S0272263121000103.

Zampini, Mary L. 1994. "The Role of Native Language Transfer and Task Formality in the Acquisition of Spanish Spirantization." *Hispania* 77 (3): 470–81. https://doi.org/10.2307/344974.

Zampini, Mary L. 1996. "Voiced Stop Spirantization in the ESL Speech of Native Speakers of Spanish." *Applied Psycholinguistics* 17 (3): 335–54. https://doi.org/10.1017/S0142716400007979.

Appendices

To check materials for the Elicited Imitation Task B (proficiency task), please see Wu, et al., (2022).

Task 2 – Meaningful Sentences.

1. Both my brother and I are studying together in the university.
2. There is another colorful feather in the model's dress.
3. The author thought that creating a video to promote his book was a better method to reach the audience from the city.
4. My therapist told me that I should breathe every time that I feel scared. Therefore, that is what I do now.
5. Even though my uncle studies the weather conditions, he gets scared when there is thunder. Lightning takes his breath away, but he needs to have faith and trust that everything will be ok.
6. Maps don't show the real shape of the earth. Some of them make the north look bigger, and others make it look wider. These companies should be more ethical.
7. I wanted to run a marathon, and I was happy when I did it. Although breathing was difficult, another competitor was sympathetic and gave me some water. At the end, I won third place.
8. The wedding at the stadium felt very different. Then, the food was incredibly good, and my mouth was always full because I could not stop eating. I think I had at least four smoothies.
9. There is an old theory that says that if babies teethe faster than normal it's because they will be very smart. I now understand why I have a tooth missing...
10. This morning my mother told me that I had a strong odor, so I had to bathe. My skin was very smooth after the nice, long bath.
11. Last week I saw an artist who gave me the thumbs up for a picture with her. She told me, though, that she would not authorize me to post the picture on social media.
12. My dad recently started a business with butter. The other of his businesses has nothing to do with dairy products, as it is a math school.
13. Last time I saw my friends was last year; I really want to see them this week. I heard that Carlos looks very different as he is very thin now.
14. Those couples who cuddle in front of the single don't deserve to go to heaven.
15. I can eat pretty much anything.
16. My little sister was very nervous about her presentation at the science fair. I had to soothe her so that she would calm down.

Task 3 – Carrier Phrases. Words for each Carrier Phrase.

I say the word _____ in English

Faith - Feather - Brother - Wider - This - Mother - Thought - Them - Think - Thumbs - Breath - Author - North - Thunder - Teethe - Breathing - Though - Theory - Eating - Stadium - Method - Mouth - City - Three - Nothing - Therapist - Together - Studying - Audience - Bathe - Seethe - Math -Breathe - Competitor - University - Therefore - Smooth - Then - There - Thin - Wedding - Those - Pretty - These - Video - Earth - Writhe - Another - Marathon - Model - Authorize - Ethical - Products - Others - Creating - Soothe - Everything - Anything - Better - Loathe - Weather - Tooth - Both - Artist