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The Effect of Language Contact on /tʃ/ Deaffrication in Spanish from the US–Mexico Borderland

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Abstract: This study examines the sociophonetic variation in the L1 speech of Spanish–English bilingual speakers living in the Ciudad Juárez, Mexico–El Paso, TX border metropolis. The purpose of this research is to analyze the sociolinguistic production of /tʃ/ deaffrication in U.S. Spanish, particularly, in simultaneous and sequential bilinguals. Based on the Revised Speech Learning Model (SLM-r), it was hypothesized that L1 production of /tʃ/ deaffrication can be significantly affected by the establishment of a new L2 phonetic category /ʃ/ in bilinguals. Interviews with forty-four adult participants, including fourteen first generation simultaneous bilinguals, twelve sequential bilinguals, and eighteen monolingual Spanish speakers were acoustically and auditorily analyzed. Participants were recorded while they performed two types of tasks: a formal (reading) and two semi-informal speech production tasks. Results showed that simultaneous and sequential bilinguals had a significantly lower realization of [ʃ] than monolinguals, suggesting that L1 sociolinguistic variability is influenced by contact with English. Results also indicate the significance of the preceding segment on the realization of the variable under study in monolingual speech, with preceding /a, n, r, l/ favoring the variation and preceding /s, e, i, o, u/ disfavoring it. Comparisons of the variation in monolingual and bilingual speech show that the sociolinguistic factors (preceding segment, sex, and age) that influence the variation in monolingual controls do not influence the variation in bilingual speech.

Keywords: sociophonetic variation; language contact; affricate weakening; deaffrication of /tʃ/; Mexican Chihuahua Spanish; El Paso Spanish

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1. Introduction

The co-existence of Spanish, the heritage language, and English, the majority language, in El Paso, Texas creates a contact-linguistic setting that is particularly interesting for the study of variation. This study presents empirically based research that extends knowledge about sociolinguistic variation in heritage language. The paper considers the extent to which a bilinguals' L1 sociolinguistic variation changes as a result of contact with the L2, especially, in cases where the variation in question involves sounds also found in the L2, but performing different functions (e.g., allophones in one language and phonemes in the other). This situation can create a potential for cross-linguistic influence (Flege 1995; Best and Tyler 2007). The present study uses the revised version of the Speech Learning Model (SLM-r) (Flege and Bohn 2021) to examine how the creation of a new L2 speech category can potentially influence sociolinguistic variability in bilinguals' L1. Since the SLM-r, as well as the original SLM, focus on the influence of the L1 on the L2, the present study will extend the model to make specific predictions about how newly established representations in the L2 can affect the perception and production mechanisms in the L1.

Previous studies on heritage languages have shown that heritage speakers (HSs) are close to monolingual speakers in some language areas, e.g., they often develop monolingual-like competence in sound production (Au et al. 2002; Amengual 2012) and perception (Antoniou et al. 2012; Mazzaro et al. 2016). However, little is known about the nature of phonological representations in Heritage Spanish Speakers (HSSs), their sociolinguistic competence, their use of variables and whether these are influenced by the same social and linguistic constraints as monolingual speech. This is an important consideration because it can shed light onto the dynamics of language variation in contact situations and the nature of bilinguals' phonological systems.

To investigate the influence of the second language on the variability of the native language, the present study examines the sociolinguistic production of /tʃ/ deaffrication in U.S. Spanish, particularly HSSs and sequential bilinguals living in the Ciudad Juárez, Mexico–El Paso, TX border metropolis. El Paso has been recognized as the oldest and largest city on the U.S.-Mexico border, as well as one of the oldest sites of Spanish-English contact in the United States (Hidalgo 1995). El Paso constitutes, together with Ciudad Juárez, its neighbor to the south, a metropolitan area of approximately 3 million people. Due to its border location, and its unique binational, bicultural, and bilingual characteristics, El Paso provides the perfect climate for a scholarly investigation on bilingualism. With a population of around 800,000, more than eighty percent of the people in El Paso are of Hispanic origin (U.S. Census Bureau 2019). Eighty-three percent of Hispanics speak Spanish at home (Krogstad and Lopez 2017). A large portion of those Hispanics is bilingual, but specific numbers are difficult to obtain. An article by Fernández et al. (2007) on education, race/ethnicity, and out-migration from El Paso established that, among those who stay in the city, about 51.9% are Spanish-English bilinguals, 26.7% are English monolingual, and 21.4% are Spanish monolinguals.

The two bilingual groups (HSSs and sequential bilinguals) tested here spoke Spanish from birth but differed in their age of onset of acquisition of English. Whereas the HSSs were exposed to English early on and received formal education in English, the sequential bilinguals were exposed to English after puberty and were educated in Spanish. Unlike monolingually raised speakers, heritage speakers acquire Spanish in a bilingual environment and they often shift to an increased use of English once they start attending school (Montrul 2010). Sequential bilinguals grow up in a monolingual Spanish environment and begin to learn their second language after childhood. These populations are optimal to evaluate the new SLM-r, which focuses on how bilinguals produce and perceive speech sounds and how the phonetic system reorganizes in response to new phonetic categories acquired during L2 learning (Flege and Bohn 2021).

/tʃ/ deaffrication has been observed in disparate Spanish dialects, such as Mexico (Brown 1989; Amastae 1996; Méndez 2017; López Velarde and Simonet 2020); Spain (Regan 2020) Panamá (Cedergren 1973); and US Spanish (Jaramillo and Bills 1982) among others. In Mexico, the fricative [ʃ] is found in some northwestern dialects, such as Chihuahua, but as an allophone of /tʃ/ (Hualde 2005). Thus, in northwestern Mexican speech, *leche* "milk" is variably realized as [létʃe] or [léʃe]. In English, /tʃ/ and /ʃ/ are members of a phonemic contrast, as seen in minimal pairs such as *chop-shop* and *cheat-sheet*. Standard Spanish does not have this contrast, because its inventory only contains the affricate /tʃ/, orthographically represented as <ch>. Given this cross-linguistic difference between English and Spanish, the purpose of this study is to explore whether the L1 variability of /tʃ/ in bilingual speakers who have acquired the /tʃ/ and /ʃ/ contrast in their L2 is different to that of monolingual Spanish speakers.

The deaffrication of /tʃ/ in the Spanish of Chihuahua represents the most distinguishable pronunciation feature of this dialect (Amastae 1996). Speakers from other parts of the country stereotypically imitate, or rather make fun of, Chihuahua speech by using deaffrication in words such as Chihuahua [ʃiwáwa]. Despite the criticism from other parts of the country, most Chihuahua inhabitants, except for those of the upper socio-economic classes, consider /tʃ/ deaffrication to be a characteristic feature of Chihuahua Spanish (Méndez 2017). Previous research (Mazzaro and González de Anda 2019) suggests that /tʃ/ deaffrication is gradually losing some of its stigma in this dialectal area.

Previous sociolinguist studies on /tʃ/ deaffrication (Cedergren 1973; Jaramillo and Bills 1982; Brown 1989; Amastae 1996; Méndez 2017; Regan 2020) found that it is affected by several linguistic and extra-linguistic factors. Based on this literature, the present study explores some of the factors hypothesized to be relevant in this Spanish dialect (Amastae 1996; Méndez 2017). Specifically, the linguistic factors consisted of preceding and following segment and syllabic stress, while the extra-linguistic factors included sex, age, and style (reading vs. narrative).

In what follows, I review the background research on /tʃ/ deaffrication and SLM-r (Section 2), which form the basis for the hypotheses (Section 3) and the methodology (Section 4) used in this study. The results are reported in Section 5, followed by Section 6 where I evaluate the hypotheses and present the conclusions.

2. Background Literature

2.1. /tʃ/ Deaffrication

The Spanish inventory contains a single affricate phoneme /tʃ/, the prepalatal voiceless affricate, as in muchacho /mutʃátʃo/ "boy". The realization of this phoneme corresponds with orthographic <ch>. The place of articulation of /tʃ/ is quite variable, as well as its manner of articulation (Hualde 2005). With regards to manner, the loss of the occlusive segment of the affricate is very widespread, which results in the fricative [ʃ] (as in English *shop*): muchacho [muʃáʃo]. This phenomenon has been reported in disparate dialectal areas such as Andalucía, Northern Mexico (Sonora and Chihuahua), Panamá, and parts of Chile (Hualde 2005).

The phoneme /tʃ/ appears only in prevocalic position, either word-initial or medial. It never appears in coda position, except in borrowed words from other languages such as Catalan, where word final <ch> appears in proper names (e.g., Llorach) (Hualde 2005). Concerning the distribution of the weakened variant [ʃ], according to a laboratory study performed by Herrera (2006), the lenited variant can appear in any phonetic context, except when there is a preceding homorganic nasal [n] or lateral [l], as in ancho [ánʲtʃo] "wide" and colcha [kólʲtʃa] "blanket". In these cases, a brief occlusion is maintained (Herrera 2006). However, the occlusion segment of the affricate still lenites or shortens even in these contexts. Presenting evidence from different languages, Herrera argues that the occlusion retained when [tʃ] is preceded by [n] and [l] prevents sequences of such consonants with [ʃ], which seem to be disfavored in Spanish.

2.2. Sociolinguistic Studies on /tʃ/ Deaffrication

The first sociolinguist study on /tʃ/ deaffrication was performed by Cedergren in 1973. She analyzed the social and linguistic aspects affecting deaffrication in Panamá City which, at that time, was a recent phenomenon. Her results drawn from the auditory analysis of 79 sociolinguistic interviews showed that deaffrication was a case of change in progress, initiated by younger middle class adults and more frequently found among women. Her analysis of linguistic factors showed that [ʃ] was favored in intervocalic position and disfavored when preceded by a consonant and a pause (i.e., word initial position). Unfortunately, Cedergren (1973) collapsed all preceding consonants in one group, so it was not possible to evaluate the frequency of [ʃ] by previous consonants that tend to disfavor deaffrication (/n, l/) vs. others such as /s, r/ that tend to favor it. The most unexpected result from her study was that the more formal register favored [ʃ], which was accounted for by the fact that deaffrication in Panamá City is a change in progress initiated by young lower-middle class women. So, at the initial stages of this change in progress, the variable was not stigmatized, as it is in every other variety reviewed in this study.

Moving on to the Spanish spoken in the USA, one of the first sociolinguist studies on /tʃ/ deaffrication was conducted by Jaramillo and Bills (1982) in the rural community of Tomé, New Mexico. Their interviews with 36 Spanish-speaking residents of Tomé showed that the phonetic contexts conducive to weakening of /tʃ/ were preceding vowels and consonants, except for /n/ and /l/. Jaramillo and Bills (1982) did not find a single case of deaffrication with preceding homorganic nasal and lateral consonants. With regard to vowels, there was no difference in the degree of weakening across different vowels, either preceding or following the sound in question. The analysis of social factors showed no differences in the distribution of [ʃ] between women and men, but there were differences in the distribution of [ʃ] by generational groups and educational level. Younger people in the sample (17–30 years old), who also happened to have the highest levels of education (college degree), had lower percentages of [ʃ] than the two older groups (31–50 and 51+) who had attained high school and/or grade school. The influence of preceding pause, syllabic stress and style were not investigated in this study.

Around the same time as Jaramillo and Bills (1982), Brown (1989) conducted a study on the Spanish from Sonora, Mexico. Thirty-two young speakers (16 women and 16 men) between the ages of 16–22 were interviewed for this study. As opposed to Jaramillo and Bills (1982), who categorically found the standard variant [tʃ] after homorganic nasal [n] and lateral [l] consonants, Brown (1989) only reported a greater use of [tʃ] after [n]. With the exception of two participants, all her speakers used the fricative very frequently, with an overall percentage of 65.6. When there was a preceding nasal, 13 speakers in her sample lenited the affricate to some extent, which is interesting given that Jaramillo and Bills (1982) reported none. There was no mention of the effect of the lateral on the variable under study.

More relevant to the present study, was the sociolinguistic analysis performed by Amastae (1996) who explored the realization of <ch> in 55 native speakers from Ciudad Juárez. The linguistic factors analyzed were preceding and following phonetic contexts. The social factors were sex, socioeconomic status (SES), age, and education level. Results of the overall realization of the non-standard variant was 42%. With regard to the linguistic factors, there was a low percentage of [ʃ] with preceding /n/ and a high percentage with preceding /s/ and vowels. The following context did not seem to influence the variable in question, and syllable stress was not analyzed in this study. Regarding the social factors, particularly SES and formal education, Amastae (1996) proposed that the weakening of /tʃ/ in Ciudad Juárez was a case of change from below more frequently found in speakers of low SES and low formal education. The change entered the city from 1940–1960 during the "bracero" program that gave jobs to thousands of Mexicans from the borderland and the interior of the state. The influx of immigrants from the interior of the state, mainly rural areas, brought with it new linguistic variants to Ciudad Juárez. Throughout the following years, many of those variants were incorporated into the city speech, including the newborns of Ciudad Juárez and other social groups. Amastae (1996) pointed out that despite the spread of /tʃ/ weakening into almost every social group, it continues to be a stigmatized feature that many people criticize. Amastae reported many anecdotes of speakers that denied having the variable in their speech, while they unconsciously used it in the recorded dialogues.

Twenty years after Amastae's (1996) study, Méndez (2017) conducted another sociolinguistic study in Ciudad Juárez. His study found that the standard variant [tʃ] was more frequent (67.2%) than the non-standard one [ʃ] (32.8%). Concerning the linguistic factors investigated, preceding segment was the only factor selected as significant by the multivariate analysis. A preceding [s] and the high vowels [i, u] favored the occurrence of [ʃ], while preceding [n, r] and pause disfavored it. The mid and low vowels [e, o, a] were rather neutral in their effect on [ʃ]. Of the social factors considered, similarly to Amastae (1996), SES and education level were the two most important, with low SES and low levels of formal education favoring [ʃ]. Interestingly, the distribution of [ʃ] did not shift much across tasks (interview 33.3% vs. reading 32.1%). Either participants were monitoring their speech throughout the session avoiding the use of [ʃ], or they were unaware of the variable and could not manipulate its use depending on the register. This further supports the idea proposed by Amastae (1996) that the variable is below the level of social consciousness (Labov 1972). Most of Méndez's (2017) participants considered [ʃ] to be a characteristic feature of Chihuahua Spanish, but some participants mentioned that it was more common in rural areas. Few participants (20%) regarded /tʃ/ weakening as "incorrect" and negatively perceived, and they avoided its use at all costs. Crucially, the participants that expressed these views were mostly from the upper socioeconomic class and had high levels of formal education. One of Méndez (2017) speakers stated about [ʃ] that "Normalmente la gente un poquillo como naquilla lo hace", "Normally, tacky people do it". Although these remarks suggest that /tʃ/ weakening carries some stigma, the large majority of participants (97.5%) agreed that it is a linguistic feature that identifies Chihuahua Spanish.

Mazzaro and González de Anda (2019) explored the link between the perception and production of the /tʃ/ variable in Chihuahua Spanish. Thirty-three native Spanish speakers from Chihuahua completed a production task to establish whether they produced [ʃ] and a discrimination task to determine if they were able to perceive the variants [tʃ] and [ʃ]. Their results of production showed that deaffrication was favored by the youngest generation and by men. The authors argued that the classic characterization of deaffrication as a change from below is not accurate. Instead, deaffrication in Chihuahua displayed all the characteristics of stable linguistic variation, with low rates of stigmatized forms by women and higher rates of the stigmatized forms by men. This was further supported by the frequency of use of the variant across generations: there was a drop in the use of the non-standard form by middle-age speakers, which could indicate that the speakers most affected by the "linguistic marketplace" (Bourdieu and Boltanski 1975) avoid the non-standard variant more than other groups.

In terms of perception, 84.4% of the listeners were able to perceive the variation and had a finer metalinguistic awareness of [ʃ]. Mazzaro and González de Anda (2019) claimed that the high perception of the /tʃ/ variable has to do with the fact that it has become a "stereotype" (Labov 1972) of Chihuahua Spanish and is subject to criticism and jokes from speakers of other dialects. Overt comments about deaffrication may increase participants' metalinguistic awareness of this variant that is stereotypically associated with their dialect. Regarding the link between perception and production, their results showed that individuals who perceived deaffrication in the perception task tended to produce it more as well, resulting in a closer production–perception relationship for this variant. The study showed that the perception of variation that is socially salient and stigmatized such as /tʃ/, can condition its production, showing a positive relationship between both.

Regan (2020) conducted a sociolinguistic study on /tʃ/ variation in Huelva (Western Andalucía), Spain. The study acoustically analyzed [tʃ] and [ʃ] realizations based on 31 sociolinguistic interviews (15 men, 16 women) with speakers from the city of Huelva and surrounding towns. His results revealed that [tʃ] is most favored by younger and middle-aged women of all educational levels and younger and middle-aged men with university education. However, [ʃ] remains the preferred form among local men with lower levels of formal education. The author concludes that [ʃ] is a linguistic feature used by men to construct local identity and that the shift from [ʃ] to [tʃ] constitutes a change in apparent time in Huelva (Regan 2020).

2.3. L2 Influence on the Perception and Production of L1 Sounds

Previous work on cross-linguistic influence in bilingual speakers has focused on how an early acquired language (L1) affects learners' perception and production of a late acquired second language (L2). This line of work assumes that the L1 acts as a filter that categorizes target language sounds with reference to the existing L1 "representations" (Flege and Bohn 2021). Within perception, the phenomenon of foreign accent in the L2 was explained as the learner's difficulty to perceive phonological or phonetic differences between the L2 category and the existing L1 category. In this case, an "equivalence classification" (Flege 1995) between the L1 and (a different) L2 representation will block the formation of a new category in the L2 leading to a foreign accent in the L2. Conversely, when learners are able to discover at least some phonetic (or acoustic) differences between an L2 sound and its closest counterpart in the L1, a new phonetic category can be established. The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that new categories will be formed.

Despite the large evidence showing that the L1 can also be affected by L2 learning (Chang 2011), there are no formal theories that explain how the L2 can influence the phonological system of the L1. Although Flege and Bohn's (2021) SLM-r focuses on L2 rather than L1 speech perception, it provides an adequate model to analyze how the phonetic systems of individuals reorganize over the life-span in response to the phonetic input received during naturalistic L2 learning. Similar to the original SLM, SLM-r focuses on the attainment of segmental pronunciation of vowels and consonants in the L2 (Flege and Bohn 2021). A basic assumption of SLM-r is that the, L1-on-L2 and L2-on-L1 effects arise inevitably because the phonetic elements of a bilingual's L1 and L2 subsystems exist in a common phonetic space. Since the L1 and L2 influence each other, it is expected that the pronunciation of bilinguals will differ from the pronunciation of monolinguals in either language (Grosjean 1989, 1998; Yeni-Komshian et al. 2000).

Because of its more explicit focus on the impact of L2 on L1 speech, the SLM-r is an appropriate framework to apply in this study. With SLM-r it is possible to make specific predictions about how age of exposure to the L2, frequency of use of the L2 and proficiency in the L2 can influence an already formed L1 phonological system. Another advantage of SLM-r is its clear statement of how learning occurs (statistical learning), the reference to shared phonetic space, and the way in which new representations are created. Several of these factors were already present in SLM, but the emphasis on the quantity and quality of input the learner receives and the relationship between proficiency in the L1 and the L2 is more explicit in the revised model.

SLM-r proposes that "L2 speech learning is profoundly shaped by perceptual biases induced by the L1 phonetic system" (Flege and Bohn 2021, p. 24). These biases can change as a function of exposure to L2 sounds. This is an important consideration, because it means that L1 perception shifts as a result of L2 experience. In the case under study, [ʃ] already exists in the shared phonetic space of L1 speakers of Chihuahua Spanish, but as a prototype-like instantiation of /tʃ/. SLM-r proposes that, first, the L2 learner must discern a phonetic difference between the realizations of an L2 sound and the L1 sound that is closest to it in phonetic space. Second, a functional "equivalence class" of speech tokens that resemble one another, and so are close together in phonetic space, must emerge. The sounds that are part of such equivalence classes remain perceptually linked to the closest L1 sound until the distribution of tokens defining the equivalence class has stabilized. Third, at an undefined moment in phonetic development, the perceptual link between the L2 "equivalence" class and the L1 category breaks. Once this break or delinking has occurred, a new L2 phonetic category develops as a result of statistical regularities of the distribution of L2 sounds categorized as instances of the new L2 phonetic category. SLM-r proposes that this three-stage process is accelerated by increased L2 experience and growth of the L2 lexicon.

SLM investigated age of acquisition (AOA) as a factor predicted to influence the outcome of L2 acquisition. Flege (1995) observed that at a time when "children's sensorimotor abilities are generally improving, they seem to lose their ability to learn the vowels and consonants of an L2" (p. 234). The general idea being that earlier is better than later for L2 acquisition (Flege and Bohn 2021). As AOA of the L2 increases, there is a decrease in the likelihood to perceive phonetic differences between similar L1 and L2 sounds, and between L2 sounds that are noncontrastive in the L1. However, SLM-r no longer focuses on differences between early and late learners due to lack of adequate explanation for the age-related effects in L2 speech learning. Instead, quality and quantity of L2 input are more important, because they can determine the extent to which L2 learners differ from native speakers. SLM-r is more explicit about how much phonetic information and input is needed to cause the formation of new L2 phonetic categories. Rather than using length of residence (LOR), which is problematic because it does not vary linearly with the phonetic input that L2 learners receive and it provides no insight into the quality of L2 input, SLM-r uses full-time equivalent (FTE) years of L2 input as an estimate of the input received. Years of FTE input is calculated by multiplying LOR by the proportion of L2 use (derived from questionnaire estimates of percentage L2 use).

From the above, it becomes clear that creating a new category during L2 acquisition is the end state of a gradual process that requires enough input, L2 lexical growth, and frequent use of the L2. Unfortunately, SLM-r is not clear about how much increase in L2 proficiency is required in order for the creation of L2 categories to take place. Flege and Bohn (2021, p. 44) stated that "This might be evident even in fairly short periods of time." This study consisting of bilinguals with different LOR and AOA may provide some hints as to how much input is needed for the L2 category to be formed and whether the formation of a new phonetic category in the L2 can influence L1.

3. Research Questions and Hypotheses

The questions and hypotheses proposed are stated below:

(i) Can contact with English affect L1 /tʃ/ deaffrication in sequential and simultaneous bilinguals from Chihuahua and El Paso?

It is hypothesized that the contact with English will decrease /tʃ/ deaffrication in both groups of bilinguals. This is because extended and intense contact with English will be sufficient to form a new phonetic category for /ʃ/. In fact, SLM-r argues that a new phonetic category in the L2 can be created quite early, but the model is not explicit about how soon. Before this happens, SLM-r proposes that there will be a delinking of the previously established L1 perceptual link (in the present case /tʃ/). Once the /ʃ/ category has been formed, all new phonetic instances of /ʃ/ will be perceptually linked to it. As proposed by SLM-r, L1-on-L2 and L2-on-L1 effects arise inevitably because the phonetic elements of a bilingual's L1 and L2 subsystems exist in a common phonetic space, so the creation of a new phonetic category of /ʃ/ is expected to influence the variability observed in L1 speech.

(ii) Are AOA and LOR effective predictors of L2-on-L1 influence?

As stated in Section 2.3, AOA and LOR were used by SLM to estimate the outcome of L2 acquisition (Flege and Bohn 2021). In this study they will be used to predict L2-on-L1 influence. As explained in Section 4.1, both groups of bilinguals have acquired Spanish since birth in the home environment and have been exposed to it since then, so the variable in question will be present in both groups of bilinguals. Sequential bilinguals are expected to have higher rates of /tʃ/ deaffrication than HSSs, due to their being exposed to the L2 at a later stage and having shorter LOR in the US than the HSSs.

It is hypothesized that both groups of bilinguals will have lower rates of deaffrication than the monolingual controls. This is because the monolingual group has not been exposed to English for as long as HSSs and sequential bilinguals.

(iii) Does proficiency and frequency of use of the L2 affect L1 variation?

To evaluate the predictions made using SLM-r, this study analyzes L2 learners' proficiency in English and Spanish, as well as their frequency of use of each language. These two measures were obtained through questionnaires, as described in Section 4. SLM-r anticipates that L2-on-L1 effect sizes will increase as proficiency in the L2 increases. It is expected that /tʃ/ deaffrication in L1 speech will decrease with higher L2 proficiency and with higher frequency of L2 use. Frequency of use will be evaluated using FTE years of L2 input.

(iv) What sociolinguistic (linguistic or extra-linguistic) factors play a role on /tʃ/ deaffrication in each group? Does the patterning of factors that influence the variability in bilingual speech mirror that of monolingual speech?

Among the linguistic factors, this study analyzed the influence of the preceding segment on the occurrence of /tʃ/ deaffrication. The general categories considered were pause (for /tʃ/ in initial position in the word), vowels, and consonants. Consonants and vowels were analyzed individually first, and then collapsed with other members if they behaved similarly. Following previous research (Jaramillo and Bills 1982; Brown 1989; Méndez 2017), it is expected that the previous segment effect will be a strong constraint on the variation. Particularly, the alveolar nasal /n/ and the lateral /l/ will disfavor deaffrication of /tʃ/ and vowels will favor it. Other linguistic factors explored were syllabic stress and following segment. Although previous literature did not discuss stress and following segment (Cedergren 1973; Jaramillo and Bills 1982; Brown 1989; Amastae 1996) or did not find them significant (Méndez 2017; Regan 2020), it is important to explore whether new or specific patterns are emerging in this dialect of Spanish. Since /tʃ/ deaffrication is considered a lenition process where the affricate losses its occlusive segment, syllabic stress or, rather, lack of stress would be expected to positively influence its occurrence.

Among the social factors, this study analyzed the influence of sex and age on the occurrence of /tʃ/ deaffrication. While these factors have been analyzed in the previous studies cited in 2.1, their effect has been contradictory or different in the various dialects studied. For instance, while Cedergren (1973) and Amastae (1996) found that women favored /tʃ/ deaffrication, Jaramillo and Bills (1982) and Brown (1989) found no significant differences, and Méndez (2017), Mazzaro and González de Anda (2019) and Regan (2020) found that men favored the use of the stigmatized variable. With regard to the effect of age, most of the studies cited above (Cedergren 1973; Amastae 1996; Méndez 2017; Regan 2020) found higher rates of [ʃ] in younger speakers. Only one study (Jaramillo and Bills 1982) found that younger speakers produced lower proportions of [ʃ] but, the authors explained that it could be due to younger participants having higher levels of formal education (college degree) than older participants who have attained high school and/or grade school. Because of its non-standard nature, /tʃ/ deaffrication is expected to occur more often in male speech. Based on previous literature, younger speakers will be more frequent users of [ʃ].

The effect of task was also explored in this study by comparing the frequency of deaffrication in reading (formal) vs. narrative of a fairy tale (semi-informal) vs. talking about favorite food (informal). Again, this factor has been studied before, but its effect has not been clear. For example, Cedergren (1973) found that the formal register favored the non-prestigious variant [ʃ], while Méndez (2017) found no significant differences in the use of the stigmatized variant in formal (reading) and informal (interview) styles. HSSs are expected to show less style shifting and, thus, similar percentages of [ʃ] across reading and speaking tasks. This is because social and stylistic variation in the L1 are learned later in life, at around age 10 (Fischer 1958; Romaine 1980). HSSs in this study were exposed to English before 6, so they may not have learned all the social and stylistic nuances of deaffrication by the time their contact with the L2 started.

4. The Present Study

4.1. Participants

The present study focuses on two types of bilinguals: simultaneous bilinguals (here HSSs), who were exposed to English early on (before 6 years) and received formal education in English, and sequential bilinguals, who were exposed to English after maturation (12 years) and whose schooling was in Spanish. The latter were born and raised in a native Spanish context. A total of forty-four participants (n = 44) were divided into three groups: 14 participants were HSSs, who acquired English at the average age of 3, 12 sequential bilinguals who acquired English at the average age of 15, and 18 monolingual Spanish speakers serving as controls (Table 1).

Table 1. Participants' demographic information.

	HSS (n = 14)		Sequential (n = 12)		Control (n = 18)	
Mean age at testing (SD)	22.9 (2.77)		39.9 (15.1)		24.7 (9.99)	
Place of birth	US & Mexico		US & Mexico		Mexico	
Mean AOA [1] in the USA	3.7		28.6		24.2	
Overall Lg. [2] Use	3.5/7		4.9/7		-	
Gender	F 6	M 8	F 10	M 2	F 12	M 6
DELE [3]	42/50		46/50		-	
Mean LOR [4]	MX 3.7	USA 19.1	MX 28.7	USA 11.3	MX 24.1	US 0.4
Self-Proficiency (out of 4)	Eng. 3.7	Span. 3	Eng. 2.7	Span. 3.9	-	
More Comfortable Lg. [2]	Spa 8%	Eng. 46%	Spa. 91.7%	Eng. 8.3%	Spa. 100%	
	Both 46%		Both -			

[1] AOA (age of arrival); [2] Lg. (language); [3] DELE (Diploma de Español como Lengua Extranjera); [4] LOR (length of residence).

As shown in Table 1, the HSSs included participants born and raised in the US and participants who came to the US at an early age (age at testing, $\overline{x}$ = 22.9; AOA, $\overline{x}$ = 3.7; LOR, $\overline{x}$ = 19.1). Their self-proficiency rating in English was almost native (3.7/4) and in Spanish it was good/fluent (3/4). When asked what language they felt more comfortable in, 46% felt more comfortable in English, 46% felt more comfortable in Spanish, and only one speaker felt comfortable in both languages. The proficiency score in the DELE test (developed by Cuza et al. 2013) was 42/50 (advanced proficiency). The frequency of language use was measured with a Likert scale from 1 to 7, with 1 being for participants that use only English and 7 for those who use only Spanish. The overall language use of these participants was 3.5, which means that they appear to be using a bit more English than Spanish.

The sequential bilinguals included first generation immigrants from Chihuahua, Mexico (age at testing, $\overline{x}$ = 39.9; AOA, $\overline{x}$ = 28.6; LOR, $\overline{x}$ = 11.3), who arrived to the USA after the age of 12 and with a fully developed L1 grammar. Their self-proficiency rating in Spanish was almost native (3.9/4) and in English it was good/fluent (2.7/4). The proficiency score in the DELE test was 46/50 (advanced proficiency). When asked which language they felt more comfortable in, the majority (91.7%) indicated Spanish. As for language use, they use a bit more Spanish than English (4.7/7).

The control group was formed by recent arrivals to El Paso, Texas, from Mexico. They were all university students enrolled in an ESL program at the University of Texas at El Paso (age at testing, $\overline{x}$ = 24.7; AOA, $\overline{x}$ = 24.2; LOR, $\overline{x}$ = 4 months). These speakers use only Spanish and, obviously, they feel more comfortable speaking this language.

All participants resided in the borderland area of El Paso, Texas and Ciudad Juárez, México. Except for five monolingual participants who have only completed high school, the remaining participants were all receiving a university education or have already completed their university degree. The high number of college students or college graduates in our sample is due to recruiting our participants in college settings, but it is not representative of the general population native to El Paso and Ciudad Juárez. Because of the overrepresentation of highly educated people in our sample, we did not look at education as a factor that can influence the variable under study.

Previous sociolinguistic studies on the production of /tʃ/ deaffrication (Amastae 1996; Méndez 2017; Regan 2020) looked at age and gender as factors that influenced the variable under study. As stated above, their findings have been contradictory in the different

Spanish dialects analyzed. This study will compare the effect of both social factors in bilingual and the control groups.

4.2. Materials

The informants were recorded directly onto a laptop computer using Audacity 2.1.2 and a Blue Snowball USB microphone. The speech was sampled at 44.1K, and the tokens containing /tʃ/ were analyzed with PRAAT (Boersma and Weenink 2021).

All the materials were in Spanish, and sessions were completely conducted in Spanish in a sound-treated room. First, the participants completed an adult language background questionnaire, which elicited information on place of birth, primary language of schooling, patterns of language use, etc. This questionnaire also elicited a self-proficiency judgment in both English and Spanish in the four linguistic skills via a Likert scale, ranging from basic/limited (1) to excellent/native (4). In addition to the self-proficiency measure, bilingual participants completed an independent proficiency task, adapted from the DELE. Following previous research using the same methodology, participants who scored between 40 and 50 points out of 50 were considered to be "advanced" learners; those with scores 30 to 39 were considered to be "intermediate" learners and those with scores between 0 and 29 were considered to be "beginner" learners (Cuza et al. 2013).

The participants' speech was elicited by completing three tasks: (1) Reading from a word-list; (2) narrating a fairy tale; and (3) chatting about the participants' favorite food. For the reading task, words from a list were presented on a computer screen one at a time using Microsoft Power Point slides. The participants were instructed to read words in isolation with a pause after each word. The stimuli consisted of 4 words only, because the original purpose of this reading list was to elicit the production of a different sound, and the words containing <ch> had been used as distractors. Despite the reduced amount of tokens in the reading task, it was possible to compare the participants' performance in reading vs. speaking tasks. The words in the reading task contained /tʃ/ in medial position, in stressed (e.g., duchar "to shower") and in unstressed positions (e.g., bicho "bug", mucho "a lot", and dicho "saying or said"). In the second task, speakers narrated the "Little Red Riding Hood", based on Perrault's version of the fairy tale. First, participants were shown the pictures as a refresher. When they felt ready, participants narrated the story in their own words, using the images as guidance. In the third task, participants talked about their favorite food, where they eat it, and/or who prepares it. This last section was considered the most casual style of speech, since speakers were free to talk with only a simple open-ended prompt.

4.3. Spectrographic Inspection of Tokens and Coding

Recordings were transcribed with PRAAT (Boersma and Weenink 2021) using regular orthography. The transcriptions were force-aligned with Praatalign (Lubbers and Torreira 2016). After alignment, the text grids were manually inspected for accuracy. The top tier contains the auditory classification of the variants, performed by the author and another trained phonetician. The second tier contains information about the manner of articulation. In the case of the affricate, its manner of articulation included the stop portion and the fricative portions, marked as "s" and "f". If the variant was a fricative, it would only include the fricative portion. The third tier contained information about syllabic stress. If <ch> was present in a stressed syllable, the syllable was marked with "s", if it was present in an unstressed syllable it was marked with "u". The last two tiers were automatically generated by PraatAlign based on the audio and transcription. The fourth tier contained the word boundaries and the fifth tier contained the segmental analysis.

The coding of variants was based on both auditory analysis and inspection of the spectrograms and waveform. If the sound was heard as [tʃ] and there was a stop portion within the affricate segment, then it was coded as an affricate (Figure 1). Sometimes the affricate sound contained a release, which was included as part of the stop section. In the case of Figure 1, there were two releases. In other cases, there were three or four releases (Figure 2) and in some cases there were none (Figure 3).

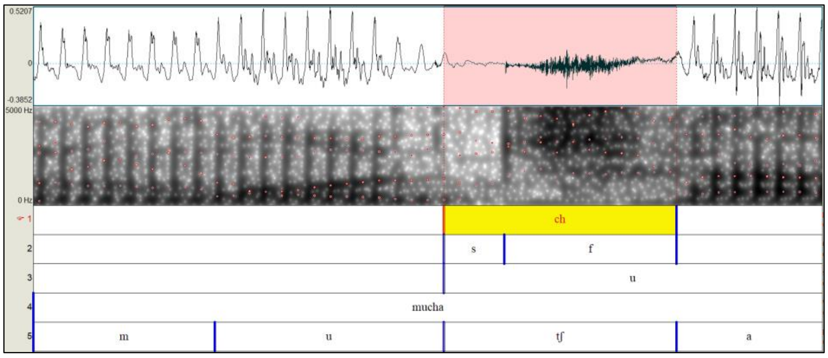

Figure 1. Transcription of the interview in PraatAlign. Male speaker (UT008). The audio for this example is available at AudioS1_UT008_con_mucha.wav.

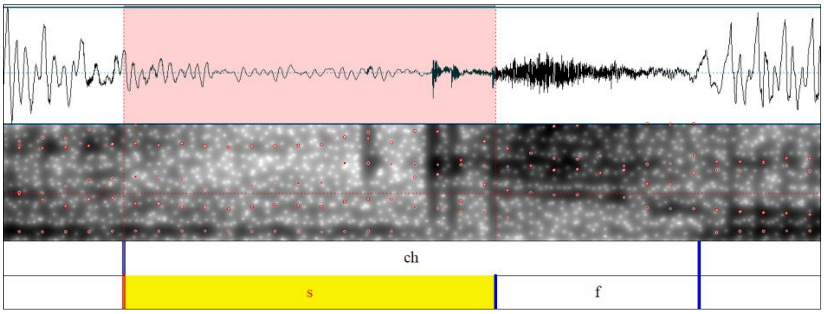

Figure 2. Coding of [tʃ] in the word aprovechó "took advantage of". The affricate has a stop section with several releases. Male speaker (UT002). The audio for this example is available at AudioS2_UT002_caperucita_aprovecho_la.wav.

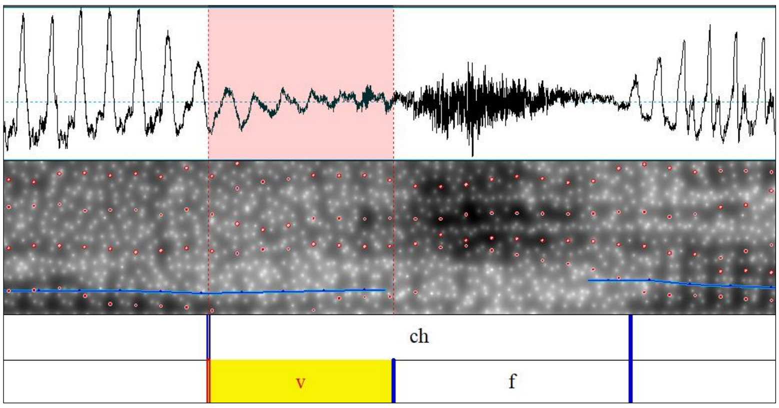

Figure 3. Coding of [tʃ] in the word mucha "a lot". The affricate has a stop section with no clear release. Male speaker (UT086). The audio for this example is available at AudioS3_UT086_con_mucha.wav

Despite the fact that there was no visible release, the [tʃ] in Figure 3 had a stop portion and it was perceived as an affricate sound. Another interesting feature about the stop portion in [tʃ] is that sometimes there was voicing (marked as "v" in the manner tier) either during the whole stop segment, as in Figure 3, or part of it. Voicing is observed by the presence of periodicity in the spectrogram.

Deaffricated variants contained no stop portion (Figure 4) and were classified as "sh" in tier 1.

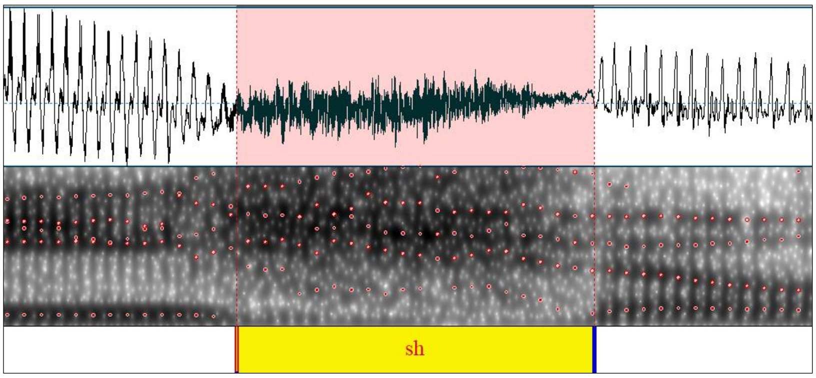

Figure 4. Coding of [ʃ] in the word bicho "bug". Female speaker (UT030). The audio for this example is available at AudioS4_UT030_list_bicho.wav.

4.4. Statistical Analyses

The data collected from HSSs was be compared to that of sequential bilinguals and monolingual controls. HSSs in El Paso are exposed to not only Spanish monolinguals, but also to sequential bilinguals, so the comparison between groups can help determine if any difference between HSSs and sequential bilinguals is due to an earlier contact with English. According to Menke and Face (2010), it is also important to compare HSSs to monolingual controls of the same dialect in order to determine the baseline phonological system to which HSSs are being compared. So, bilingual groups will be compared to the monolingual Spanish speakers who belong to the same dialectal region as both groups of bilinguals.

Before performing the statistical analysis, I excluded certain tokens: words containing <ch> that are not native to Spanish, e.g., chef, and frequent words that appear more than three times per individual and per task, e.g., chile "chili" and mucho "a lot". In the case of frequent words, only the first three instances were included, because analyzing all tokens of frequent words would bias the results obtained. All other tokens (n = 681) were entered in the statistical analysis. The word-list reading task yielded a total of 165 tokens, the narrative task yielded a total of 100 tokens, and the semi-spontaneous talk yielded 416 tokens.

The effects of the linguistic and extra-linguistic variables were tested using random forests and conditional trees in R (R Core Team 2020). Random forests and conditional trees are more appropriate than mixed-effects models for naturalistic, unbalanced data with complex interactions (Tagliamonte and Baayen 2012).

The functions used in R were cforest, varimp, and ctree in the party package (Strobl et al. 2008). Random forests evaluate the relative importance of each independent variable, using a procedure that tests whether any independent variable is a sensitive predictor of the response variable. To do so, random forests follow a process of trial and error working with random samples of the data (Tagliamonte and Baayen 2012). A conditional tree "provides estimates of the likelihood of the value of the response variable based on a series of binary questions about the values of predictor variables" (Tagliamonte and Baayen 2012, p. 159). Conditional trees help visualize complex interactions within a data set.

Contingency tables and bar plots were used to further explore the influence of independent factors on /tʃ/ deaffrication with Jamovi, a statistical package based in R (The Jamovi Project 2021).

5. Results

The first research question asks whether contact with English can affect L1 /tʃ/ deaffrication in HSSs and sequential bilinguals. This hypothesis was partially confirmed by the results presented in Table 2. HSSs produced [ʃ] in 4.2% of tokens, compared to 9.2% from sequential bilinguals and 39.3% from monolingual speakers. Percentages of individual speakers are shown in Appendix A. A Bonferroni Post Hoc test revealed a significant difference between the bilingual groups and the control group, but no significant differences were detected between the HSSs and the sequential bilinguals. Figure 5 illustrates the distribution in each group.

Table 2. Distribution of [tʃ] and [ʃ] across bilingual groups.

Group		Variant [tʃ]	Variant [ʃ]	Total
HSS	N	161	7	168
	%	95.8%	4.2%	100.0%
Sequential	N	157	16	173
	%	90.8%	9.2%	100.0%
Control	N	196	127	323
	%	60.7%	39.3%	100.0%
Total	N	514	150	664
	%	77.4%	22.6%	100.0%

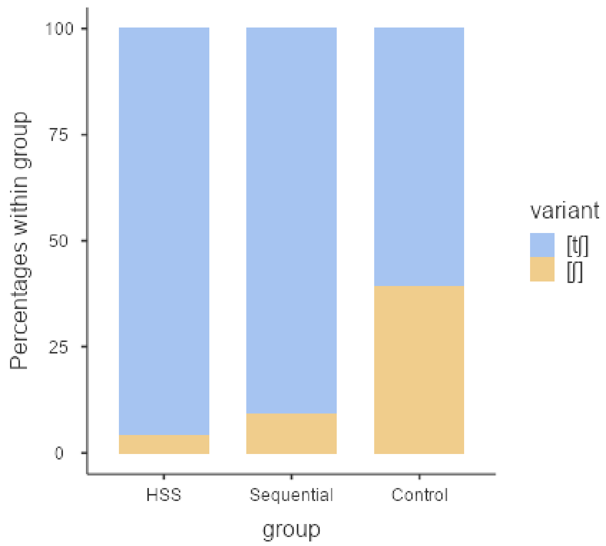

Figure 5. Distribution of [tʃ] and [ʃ] across groups.

The second research question asks whether AOA and LOR are effective predictors of L2-on-L1 influence. These two factors were used by SLM to estimate the outcome of L2 acquisition (Flege and Bohn 2021).

AOA and group are highly correlated, since the participants were classified into groups according to AOA. Table 1 shows the average AOA for each group: HSSs = 3.7 and sequential bilinguals = 28.6. LOR is also highly correlated with group, because HSSs tend to have a longer LOR (19.1) than sequential bilinguals (11.3). Thus, AOA and LOR are also correlated. Finally, language proficiency is also related to the group, since HSSs tend to have higher proficiency in English (3.7) than sequential bilinguals (2.7). Because all these variables are highly correlated, a random forest was conducted to determine which of them has a stronger influence on /tʃ/ deafrication (Figure 6). This analysis includes only the bilingual participants, because AOA and LOR are not applicable to monolingual speakers.

As shown by the random forest in Figure 6, the most important predictor of /tʃ/ deafrication is the individual speaker. After that, proficiency in English is the most successful variable in predicting the alternation between [ʃ] and [tʃ] and AOA is listed as the third most important factor. FTE years of L2 input was listed as the fourth factor and LOR was the last one. Thus, to answer the second research question and the third, L2 proficiency is the best predictor of /tʃ/ deafrication in the L1. AOA, which has been traditionally used to determine outcome of L2 acquisition, is less effective in predicting the variable under study. All in all, the variables proposed by SLM-r are better predictors of L2-on-L1 effects compared to SLM.

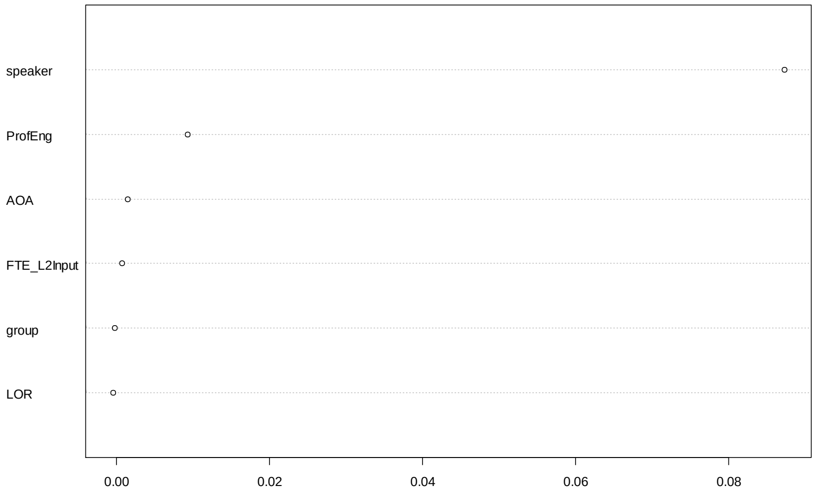

Figure 6. Random forest including AOA, bilingual group, LOR, L2 proficiency and FTE of L2 input.

The last research question asked whether the linguistic and extra-linguistic factors hypothesized to affect /tʃ/ deaffrication are actually good predictors of the variable in bilingual and monolingual speech. It also asked whether the patterning of factors that influence the variability in bilingual speech mirror that of monolingual speech.

This part of the question was addressed by conducting a random forest with the monolingual controls, the two bilingual groups and the linguistic (preceding segment, following segment, position in the word and stress) and extra-linguistic factors (gender, age and style).

The random forest (Figure 7) shows that the most important predictor of /tʃ/ deaffrication is the individual speaker followed by the group and the preceding segment. The selection of group as an important predictor matches what was found in the distribution of the variable across groups, addressed in the first research question. The results of the preceding segment confirm its importance in influencing /tʃ/ deaffrication. The rest of the factors tested were not successful predictors of the variable under study. A conditional tree (Figure 8) conducted with all factors (except for the individual speaker) shows the interaction between them. It also allows us to address the second part of the question regarding the patterning of sociolinguistic factors in bilingual and monolingual speech.

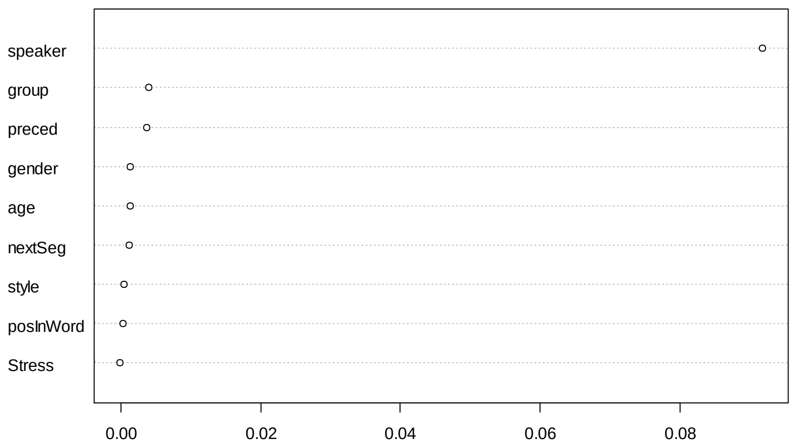

Figure 7. Random forest including individual speaker, group, the linguistic factors (preceding segment, following segment, position in the word, and stress) and the extra-linguistic factors (gender, age, and style).

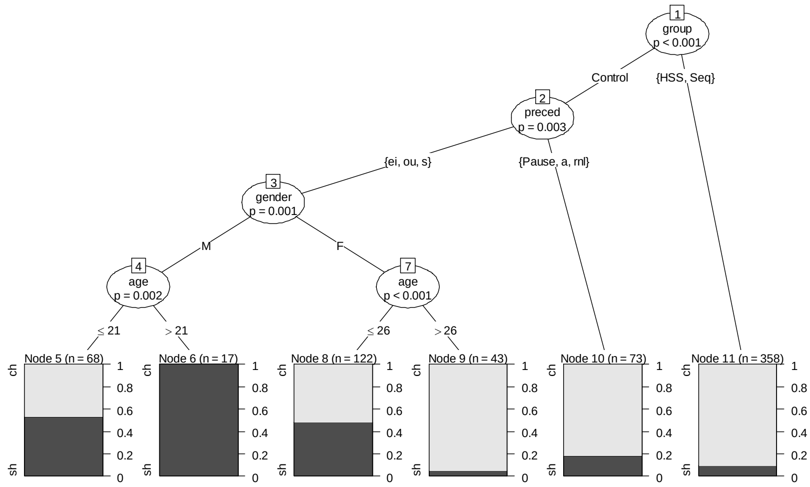

Figure 8. Conditional inference tree of social and linguistic factors that significantly predict the use of /tʃ/ deaffrication.

Figure 8 shows that the most important factor is the group, with bilingual speakers producing low rates of [ʃ] independently of the other factors. For the monolinguals, the variation is driven by other factors including preceding segment, gender, and age. With regard to preceding segment, a previous pause or /a, n, r, l/ results in lower rate of /tʃ/ deaffrication compared to preceding /s, e, i, o, u/. Similar effects were reported by Cedergren (1973), Jaramillo and Bills (1982), Brown (1989), Amastae (1996) and Méndez (2017). At first, previous segments were analyzed individually, except for the vowels /e,i,o,u/ that were grouped into front /e, i/ and back /o, u/ (see Appendix B, Table A1 and Figure A1). Then, the consonants /r/, /l/ and /n/ were also collapsed into one group due to the very limited amount of tokens and their similar effects on deaffrication, as shown in Figure 8. Working our way down the inference tree, we observe that male speakers behave differently than female speakers. Male speakers, especially older ones, have overall higher rates of /tʃ/ deaffrication. Female speakers, especially, younger ones, show higher proportions of [ʃ]. These findings are rather puzzling, but they could be due to an uneven distribution of age in our sample. So, before proposing possible explanations for this effect, a future study should increase the number of older participants in the sample.

6. Discussion and Conclusions

This study was designed to explore the effect of language contact on /tʃ/ deaffrication in the Spanish from the US-Mexico borderland. This section summarizes the main findings and the implications for the study of L1 variation in bilingual speakers.

Results showed that contact with English affects the occurrence of /tʃ/ deaffrication in bilinguals. There was a significant difference between the monolingual and the bilingual groups in the rate of [ʃ] (monolingual controls 39.3% vs. HSSs 4.2% and sequential bilinguals 9.2%). The decreased rate of [ʃ] in bilinguals could be due to the creation of a new L2 phonetic category for /ʃ/ that contrasts with /tʃ/. The re-mapping of perceptual links categorized as instances of the new phonetic category has likely influenced bilinguals' production of /tʃ/ deaffrication in Spanish. This cross-linguistic effect occurs because the phonetic elements of the L1 and L2 are related to one another and exist in a common L1-L2 phonetic space (Flege and Bohn 2021).

Bilingual groups significantly differed from the monolingual group, but there were no significant differences between them. As stated earlier, both groups of bilinguals acquired Spanish since birth and have been exposed to /tʃ/ deaffrication from other Spanish monolingual and Spanish-English bilingual people in their speech community. Predictions based on SLM that AOA of English and LOR in the L2 would lead to the creation of a new L2 phonetic category for /ʃ/ that would likely affect L1 variability in HSSs more than sequential bilinguals were not borne out. Instead, SLM-r (Flege and Bohn

2021) estimates that intense contact with English and increased experience with the L2 are better predictors of L2 outcome and, thus, L2-on-L1 influence was correct. This finding supports latest research that the adult brain retains considerable plasticity for processes relevant to L2 speech production and perception (Flege and Bohn 2021).

Despite the lack of significant differences, sequential bilinguals were closer to the monolingual controls in their production of /tʃ/ deaffrication. A closer contact with Ciudad Juárez and native Spanish speakers from the region may have increased sequential bilinguals' exposure to monolingual Spanish input which, as shown by the present results, contains higher rates of the variable in question.

The most important predictor of L2 influence on L1 /tʃ/ deaffrication was L2 proficiency. This finding supports SLM-r, which stipulated that L2-on-L1 effect sizes would increase as proficiency in the L2 increases. SLM-r contends that "interactions between L1 and L2 phonetic categories provide a reflex that is diagnostic of L2 category formation or its absence" (Flege and Bohn 2021, p. 42). In addition to L2 proficiency, SLM-r anticipated that there would be greater L2-on-L1 effect sizes as a result of more frequent use of the L2. Frequency of L2 use, measured with FTE years of English input, was not an effective predictor of L2-on-L1 influence in this study. The random forest (Figure 6) listed it in fourth place after AOA. This could be due to the fact that FTE years of English input was based on the current (at the time of testing) frequency of L2 use. Because the frequency of L2 use can vary over time, this calculation may not be an accurate reflection of true FTE years of L2 input.

Of the sociolinguistic factors analyzed, the most important predictor of /tʃ/ deaffrication was the preceding segment, with preceding /n, r, l, a/ and pause disfavoring [ʃ] and preceding /e, i o, u, s/ favoring it. Interestingly, preceding segment influenced the variation in monolingual speech, but not in bilingual speech. The lack of clear linguistic patterns in bilingual speech could be due to the overall low rate of [ʃ] which, when distributed across different preceding segments, may have been too small to yield significant differences. The next important predictor of /tʃ/ deaffrication was gender which, as expected, showed higher overall rates of [ʃ] in males. According to Mazzaro and González de Anda (2017, p. 305) "/tʃ/ deaffrication displays all the characteristics of stable linguistic variation, with low rates of stigmatized forms by women and higher rates of the stigmatized forms by men." An unexpected result was the effect of age on the variable under study, which showed higher proportions of [ʃ] in older men. Previous research (Méndez 2017; Mazzaro and González de Anda 2019) reported higher frequency of deaffrication in younger participants. As stated earlier, this could be due to an unbalanced distribution of the data and, crucially, a low number of older speakers in the present study.

The effect of age on /tʃ/ deaffrication should be addressed in a future study with a more balanced distribution of participants across the age groups. Moreover, the inclusion of participants of high socio-economic status would allow us to better determine whether /tʃ/ deafrication is gradually losing some of its stigma, as suggested by Mazzaro and González de Anda (2019). A future study should also analyze the [tʃ] and [ʃ] alternation in the L2 speech of these bilinguals to verify that a new L2 phonetic category has been successfully established.

Perhaps the most important finding of this study is that contact with another language can significantly affect sociolinguistic variability in the native language. The results have shown that L1 variability in bilinguals is significantly different from monolingual norms, demonstrating partial convergence with the sound categories of English. This means that the creation of new L2 phonetic categories for similar sounds in the L1 are likely to cause re-structuring of the shared phonetic system (Flege and Bohn 2021). This effect has been found for simultaneous and sequential bilinguals immersed in the L2 environment. Of all the factors tested, proficiency in English has been the most effective predictor of /tʃ/ deaffrication. It is important to note that the variability, albeit in lower percentages, was still present in bilinguals from this speech community. The fact that bilinguals have been exposed to /tʃ/ deaffrication from birth and that the feature constitutes a diatopic marker of northern Mexican Spanish, can explain the presence of [ʃ] in the L1 of bilinguals from El Paso. Because the rate of /tʃ/ deaffrication was very low in bilinguals, performing statistical analysis to compare the behavior of each factor group did not always yield reliable results. Nevertheless, the results obtained in this study appear to show that the sociolinguistic factors (preceding segment, sex and age) that influence the variation in monolingual controls do not influence the variation in bilingual speech.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/languages7020101/s1, AudioS1_UT008_con_mucha.wav. AudioS2_UT002_caperucita_aprovecho_la.wav. AudioS3_UT086_con_mucha.wav. AudioS4_UT030_list_bicho.wav.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are not publicly available due to confidentiality restrictions.

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Conflicts of Interest: The author declares no conflict of interest.

Appendix A

Contingency Tables

		Variant		
Speaker		**[tʃ]**	**[ʃ]**	**Total**
UT001	N	10	1	11
	%	1.5%	0.1%	1.6%
UT002	N	13	0	13
	%	1.9%	0.0%	1.9%
UT005	N	4	3	7
	%	0.6%	0.4%	1.0%
UT006	N	10	2	12
	%	1.5%	0.3%	1.8%
UT007	N	20	0	20
	%	2.9%	0.0%	2.9%
UT008	N	12	0	12
	%	1.8%	0.0%	1.8%
UT014	N	3	0	3
	%	0.4%	0.0%	0.4%
UT016	N	14	0	14
	%	2.1%	0.0%	2.1%
UT017	N	8	1	9
	%	1.2%	0.1%	1.3%
UT019	N	11	1	12
	%	1.6%	0.1%	1.8%
UT022	N	6	0	6
	%	0.9%	0.0%	0.9%
UT024	N	7	0	7
	%	1.0%	0.0%	1.0%

UT025	N	5	0	5
	%	0.7%	0.0%	0.7%
UT026	N	23	0	23
	%	3.4%	0.0%	3.4%
UT027	N	6	2	8
	%	0.9%	0.3%	1.2%
UT030	N	21	5	26
	%	3.1%	0.7%	3.8%
UT031	N	10	0	10
	%	1.5%	0.0%	1.5%
UT032	N	30	1	31
	%	4.4%	0.1%	4.6%
UT034	N	1	16	17
	%	0.1%	2.3%	2.5%
UT035	N	34	0	34
	%	5.0%	0.0%	5.0%
UT036	N	1	15	16
	%	0.1%	2.2%	2.3%
UT037	N	3	9	12
	%	0.4%	1.3%	1.8%
UT038		29	13	42
	%	4.3%	1.9%	6.2%
UT039	N	0	18	18
	%	0.0%	2.6%	2.6%
UT040	N	1	10	11
	%	0.1%	1.5%	1.6%
UT047	N	31	0	31
	%	4.6%	0.0%	4.6%
UT050	N	12	0	12
	%	1.8%	0.0%	1.8%
UT052	N	24	2	26
	%	3.5%	0.3%	3.8%
UT053	N	8	0	8
	%	1.2%	0.0%	1.2%
UT054	N	7	10	17
	%	1.0%	1.5%	2.5%
UT057	N	5	11	16
	%	0.7%	1.6%	2.3%
UT078	N	11	0	11
	%	1.6%	0.0%	1.6%
UT079	N	32	0	32
	%	4.7%	0.0%	4.7%
UT081	N	11	0	11
	%	1.6%	0.0%	1.6%
UT086	N	18	0	18
	%	2.6%	0.0%	2.6%
UT107	N	15	0	15
	%	2.2%	0.0%	2.2%
UT108	N	10	1	11
	%	1.5%	0.1%	1.6%
UTCJ1	N	3	6	9
	%	0.4%	0.9%	1.3%
UTCJ3	N	9	15	24
	%	1.3%	2.2%	3.5%
UTCJ4	N	1	10	11
	%	0.1%	1.5%	1.6%
UTCJ5	N	13	1	14
	%	1.9%	0.1%	2.1%

UTCJ6	N	18	0	18
	%	2.6%	0.0%	2.6%
UTCJ7	N	3	6	9
	%	0.4%	0.9%	1.3%
UTCJ8	N	8	1	9
	%	1.2%	0.1%	1.3%
Total	N	521	160	681
	%	76.5%	23.5%	100.0%

Appendix B

Table A1. Distribution of [tʃ] and [ʃ] by preceding context.

Preceding Collapsed		[tʃ]	Variant [ʃ]	Total
Pause	N	32	8	40
	%	80.0%	20.0%	100.0%
a	N	19	2	21
	%	90.5%	9.5%	100.0%
ei	N	205	54	259
	%	79.2%	20.8%	100.0%
l	N	19	7	26
	%	73.1%	26.9%	100.0%
n	N	56	2	58
	%	96.6%	3.4%	100.0%
ou	N	173	82	255
	%	67.8%	32.2%	100.0%
r	N	3	0	3
	%	100.0%	0.0%	100.0%
s	N	14	5	19
	%	73.7%	26.3%	100.0%
Total	N	521	160	681
	%	76.5%	23.5%	100.0%

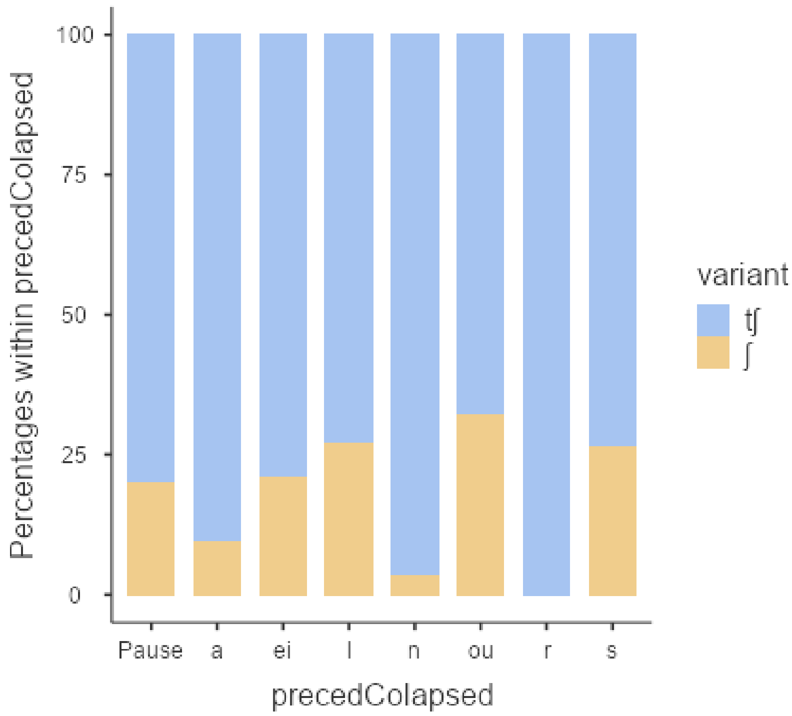

Figure A1. Distribution of [tʃ] and [ʃ] by preceding context.

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