Chapter 10: The Perception-Production Connection

/tʃ/ Deaffrication and Rhotic Assibilation in Chihuahua Spanish. [1] *

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Abstract
This study investigates the perception and production of two sociophonetic variables of Chihuahua Spanish: rhotic assibilation ([ř]), a change from above associated with women and higher classes, and deaffrication of the voiceless post-alveolar affricate ([ʃ]), a change from below associated with men and lower social classes. Thirty-three native Spanish speakers from Chihuahua completed a production task to establish whether they produced [ř] or [ʃ] and a discrimination task to determine if they were able to perceive these variants. Results show that while production rates were similar for [ř] and [ʃ], listeners had greater metalinguistic awareness of [ʃ], resulting in a closer production-perception relationship for this variant. We conclude that the perception and production of phonetic variants are correlated in variable-specific ways that depend crucially on a combination of linguistic and social factors, including phonological context, frequency, and social salience to the speech community.

1. Introduction

Studies of sociolinguistic perception suggest that speakers assign different social attributes to standard and non-standard speech sounds (Campbell-Kibler, 2009; Casillas, 2013; Chappell, 2016; Jewell, 1993; Labov, 1972; Niedzielski, 1999; Plichta & Preston, 2005). However, for a variant to reflect such distinctions, the variant needs to be produced and it also needs to be recognized (Fridland & Kendall, 2012). Such a connection between speaker production and speaker linguistic perception has not been well established. Studies that look at the connection between production and perception, generally focus on sociolinguistic perception,

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in other words, the distinct social indexes of a number of variants (e.g. Campbell-Kibler, 2009; Chappell, 2016). Fewer studies have looked at the relationship between production and linguistic perception of standard/non-standard variants.

The results of studies exploring the relationship between speech production and perception have been contradictory, with some studies affirming and others calling into question the relationship between linguistic perception and production. For instance, a study by Kettig and Winter (2017) found little evidence that the production of a retracted vowel in English is related to its perception. Production results show that young females were the ones producing the innovative (retracted) variants. However, perception results showed only weak statistical evidence that young females perceived vowel retraction more than any other group. The authors conclude that changes in production occur before changes in perception, as even innovative variant producers "…must accommodate the fact that they are continuously exposed to both innovative and conservative variants in perception" (Kettig & Winter, 2017, p. 94).

On the other hand, in their analysis of three different dialects of American English where different vowel shifts were occurring, Fridland and Kendall (2012) found that an individual's production directly relates to his/her perception. By comparing the results of a production task with a perception task, the authors showed that an individual speaker's perception depends on the variants that the speaker produces and the region to which that the speaker belongs. The authors concluded "…that processing is affected by both what you say and what others around you say" (p. 792).

To better understand this relationship, the present study explores the production and perception of two variables in Mexican Spanish: absolute final /r/ and /tʃ/. More specifically, we investigate the production and perception of rhotic assibilation and /tʃ/ deaffrication in

Chihuahua to determine how phonological context, frequency, and social salience influence this relationship.

2. Literature Review

2.1 Rhotics and Rhotic Assibilation

Articulatorily, standard taps and trills share the same place and voicing features: they are both usually realized as alveolar[2] and voiced. The main difference between taps and trills is that taps are produced with a single contact between the tip of the tongue towards the alveolar ridge, while trills are produced with several (usually two or three) such rapid contacts (Hualde, 2005). Acoustically, [ɾ] and [r] share a lowered third formant (Colantoni, 2001), but rhotics differ in the duration of the segment with taps being shorter than trills. Quilis (1993) reported an average of 20 ms for taps and 60 ms for trills.

According to traditional phonological accounts, the distribution of the tap and trilled rhotics in Spanish are determined by the environment in which they occur. The tap /ɾ/, as in *caro* /káɾo/ 'expensive', and trilled /r/, as in *carro* /káro/ 'car', are contrastive only in word-internal intervocalic position (Hualde, 2005). In word-initial position and after a consonant in a different syllable, only the trill occurs, e.g. *rosa* /rósa/ 'rose' and *honra* /ónra/ 'honor'. The tap occurs in onset clusters, e.g. *prosa* /pɾósa/ 'prose', and in word-final position before a vowel, e.g. *ser amigos* /séɾ amígos/ 'to be friends'. Either rhotic is possible in coda position (within a word or across word boundaries) when followed by a consonant or a pause, e.g. *arte* 'art' or *amor* 'love',

[2] Lipski (1994) and Hualde (2005) discuss other non-standard realizations including dorsalization and pre-aspiration of the trill, neutralization, retroflexion, and strengthening of rhotics in codas and onset clusters.

where syllabification is not possible. While a tap is more frequently found in these contexts (Amastae et al., 1998; Martín Butragueño, 2006), an emphatic trill can also occur.[3]

Another variant is possible in numerous varieties of Spanish, including Chihuahua Spanish: the assibilated rhotic [ř]. It has been reported in Argentina (Colantoni, 2006), Bolivia (Morgan & Sessarego, 2016), Costa Rica (Vásquez Carranza, 2007), Ecuador (Bradley, 2004), Spain (Henriksen & Willis, 2010), Dominican Republic (Willis, 2007), and Mexico (Amastae et al., 1998; Eller, 2013; Lope Blanch, 1967; Perissinotto, 1972; Rissel, 1989; Bradley & Willis, 2012), but different social and linguistic factors seem to influence the variant across varieties.

Articulatorily, Solé (1992) contends that trills may become fricatives if the finely controlled articulatory or aerodynamic requirements for trills are not met, as fricatives involve a less complex articulation and allow a wider range of oropharyngeal pressure variation than trills. Assibilated rhotics result when the vibrating tongue-tip fails to make contact with the palate, or apical vibration fails to occur, which allows the high velocity air to flow continually through the aperture generating frication (Solé, 2002). Assibilated rhotics in utterance final position result from the difficulty of sustaining trilling with the lowered decreased subglottal pressure that occurs at the end of a statement. Thus, rhotic assibilation is a natural phenomenon that arises when small (unintended) articulatory changes occur in a sound that requires a very precise articulatory execution.

As taps, trills, and assibilated rhotics can all occur in coda position, Figures 1, 2, and 3 provide spectrograms of the three variants. While tap and trill rhotics are articulated with brief periods of occlusion, assibilated rhotics are produced with partial rather than total closure between articulators. Acoustically, assibilated rhotics are characterized by the presence of high-

[3] The distribution of trills and taps is further discussed in Hualde (2005).

frequency noise on the spectrogram and of audible friction (Solé, 2002) that occurs at around 3000 Hz. In Figure 3, the aperiodic noise of the assibilated rhotic in the word *pedir* (‘ask’) begins at 3130Hz.

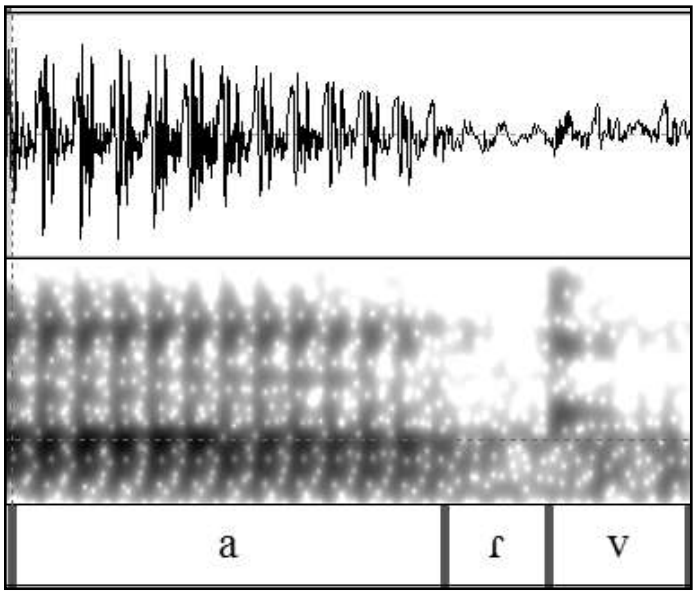

Figure 1. Tap in absolute final position in the word *guisar* (‘cook’) followed by an epenthetic vowel. Male speaker (UT075).

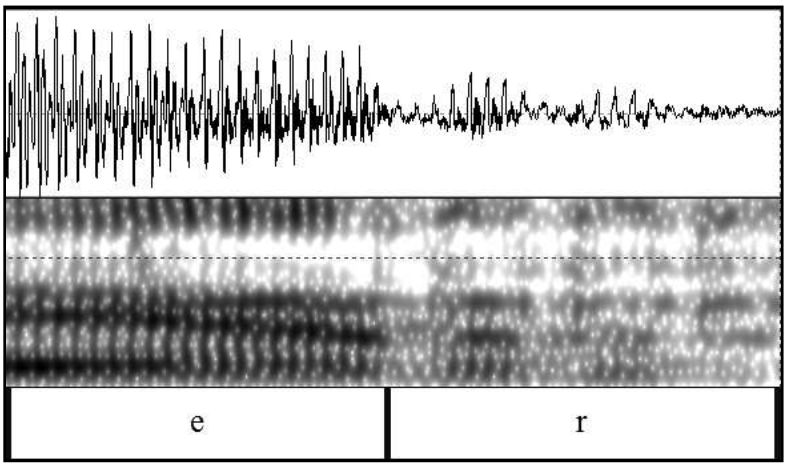

Figure 2. Trill in absolute final position in the word *poder* (‘power’). Male speaker (UT086).

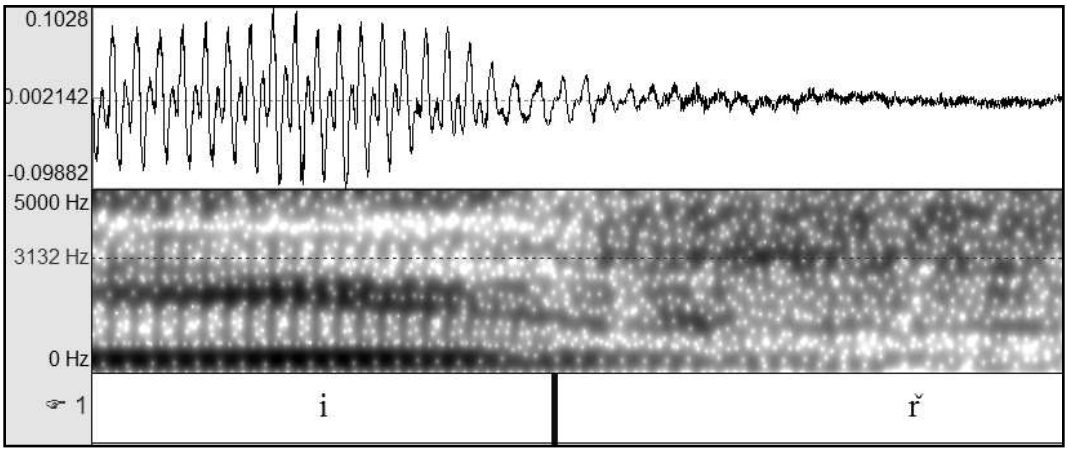

Figure 3. Assibilated rhotic [ř] in the word *pedir* (‘ask’). Male speaker (UT086).

In Mexican Spanish, assibilated rhotics were first observed in Mexico City by Lope Blanch (1967). The author argued that assibilation was a recent phenomenon that emerged around the 1950s in the speech of women in coda position. Lope Blanch (1967) concluded that assibilation was probably brought from Spain, because it had been observed there and in several other Latin American countries.

The first synchronic sociolinguistic analysis of rhotic assibilation in Mexico City was published by Perissinotto (1972), based on 110 hours of recorded conversations collected between 1963 and 1969. His results showed a high overall percentage of rhotic assibilation in absolute final position (68.2%), with female speakers producing assibilated rhotics at a rate of 81.8% and men only producing the assibilated variant with 38.9% frequency. Perissinotto (1972) also presented the distribution of the assibilated variant by age and socioeconomic status and concluded that assibilation was more common in the younger age group and in the high and middle socioeconomic classes. In other words, assibilation appeared to be a prestigious, innovative variant adopted by women, younger speakers, and higher classes.

Three decades later, Martín Butragueño (2006) found only 27% rhotic assibilation in Mexico City Spanish. A multivariate analysis of rhotic assibilation found a number of linguistic and social factors that favored assibilation: 1) absolute final position; 2) formal style; 3) mid to high education; 4) older generation; and 5) women. Martín Butragueño (2006) concluded that rhotic assibilation seemed to be receding case, as the variant was produced less frequently and by older speakers when compared to Perissinotto (1972).

Rhotic assibilation spread to the north of the country in the 1960s, with the first study conducted in Ciudad Juárez in the 1990s (Amastae et al., 1998). Their study showed that assibilation in absolute final position was present but relatively infrequent in Ciudad Juaréz, occurring in only 6% of all possible environments (word final and utterance final), while the percentage of assibilation in absolute final position was 22%. A multivariate analysis showed that assibilation was more likely in female speech, in the higher socioeconomic class as compared to the middle class,[4] among middle-aged and older speakers, and more educated speakers. All these effects suggest that assibilation was also a prestigious variant in Ciudad Juárez.

2.2. Deaffrication of the voiceless post-alveolar affricate /tʃ/

There is only one affricate phoneme in standard Spanish, /tʃ/, a prepalatal voiceless affricate limited to prevocalic position in word-initial and word-medial positions.[5] The exact point of articulation of the affricate varies across Spanish dialects, ranging from alveolar in Chilean Spanish to palatal in Cuban Spanish, but the prepalatal variant is the most frequent

[4] Amastae et al. (1998) did not analyze the speech of participants from lower socioeconomic groups.
[5] In final position, [tʃ̚] occurs in the spelling pronunciations of Catalan names with –*ch* such as Llorach, Blanch, Domenech, etc. (Hualde, 2005).

realization in Chihuahua Spanish (Casillas, 2013).[6] Articulatorily, the standard affricate consists of a closure that is followed by a frication release, as shown in Figure 4. When deaffrication occurs, the occlusion of [tʃ] is lost, which results in the fricative [ʃ] (Hualde, 2005), shown in Figure 5.

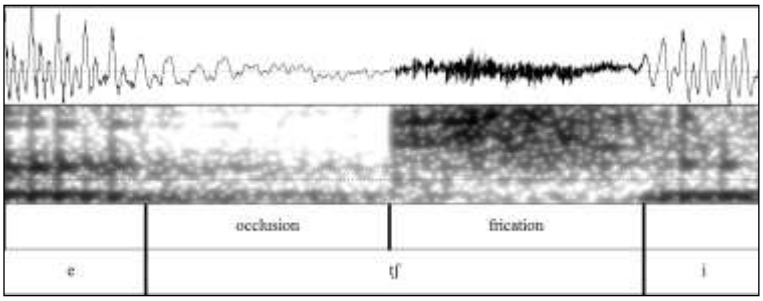

Figure 4. Standard affricate [tʃ] in the word *chile* 'chile' preceded by *de* 'of'. Male speaker (UT086).

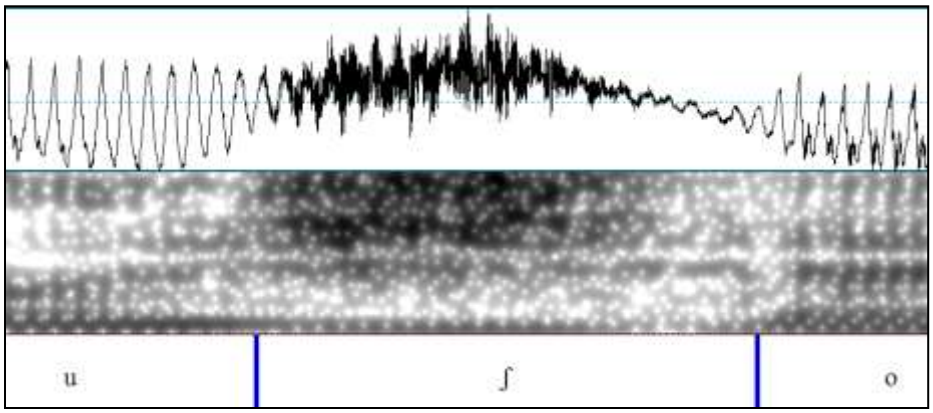

Figure 5. No occlusion in the non-standard variant [ʃ] in the word *mucho* 'a lot'. Female speaker (UT097).

[6] There is also an alveolar affricate variant similar to the same sound in Tarahumara, but it is rather infrequent in Chihuahua Spanish (Amastae, 1996).

Deaffrication of the voiceless post-alveolar affricate /tʃ/ occurs in Northwestern Mexican Spanish (Brown, 1989; Moreno de Alba, 1994; Amastae, 1996; Hualde, 2005; Méndez, 2017) as well as in New Mexico (Jaramillo & Bills, 1982) and Arizona (Noriega, 2004), which share borders with the northwest Mexican States of Baja California, Sonora, and Chihuahua. The map presented in Figure 6 shows the locations where /tʃ/ deaffrication was frequently found in Mexican Spanish in the 1990s.

Figure 6. Map of the distribution of /tʃ/ deaffrication (Moreno de Alba, 1994).

Deaffrication of /tʃ/ originated with the movement of people from rural to urban areas (Delgado, 1994), where it became the characteristic feature of northern Mexican speech. In terms of its production, Amastae (1996) found that the deaffrication in Ciudad Juárez was most likely found in the speech of lower-class men, while the lowest rates of deaffrication occurred in the speech of high-class women. Older speakers produced the deaffricated variant the least, and speakers with lower education levels were more likely to produce [ʃ] than more educated speakers. In a more recent study, Méndez (2017) also found that men and speakers of lower social classes were more likely to produce [ʃ] than other groups in Ciudad Juárez, and almost all the participants in his study (97.5%) agreed that this feature was typical of the speech of

Juarenses. However, only 20% of participants expressed the opinion that the non-standard variant was stigmatized and should be avoided.

Similarly, Jewell (1993) explored Mexican students' attitudes toward the use of [ʃ] by having participants listen to segments of interviews from Chihuahua Spanish speakers, indicating if they thought a speaker was a 'professional' or a 'laborer'. While participants connected the non-standard [ʃ] to the north of Mexico, making it a diatopic marker, Jewell (1993) found that the occurrence of [ʃ] for [tʃ] did not influence listeners' evaluations of a speaker's social class. However, another investigation of attitudes towards the /tʃ/ variants ([tʃ] and [ʃ]) in the south of Arizona (Casillas, 2013) showed that listeners awarded higher competence ratings to speakers who produced the standard variant [tʃ] and lower competence ratings to speakers who produced the non-standard variant [ʃ], suggesting that listeners may share implicit attitudes towards [ʃ] that are not apparent in explicit metalinguistic commentary.

2.3. Change from Above and Below

According to Labov (1972:290) a change from above is a linguistic change that enters the language from above the level of consciousness and social awareness; that is, speakers are generally aware of the linguistic form and they manipulate its use depending on the context and/or their interlocutors. The upper classes use these new linguistic forms in order to differentiate themselves from the lower classes, while lower classes use these forms in order to sound more formal and similar to the upper class.

Conversely, changes from below are below the level of conscious awareness. These linguistic changes originate in interior social classes, i.e. the lower-middle or upper-working class, and production rates rise to a curvilinear pattern, whereby members of the interior social

groups produce higher rates of the innovative variant and production rates decrease among the lowest and highest classes (see Labov, 1966, 1974, 1980, 1981). Labov contends that this innovation occurs to symbolically mark group solidarity, and working-class speakers may be more prone to this type of innovation as they share a cooperative ideology that renders local linguistic variants especially valued. Additionally, working-class speakers may feel more free to innovate linguistically, as they are not necessarily loyal to the status quo. On the contrary, upper-class speakers may explicitly resist linguistic variation, and this group's linguistic conservatism may be a means of maintaining the status quo. That is, upper-class speakers likely want to preserve their privileged position in the social structure, and avoid linguistic variants associated with lower social classes. This would allow the upper-class group to evade potential threats to their social status (Kroch, 1978).

In Northern Mexico, the assibilated rhotic is likely a change from above. The variant is associated with women, higher socioeconomic classes, and more educated speakers, and these effects suggest that assibilation is a change from above imported from Mexico City by the higher classes and transmitted by women (Amastae et al., 1998). The deaffrication of /tʃ/ presents almost opposing characteristics. The variable originated with the movement of people from rural to urban areas (Delgado, 1994), where it became the characteristic feature of northern Mexican speech. Because it was more frequently found in the speech of lower socioeconomic classes and lower levels of formal education, the variable was considered stigmatized and, in fact, many speakers did not acknowledge that they used it, even when the recordings showed they did (Amastae, 1996). All these characteristics seem to suggest that the deaffrication of /tʃ/ is a change from below the level of consciousness.

Since Labov's (1972) seminal work, researchers often characterize innovative linguistic variants as coming 'from above' or 'from below'. However, speakers' conscious awareness of the variants is not generally explored but rather inferred from its occurrence across different social factors. Rhotic assibilation, a change from above, and /tʃ/ deaffrication, a change from below, co-occur in Chihuahua Spanish and provide fertile ground for understanding the relationship between the perception and production of phonetic variants.

2.4. Hypothesis

Because rhotic assibilation is considered a change from above, we hypothesize that those who have more assibilation in their speech will also perceive assibilation in a more nuanced way. More specifically, we expect that older women, who tend to produce assibilated rhotics more than other groups (Amastae et al., 1998; Mazzaro & González de Anda, 2016), will perceive assibilation the most successfully. On the contrary, because /tʃ/ deaffrication is considered a change from below, we hypothesize a less clear relationship between perception and production. That is, we expect listeners to be less aware of the presence of the variant.

3. Method

3.1. Speakers

The participants in this study are native Spanish speakers recruited in the El Paso, Texas - Ciudad Juárez, border area (Table 1). The majority of participants were students enrolled in a beginner ESOL (English for Speakers of Other Languages) class at the University of Texas at El Paso, and non-college student participants were all permanent residents of Ciudad Juárez, Mexico. These participants were recruited in Ciudad Juárez using the 'friend-of-a-friend'

technique (Milroy, 1987), whereby potential informants are contacted through common friends, an approach that is particularly appropriate for the community under study.

All participants were raised in the northern Mexican state of Chihuahua. A total of 35 subjects participated in this study: 24 women and 11 men, with an age range between 18 and 69 years. For the analysis, the participants were divided into four generational groups. Generation 1: <20; Generation 2: 21-35; Generation 3: 36-55; and Generation 4: >56. All the participants had at least some college education, and they came from mid-high to high social classes. Participants were asked to complete an adult language background questionnaire that elicits information about the participants' place of birth, language(s) of schooling, and language use. The questionnaire contained a section that asked for participants' self-proficiency ratings in both English and Spanish, and only those who reported to use mostly/only Spanish in their daily everyday interactions (at home, at work, and in social situations) were selected to participate in the study. Additionally, two participants were excluded from the analysis (UT094 & UT109) because they did not complete the two tasks (perception and production). The demographic information of the participants considered in the statistical analysis is presented in Table 1.

Table 1. Participants' demographic information

	Participants' information
Participants *n*	33
Age range in years	18-69
Generation 1 (<20years) *n*	10 (7 females, 3 males)
Generation 2 (21-35 years) *n*	12 (8 females, 4 males)
Generation 3 (36-55 years) *n*	8 (5 females, 3 males)
Generation 4 (>56 years) *n*	3 (3 females)
Male: Female *n*	10:23
Median/Mean age in years	22/29.8
From location (*n*)	Ciudad Juárez (14), El Paso, TX (13), Chihuahua (2), Delicias (2), Parral (1), Jimenez (1)

3.2. Data collection

The production data was elicited by asking participants to narrate the Little Red Riding Hood and by asking them to talk about their favorite food. Participants' speech, which lasted for about 15 minutes, was recorded using Audacity 2.1.2 and a Snowball microphone, and all the recordings were transcribed using PRAAT (Boersma & Weenink, 2018). The transcriptions were aligned using Praatalign (Lubbers & Torreira, 2016), and a script was used to count the number of rhotics in absolute final position, and the number of /tʃ/s produced by each participant. All the rhotics in absolute final position were perceptually classified as either assibilated or non-assibilated, and all the /tʃ/ tokens were perceptually classified as an affricate or a fricative.

For the perception portion of the study, participants were asked to complete a discrimination task based on oral stimuli. The stimuli presented had been previously recorded by a female[7] native Spanish speaker from the state of Chihuahua and presented to participants using a Sennheiser HD280 pro headset. The stimuli consisted of six different sentences, each recorded three times (see Table 2). The speaker first used standard Spanish from the area to record the six sentences, which included an affricate [tʃ] and a tap rhotic in absolute final position. The same sentences were then recorded with the standard affricate [tʃ] and assibilated rhotic [ř] in absolute final position. The last set of sentences was recorded with a voiceless post-alveolar fricative [ʃ] and standard tap rhotic. An example sentence is provided below with its three recorded iterations: *En El Paso hace mucho calor* 'It's too hot in El Paso' (see Appendix A for a full list of sentences used).

[7] Casillas (2013:185) found that male/female voices were rated differently on the basis of their pronunciation of /tʃ/. We are not aware of any studies analyzing the perception of assibilated rhotics, but studies on other variables of Spanish and English (e.g. Chappell, 2016; Plichta & Preston, 2005) suggest that female/male speakers tend to be rated differently. Thus, it is possible to expect that if the guises had been recorded by a male speaker the results would have been different. This should be investigated in a future study.

(1) Neutral [en el páso áse mútʃo kalóɾ]

(2) Assibilated rhotic [en el páso áse mútʃo kalóř]

(3) Deaffrication of /tʃ/ [en el páso áse múʃo kalóɾ]

Table 2: Number of sentences evaluated per variant.

	Total
Neutral	6
Assibilation	6
Deaffrication	6
Total	18

For each listener, the neutral guise was played first, the guise with assibilated rhotics second, and the guise with deaffrication of /tʃ/ last. A fixed presentation order of the guises simplified the experimental design and allowed for explicit comparisons to be made between one guise to the next, but we acknowledge that presentation order might have played a role in listeners' evaluations. Additionally, a priming effect is possible, as speakers heard the same voice several times in different guises. Future studies are needed to control for presentation order and speaker voice, but none of the participants commented on the fact that the speaker reading the guises was the same. After listening to a recording, participants were asked if they noticed anything different about the speech of the person in the recording they had just listened to as compared to the previous one. The exact question was: *¿Nota algo diferente en la manera de hablar de esta persona (con respecto a la grabación anterior)?* 'Do you notice anything different in this speaker's way of talking (compared to the previous recording)?' Listeners could then orally explain if/what type of difference they perceived.

3.3. Coding and Statistical Analysis

In order to determine whether a subject produced the variant under study throughout the narrative task and description of his/her favorite food, we coded the total number of occurrences of absolute final rhotics and all cases of /tʃ/, with the exception of loanwords from English, e.g. *sketch*, which were excluded from analysis. Variant production was coded categorically, with "yes" indicative of nonstandard production and "no" indicative of no nonstandard production for each token. We classified listeners' metalinguistic awareness, or perception, of the variants in the following categorical way: i) Perceived nothing different at all (no); ii) Perceived something different but could not explain what specifically (something diff.); iii) Perceived the specific variable in question, i.e., rhotic assibilation or deaffrication (yes). Gender and age were also analyzed as categorical variables, with Male and Female levels for gender and Generations 1 (youngest), 2 (middle), and 3 (oldest) for age. Because there were very few participants in Generation 4 (N=3), it was collapsed with Generations 3 in all analyses. Finally, the participants were relatively homogenous in terms of their education level and no significant effects were found for education. As a result, education will not be discussed further in this paper.

All statistical analyses were conducted in R (R Core Team, 2017) and the alpha level was set at ($\alpha = .05$). To analyze the data, we used the step function to find the best predictors for each model. Next, binary logistic regression models were constructed using the *glm* (general linear model) function to find the best fit for the data in R (R Core Team, 2017). The dependent variable for each model was production of rhotic assibilation or production of deaffricated /tʃ/, respectively, and the independent variables tested included gender, generation, and perception of

the nonstandard variant in question. Given the relatively low number of participants, participant was not included as a random effect. Conditional inference trees were created using the party package (Hothorn, Hornik, & Zeileis, 2006) and violin plots were made in ggplot2 (Wickham, 2016).

4. Results

4.1. Production and Perception

Table 3 shows the production results for all participants; the results for individual participants are presented in Appendix B. As Table 3 shows, the overall percentage of assibilation is 17.15%, and the overall percentage of deaffrication is 11.83%. These results are based on a total number of 379 tokens for /r/ in absolute final position and 634 tokens of /tʃ/ in all positions and phonetic contexts. Borrowings from English such as *sketch* were not considered in the analysis.

Table 3. Total number of tokens of /r/ and /tʃ/ and overall percentages of assibilation and deaffrication.

Variant	%	N	Total
Assibilation	17.15 %	65	379
Deaffrication	11.83 %	75	634

The overall percentage of assibilation is higher than that of deaffrication in our study, which contrasts with previous studies that show higher percentages of deaffrication (33% in Méndez, 2017) and lower percentages of assibilation (22% in Amastae et al., 1998). This difference could be attributed to two possible explanations. First, the social characteristics of the subjects are somewhat different, with a broader range of formal education levels and social classes in previous studies as compared to a more homogenous group in the present study.

Second, we only analyzed rhotic assibilation in absolute final position, which is the context where most of the variation occurs (Perissinotto, 1972; Amastae et al., 1998). Amastae et al. (1998) found 6% of assibilation in final position (including word final and absolute final), but this overall percentage of assibilation increased to 22% when only absolute final position was considered.

To better understand the distribution of rhotic assibilation and /tʃ/ deaffrication across social factors, a more detailed breakdown of the raw data is presented in Table 4. This table includes the number of non-standard tokens produced by the 33 participants given the total number of phrase-final rhotic and /tʃ/. Because we had very few participants in Generation 4 (N=3), it was collapsed with Generations 3.

Table 4. Distribution of assibilation and deaffrication by social factors.

Factor groups		**[ř]**			**[ʃ]**	
Sex	**%**	**N**	**Total**	**%**	**N**	**Total**
Male	11%	10	93	18%	40	228
Female	19%	55	286	9%	35	406
Age						
Generation 1	29%	23	79	19%	34	176
Generation 2	10%	15	150	7%	18	273
Generation 3	12%	27	150	12%	23	185
Total N		**65**	**379**		**75**	**634**

Table 4 shows that female speakers produce higher rates of rhotic assibilation than male speakers (19% vs. 11%, respectively), while deaffrication of /tʃ/ shows the opposite tendency, with higher rates of deaffrication among male speakers (18%) than female speakers (9%). To determine if these gender differences were significant, we created binary logistic regression

models with gender and generation as independent variables. The models found a significant effect of gender for both variables, as shown below in Tables 5 and 6 (reference levels are Gender = female and Generation = 1).

Table 5. Binary logistic regression model coefficients for production of assibilation.

	Estimate	**SE**	***z*-value**	***p***
(Intercept)	-0.71	0.26	-2.69	<0.01
Generation 2	-1.35	0.37	-3.65	<0.001
Generation 3	-0.66	0.33	-2.01	0.045
Gender = male	-0.75	0.37	-2.01	0.044

Table 6. Binary logistic regression model coefficients for production of deaffrication.

	Estimate	**SE**	***z*-value**	***p***
(Intercept)	-1.65	0.26	-6.32	<0.001
Generation 2	-1.17	0.32	-3.67	<0.001
Generation 3	-0.54	0.30	-1.78	0.08
Gender = male	1.70	0.26	2.67	0.007

The models also found a significant effect of generation for both variables. The raw data for deaffrication show higher rates of [ʃ] in the youngest age group (19%), followed by the oldest (12%) and middle age groups (7%), and the results in Table 6 prove that the youngest group (Generation 1) is significantly more likely to produce deaffrication than the other groups. Similarly, the raw distribution of rhotic assibilation shows that younger speakers are the most frequent users of assibilation (29%), followed by the older (12%) and middle age groups (10%). Although the frequency of assibilation production slightly increases from the middle age group to the older age group (10% and 12%, respectively), a conditional inference tree (see Figure 7) shows that the main difference is between the youngest speakers and the other two age groups.

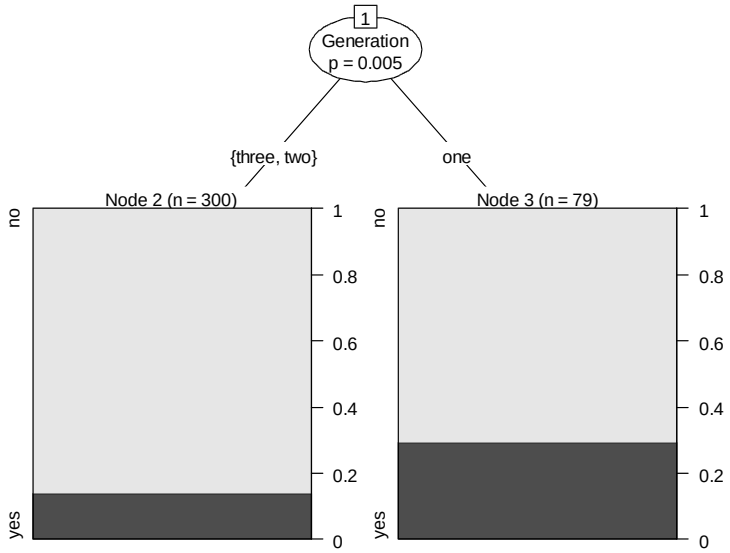

Figure 7. Conditional inference tree showing production of rhotic assibilation (yes) given generation.

Next, we investigate whether listeners were able to perceive the non-standard variants in question. As shown in Figure 8, listeners successfully identified [ř] with 9.1% frequency, the rate of those who noted something different in the speaker's pronunciation but could not identify the variant in question was 51.5%, and the percentage of those who did not notice anything different in the pronunciation of the speaker was 39.4%. These results contrast sharply with the percentage of listeners who explicitly recognized /tʃ/ deaffrication, with 84.8% of the listeners able to perceive the non-standard variant, while 9.1% noted something different in the pronunciation but could not specify what it was, and 6.1% did not notice anything different in the pronunciation.

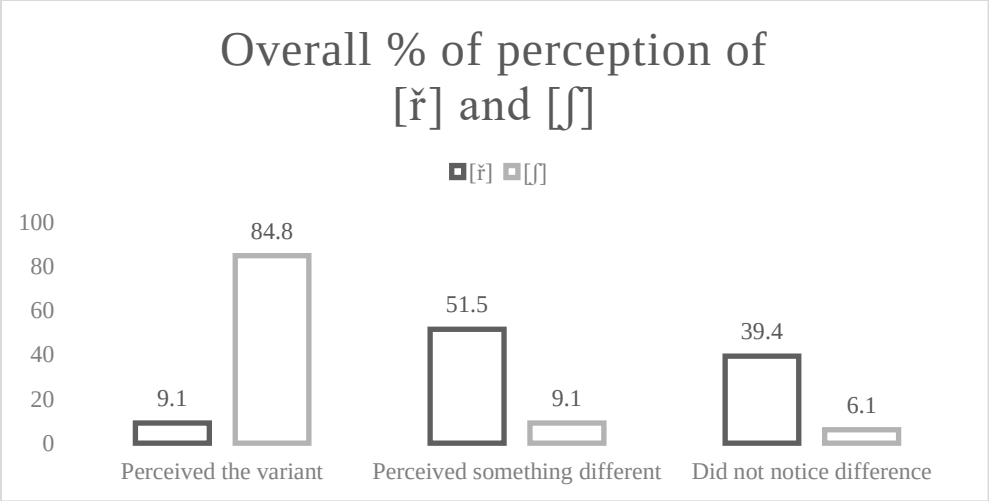

Figure 8. Perception rates of [ř] and [ʃ] in 33 listeners from Chihuahua.

4.2.The Production-Perception Relationship

This section explores the relationship between production and perception of both variables. The results are illustrated with violin plots in Figure 9 for [ř] and Figure 10 for [ʃ]. The vertical axis corresponds to the production of the nonstandard variant per speaker, and the horizontal axis corresponds to whether listeners were able to perceive the variant (yes, no, or something is different). The width of the shapes in the violin plots corresponds to the number of responses in that perception category given the number of nonstandard variants produced. The horizontal lines show the distribution of the data in quartiles.

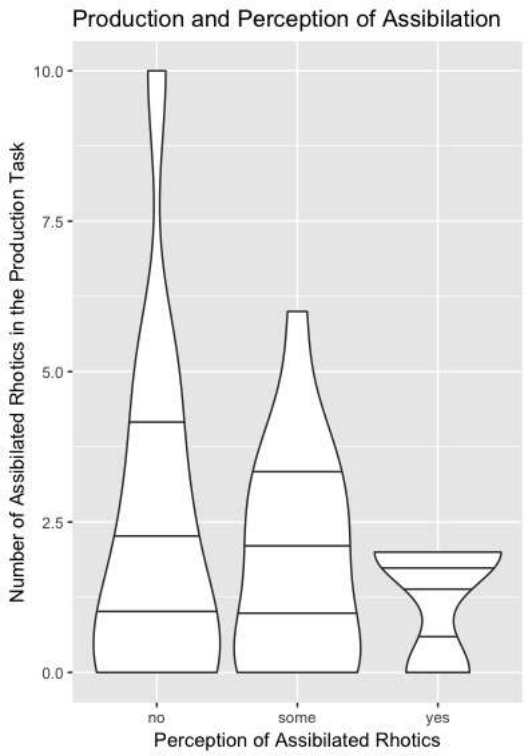

Figure 9. Violin plot showing the relationship between production and perception of [ř].

Figure 9 shows a subtle relationship between production and perception of [ř], with speakers who perceive assibilation producing assibilation somewhat less frequently than those who do not perceive it. However, this slight difference is not a significant difference, likely given the very low rates of listeners' explicit identification of rhotic assibilation. When the best-fit model for assibilated rhotic production (see Table 5) was modified to include the participants' perception of assibilation as a categorical independent variable, none of the levels of the factor reached significance.

If we turn our attention to the relationship between production and perception of [ʃ], we find different results. First, the violin plot in Figure 10 shows that individuals who perceive

deaffrication in the perception task tend to produce it more as well.[8] When perception of [ʃ] is included in the binomial logistic regression model fitted to [ʃ] production (see Table 6), perception proves to be a significant predictor of production, as shown in the revised model in Table 7. In other words, participants who explicitly commented on [ʃ] in the perception task (reference level is sh perception = yes) were significantly more likely to produce [ʃ] than individuals who could not specifically name what was different about the recording (sh perception = something diff.).

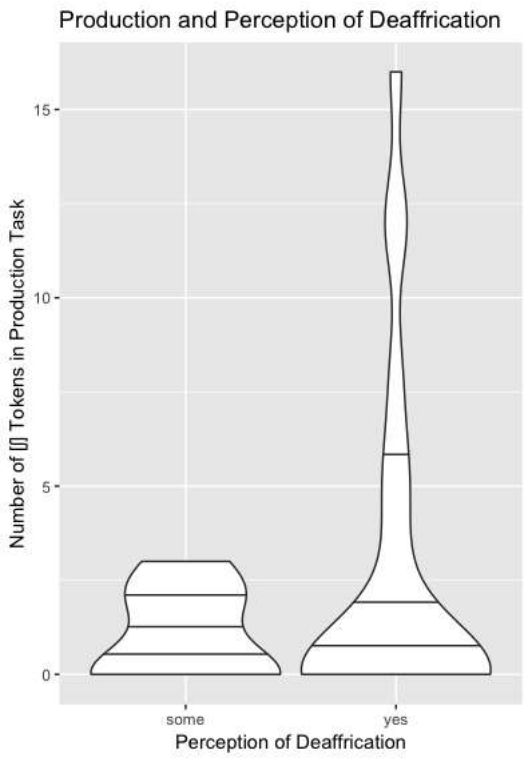

Figure 10. Violin plot showing the relationship between perception and production of [ʃ].

Table 7. Binary logistic regression model coefficients for production of deaffrication with perception of deaffrication as an independent variable.

[8] As only one participant could not perceive deaffrication at all, the perceptual "no" group could not be visualized in this plot.

	Estimate	**SE**	***z*-value**	***p***
(Intercept)	-1.61	0.26	-6.3	<0.001
Generation 2	-1.24	0.33	-3.75	<0.001
Generation 3	-0.57	0.31	-1.85	0.065
Gender = male	0.67	0.26	2.56	0.01
sh perception = something diff.	-1.47	0.75	-1.97	0.049
sh perception = no	-0.02	0.52	-0.04	0.97

5. Discussion

This section more fully explores participants' production, their perception, and the relationship between the two. With regard to production, assibilation is more common among the youngest group and slightly more common among women, contradicting previous studies that indicate the use of the assibilated variant is receding (Amastae et al., 1998; Martín Butragueño, 2006; Perissinotto, 1972). At least in Chihuahua, the fact that the variant is used most frequently by the youngest speakers suggests that it is not receding. Additionally, the principles of gender differentiation proposed by Labov (2001, p. 274) predict that for assibilation, which has been characterized as a change from above (Amastae et al., 1998), women would have higher rates of assibilation. This prediction was partly borne out in the present study, as women produce slightly higher rates of assibilation, but the difference was not found to be significant, which could suggest a more thorough diffusion of rhotic assibilation throughout the community.

For the production of deaffrication, which has been considered a change from below (Amastae, 1996), the principle of gender differentiation would predict higher rates of the innovative form by women (Labov, 2001, p. 292). Yet, in the present study, deaffrication is favored by the youngest generation and by men. We argue that the classic characterization of

deaffrication as a change from below is not accurate. Instead, 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. This classification is further supported by the frequency of use of the variant across generations: there is 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, 1991) avoid the non-standard variant more than other groups.

In terms of perception, our results showed that a very low number of participants successfully perceived assibilation (9.1%), while deaffrication was perceived by almost all participants (84.4%). There are several factors that can account for the low level of perception of assibilation and the high level of perception of deaffrication. First, it is possible that the position of the variable in the syllable could affect the degree of its perception. Assibilated rhotics occur in less salient coda position, while deaffrication occurs in more salient onset positions. Second, the difficulties in perceiving assibilation could be due to its rather low frequency of occurrence in speech. As explained earlier, the occurrence of assibilation in this dialect is most common in absolute final position, which involves a more limited phonetic environment than deaffrication, where variation occurs in a greater range of contexts (Hualde, 2005). This frequency difference is supported by the production data, in which only 379 tokens of absolute final /r/ were produced as compared to 634 tokens of /tʃ/.

Finally, the social salience of a variable to a particular speech community is likely to affect its perception. Linguistic innovations, such as assibilation, may start as an undefined linguistic variable found in a restrictive subgroup. These variables show inter-speaker variation, differences between the speech of the group and of others. Labov (1972) termed this social variation as ‘indicator’, while Silverstein (2003) called it ‘first-order indexicality’, the initial step

in registration of social meaning. When outsiders begin to adopt these features to signal group affiliation, the variable becomes a ‘marker’ (Labov, 1972) or ‘second-order index’ (Silverstein, 2003). Markers take on social meanings in line with how the user group is evaluated. A third step in the development of variables is achieved when they become the object of overt attention and comment. Labov (1972) termed these ‘stereotypes’ and Silverstein (2003) ‘third-order indexes’. Because deaffrication is openly identified with the northern dialect and is subject to criticism from speakers of other dialects, we believe that it has become a stereotype in Chihuahua. Overt comments about deaffrication may increase participants’ metalinguistic awareness of this variant that is stereotypically associated with their dialect.

Turning now to the relationship between production and perception, our hypotheses proposed that rhotic assibilation, a change from above associated with social prestige (Amastae et al., 1998), would involve a positive relationship between perception and production. In other words, we predicted that individuals who produced rhotic assibilation would perceive it more successfully than individuals who do not produce it. On the other hand, we expected an inverse relationship between perception and production for deaffrication, given that it had been previously labeled as a change from below (Amastae, 1996). That is, we expected participants who produced [ʃ] to perceive it less successfully than speakers who did not deaffricate /tʃ/.

However, a statistical analysis did not support these hypotheses. Binomial logistic regression models fitted to the production of rhotic assibilation and deaffrication, respectively, revealed a variable-specific difference: the perception of rhotic assibilation did not significantly condition rhotic production, but the perception of /tʃ/ deaffrication did significantly condition /tʃ/ production. In other words, the link between production and perception appears to be closer for more socially salient variation, as listeners’ metalinguistic awareness of a stereotyped variant

appears to influence their production. On the other hand, variation that is less socially salient and, as a result, less readily perceived does not appear to influence production in the same way. These findings suggest that the relationship between phonetic production and perception relationship is not absolute and unequivocal; rather, this relationship appears to be variable-specific within and potentially across speech communities.

6. Conclusion

This study has concluded that speakers' perception of phonetic variants is related to their production of these variants, but the perception-production relationship depends crucially upon a variable's phonological context, frequency, and social salience to the speech community. While this study represents an important step in deciphering this complex production-perception relationship of sociolinguistic variables, a great deal more work is needed.[9] For instance, this study only explored explicit, metalinguistic perception of rhotic assibilation and /tʃ/ deaffrication, and future studies should investigate implicit perceptions of these variants in matched-guise tests (Lambert et al., 1960) and more gradient discrimination of the variants (Chappell, 2017).

Another remaining question is whether perceptual or acoustic salience could play a role in explaining why listeners perceived /tʃ/ deaffrication more successfully than rhotic assibilation. While both [ř] and [ʃ] are high-intensity noises in the upper frequencies (around 3500 Hz for both), perceptual differences could also be explained in terms of the syllabic positions of the

[9] The perception of rhotic assibilation should also be explored in other phonological environments beyond absolute final position, particularly where it is more marked, such as coda position before a consonant or a vowel.

variables. Finally, speaker-listeners from lower social classes should be included in future work, as the inclusion of only middle- and upper-class speakers in this study may have affected the production of non-standard variants. More speakers from a wider range of socioeconomic backgrounds could help resolve this issue and determine whether stigmatized variants are less or more easily perceived than prestigious variants.

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APPENDIX A

1. *En El Paso hace mucho calor.* 'It's too hot in El Paso'
2. *Los tacos en Juárez tienen otro sabor.* 'Tacos have a different taste in Juarez'
3. *La leche es mas barata en El Paso.* 'Milk is cheaper in El Paso'
4. *Mi niña no quiere dejar su chupón.* 'My (little) girl won't give up her pacifier'
5. *Tengo tres perritos chihuahuas.* 'I have three small Chihuahuas'
6. *Cuando empiezo a comer chocolate no puedo parar.* 'When I start eating chocolate, I can't stop'

APPENDIX B

	[ř]			[ʃ]		
Participants	**%**	**N**	**Total**	**%**	**N**	**Total**
UT030	0%	0	12	5%	2	41
UT076	50%	2	4	60%	6	10
UT077	0%	0	14	0%	0	7
UT078	25%	3	12	0%	0	2
UT079	12.20%	5	41	0%	0	33
UT080	0%	0	4	9.10%	3	33
UT081	33.33%	3	9	0%	0	5
UT082	90.91%	10	11	0%	0	32
UT083	40%	4	10	0%	0	7
UT084	6.25%	1	16	7.41%	2	27
UT085	8.33%	1	12	8.33%	1	12

UT086	0%	0	12	0%	0	14
UT087	0%	0	6	0%	0	14
UT088	0%	0	9	57.14%	8	14
UT089	0%	0	6	0%	0	5
UT090	8.33%	2	24	0%	0	28
UT091	28.57%	2	7	0%	0	25
UT092	42.86%	3	7	0%	0	12
UT093	16.67%	2	12	44.44%	12	27
UT095	0%	0	8	0%	0	10
UT096	0%	0	7	0%	0	20
UT097	50%	5	10	42.86%	12	28
UT098	50%	3	6	0%	0	13
UT099	20%	1	5	0%	0	13
UT100	66.67%	6	9	33.33%	4	12
UT101	6.25%	1	16	0%	0	38
UT102	30%	3	10	15.38%	2	13
UT103	0%	0	7	12.50%	2	16
UT104	0%	0	9	0%	0	21
UT105	8.70%	2	23	29.41%	5	17
UT106	18.18%	2	11	32%	16	50
UT107	0%	0	23	0%	0	28
UT108	57.14%	4	7	0%	0	7
TOTAL			**379**			**634**