

EFFECTS OF NATIVE PHONOLOGY ON SPOKEN WORD RECOGNITION AND
SECOND LANGUAGE PHONOLOGICAL PROCESSING

by

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A Dissertation Submitted to the Faculty of the

GRADUATE INTERDISCIPLINARY PROGRAM IN
SECOND LANGUAGE ACQUISITION AND TEACHING

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

2020

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

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ACKNOWLEDGMENTS

This journey has been immensely better by the support, insight, knowledge, and help of many. First and foremost, I would like to express my deepest gratitude to Dr. Miquel Simonet for his advice, guidance, and mentoring throughout the past few years. Thank you for always pushing me to my limits and beyond. Your enthusiasm for experimental design and writing and your discipline in research have been the best role model for my academic and professional development. My sincere gratitude to Dr. Natasha Warner, for inspiring me to become a more confident scholar and for making me enjoy statistics. I would also like to express my appreciation to Dr. Beatrice Dupuy for her support, encouragement and the many opportunities she provided me with to succeed. My most sincere gratitude to Dr. Adam Ussishkin for his valuable advice and support and the expert comments and critiques on this work.

In addition to the members of my committee, I am very grateful to my professors in Universidad de Sonora, Saint Louis University, and The University of Arizona for their mentoring and teaching. Special thanks to Dr. Kara McBride without whom none of this would have been possible. To Dr. Ana Carvalho for having given me the opportunity to work with her and learn from her. I am also thankful to Dr. Óscar López for his punctual guidance and support. I am thankful to Dr. Amy Wright for her advice, enthusiasm and friendship. I would like to thank Dr. Nolvía Cortez for believing in me and for her encouragement.

I am deeply indebted to all the powerful women that accompanied me in this crazy and wonderful experience. To Anaid Stere-Lugo, whose magic made things bright again. To my friends Wid Allehaiby, Laurel Schenkoske, and Miriam Rodríguez Guerra for your unconditional support, words of wisdom, and times shared in cafés, which have now turned into fond memories that will be forever cherished. My deepest gratitude to Adriana Picoral, Bruna Sommer-Farias,

Elif Burhan, Jennifer Slinkard, and Sara Al-Bahlani for your enthusiasm and tireless support. It has been a true pleasure to share with you all the ups and downs in this journey. Special tanks to Kelley Merriam-Castro whose endless support and bright spirit made this journey much smoother.

My most sincere gratitude is also extended to my participants who made this dissertation project real. I am also thankful to Dr. Haydee Carrasco and Grupo de investigación en Neurolingüística (GriN) at Universidad Autónoma de Querétaro, whose invaluable help made this project possible. I also thank the Graduate and Professional Student Council and the College of Humanities at The University of Arizona for funding this research project.

Agradezco a mi familia por su apoyo. Muchas gracias por estar siempre conmigo a pesar de mi ausencia. Gracias a mi hermana, Mayra, por compartir su fortaleza y amor y por regalarme una de las mayores alegrías de la vida, Elí. Gracias a mi cuñado, Alán, por su apoyo. Muchas gracias a mi hermano, Gerardo (el mentado Romario), mi compañero, el de la sonrisa eterna. Gracias Imelda Flores por siempre estar ahí. Special thanks to the Hilliard family for all their love. Gracias a mis tíos y tías. Gracias a mi nana Juanita, cuya esencia se queda entre nosotros.

Les agradezco de manera infinita a mis padres, Alma y Gerardo, por su amor y apoyo incondicional. Gracias por permitirme ser parte de ustedes. Los llevo siempre en mi corazón. Thank you, Joe Hillard, for being there by my side from the beginning. Thank you for your willingness to embark on new adventures with me. I love you. Thank you for your patience throughout the years, particularly during the writing of this dissertation. You made this possible.

DEDICATION

Para mis padres, la luz de mi vida.

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ABSTRACT

The present investigation examined the effects of sociophonetic variation on word recognition and the acquisition of second language phonology. In *norteño* Mexican Spanish /tʃ/ undergoes a process of variation in which this sound may be produced either as an affricate, [tʃ], or a fricative, [ʃ]. Speakers of *norteño* dialect, thus, are likely to produce a word like *charco* ‘puddle’ as either [ˈtʃarko] or [ˈʃarko]. This produces an asymmetry between native Spanish speakers in Mexico: *Norteño* speakers have experience with both [ʃ] and [tʃ] in their native variety whereas speakers from central Mexico, whose dialect includes only one variant, [tʃ], do not. In addition, in Spanish [ʃ] and [tʃ] do not represent a phonemic contrast. Unlike Spanish, English possesses a phonemic contrast distinguishing between /tʃ/ and /ʃ/, as in *cheat-sheet*. The aim of this dissertation is twofold. First, this project investigates the effects of sociophonetic variation on the recognition of words by two groups of native Mexican Spanish speakers: one group of *norteño* speakers and one group of central dialect speakers (Experiment 1). The results from a lexical decision task with cross-modal priming show that both variants, [tʃ] and [ʃ], facilitate word recognition for listeners in both groups. Reaction times for target words preceded by primes with [tʃ] as the initial sound were faster. This suggests that the affricate variant is privileged over the fricative at some level of representation. Second, this dissertation explores and compares the perceptual behavior of the English phonemic contrast, /tʃ-/ʃ/, by speakers of *norteño* and central Mexican Spanish who are learning English as a foreign language (Experiment 2). The results of a word-categorization task show that both groups of learners find *cheat* and *sheet* difficult to identify, but that *norteño* listeners find this task to be particularly challenging. The results of a categorical discrimination task show that all learners, but much more so the *norteños*, distinguish the members of the /tʃ-/ʃ/ contrast only at chance level. Overall, the results of the present study

suggest that the phonetic variants found in one's native dialect do not affect the patterns of lexical activation in the native language, but they do modulate the perception of nonnative sounds. Finally, these results demonstrate that people who speak different regional varieties of the same language may face different obstacles when learning the sounds of their second language.

CHAPTER 1

INTRODUCTION

This dissertation explores the effects of sociophonetic variation on patterns of lexical processing of native segments and the acquisition of second language phonology. Words are never produced the same way by the same individual, and this is true for speakers of all languages. In some instances, this variation may in fact be the result of a conventionalized process. *Norteño* Spanish, for instance, is a dialect spoken in northwestern Mexico, and one of its distinctive features is the variation that affects the sound /tʃ/. In *norteño* dialect, /tʃ/ undergoes a process of sociophonetic variation in which this sound may be produced as either an affricate, [tʃ], or a fricative, [ʃ]; this process is known as *shesheo* (Méndez, 2017). Speakers of *norteño* Spanish are recurrently exposed to this variation, and they are likely to produce both variants themselves in day-to-day communication (Brown, 1989; Herrera Zendejas, 2006; Serrano Morales, 2000). The sociophonetic variation affecting /tʃ/ is not found in other dialects of Mexico (Moreno de Alba, 1994). This produces an asymmetry between speakers native to different dialectal zones in Mexico. Speakers of *norteño* Spanish, for example, have had ample experience with *shesheo*, however, individuals native to the central region of Mexico and speakers of central dialect lack exposure to this variation. This study investigates the effects of life-long experience with sociophonetic variation, particularly *shesheo*, and its effects on patterns of word recognition. Specifically, it centers on the comparison of two groups, a group of *norteño* speakers and a group of speakers of Mexican central dialect, and the relationship between linguistic experience and the patterns of lexical access. In addition to exploring the effects of linguistic experience in the individual's native language, this project further analyzes the relationship between native phonology and the acquisition of a second language (L2) sound system. More specifically, this

project investigates the acquisition of the nonnative contrast, /tʃ/ and /ʃ/, by Spanish-speaking learners of English who differ in their dialect experiences.

1.1 SPOKEN WORD RECOGNITION IN THE NATIVE LANGUAGE

Conventionalized phonological variation may be one of the many possible factors involved in the phonetic variability found in speech production. In English, for instance, variation may be found in speakers' production of /t/ and /d/ tapping (Connine, 2004; McLennan, Luce, & Charles-Luce 2003), word final /t/ and /d/ glottalization (Deelman & Connine, 2001; Sumner & Samuel, 2005), /t/ post-nasal deletion (Pitt, 2009; Ranbom & Connine, 2007), and schwa deletion (Connine et al., 2008; LoCasto & Connine, 2002). Similarly, in some varieties of Spanish, when found in coda position, /s/ is produced with a reduced variant as the result of a process of debuccalization.

The effects of phonetic variation on the recognition of spoken words have been investigated in several studies. By means of lexical decision tasks employing the priming paradigm, these have explored the effects of full and reduced forms on lexical activation. However, the results of these studies are contradictory. Evidence from some of these investigations suggest that full forms seem to be privileged over reduced forms in the mental lexicon (Sumner et al., 2014; Sumner & Samuel, 2005, 2009), whereas other studies find an advantage in the opposite direction (Connine, 2004; Connine et al., 2008) or even no difference between forms at all (Deelman & Connine, 2001; McLennan, Luce, & Charles-Luce 2003; Sumner & Samuel, 2005, 2009).

In a recent investigation, the author and a collaborator (2019) explored the effects on *shesheo* on lexical activation by speakers of *norteño* Spanish. We observed that both variants of /tʃ/, the affricate and the fricative, facilitated the recognition of spoken words. However, the affricate variant triggered shorter response times than the fricative variant, which suggests an

advantage for [tʃ] over [ʃ] among our group of *norteño* listeners. The results of this study, nonetheless, do not confirm whether the effects identified are, in fact, the result of dialectal experience. In an attempt to bridge this gap, in this dissertation project I compare the patterns of lexical activation by two groups of native speakers of Mexican Spanish who differ in their linguistic experiences: a group of *norteño* speakers with ample experience with *shesheo* and a group of central dialect speakers with no reported experience with this variation.

More specifically, the research questions leading this study are the following: How does linguistic experience affect the patterns of word recognition by these two groups of listeners? Are both variants of /tʃ/, the affricate, [tʃ], and the fricative, [ʃ], equally effective at tapping into lexical representations in the mental lexicon of individuals with different linguistic experiences? The current study addresses these questions by means of a cross-modal, lexical decision task with immediate priming.

1.2 PHONOLOGICAL PROCESSING IN THE SECOND LANGUAGE

The production of nonnative sounds by L2 learners is likely to differ from that of native speakers. This discrepancy in production is commonly perceived as accented speech among nonnative speakers. These effects have been extensively studied by a large number of investigations, and it has been found that having an accent is not only manifested in production but also in perception (Best & Tyler, 2007; Bohn, 2017; Chang, 2018; Colantoni et al., 2015; Flege, 1995; Simonet, 2016). Several models of L2 speech perception suggest that these effects can be accounted for by the interaction between the two linguistic systems in the bilingual mind (Best & Tyler, 2007; Escudero, 2005; Flege, 1995; van Leussen & Escudero, 2015).

Cross-linguistic interaction between native and nonnative sounds in the bilingual mind can be found in the obstacles encountered by L2 English language learners with diverse

linguistic backgrounds. A well-known example can be observed in native speakers of Japanese who have difficulties when acquiring the nonnative, English contrast /ɪ/-/i/ (Aoyama et al., 2003; Goto, 1971; Guion et al., 2000; MacKain et al., 1981). Similarly, the English /i/-/ɪ/ and /æ/-/ɑ/ contrasts have proven to be very challenging to acquire by Spanish native speakers (Barrios et al., 2016; Casillas, 2015; Escudero & Boersma, 2004; Flege et al., 1997). The results of previous studies addressing these interactions have suggested that the obstacles learners face in the acquisition of nonnative contrasts are directly affected by the cross-linguistic assimilation patterns learners create through their own native phonology.

Most of the investigations cited have focused on the acquisition of vowels. In fact, only a handful of studies have been concerned with cross-linguistic assimilations between obstruents in the first language (L1) and the L2, with a particular focus on voicing contrasts (Kaufmann et al., 2010; Park & de Jong, 2008; Tsao et al., 2006). The current project fills this gap by addressing the acquisition of a set of English obstruents, /tʃ/ and /ʃ/. These two segments create a phonemic contrast in English—these differ in manner of articulation but not voicing—, which is absent in Spanish. In order to acquire this nonnative contrast, then, Spanish-native speakers learning English will have to develop a new category, /ʃ/, to be contrasted with the current existing segment, /tʃ/, found in their native phonological inventory. The assimilation process will not necessarily be the same for native speakers of *norteño* dialect, who have both [tʃ] and [ʃ] in their native sound system, but these are mapped to a single phoneme, /tʃ/. For this reason, *norteño* listeners will have to unlearn that [tʃ] and [ʃ] are variants of the same phoneme and instead learn that these are, in fact, two different sounds in the target language, English.

The final set of research questions this dissertation aims at responding to are the following: Are native speakers of *norteño* dialect more or less likely than speakers of central

Mexican Spanish to succeed in the discrimination of the two segments of the English /tʃ/-/ʃ/ contrast? If these two groups of L2 English learners differ in their patterns of discrimination, what assimilation process proves to be more challenging: the development of a novel category or the remapping of an existing sound to a new phoneme? These questions are addressed in two separate categorization experiments, one of identification and one of discrimination, and are further discussed in this dissertation.

CHAPTER 2
PRELIMINARY STUDY ON SOCIOPHONETIC VARIATION
IN NORTEÑO MEXICAN SPANISH

2.1 INTRODUCTION

This dissertation investigates the effects of experience with sociophonetic variation on lexical activation in the native language and the acquisition on nonnative sound categories. The speech by *norteño* Mexican speakers, a dialect spoken in the northwestern region of Mexico, is characterized by their pronunciation of the first initial consonant in words such as *charco* ‘puddle’ (Serrano Morales, 2009). In most Mexican Spanish dialects, the consonant <ch> as in *charco* is produced as a postalveolar affricate, [tʃ]. Thus, a word like *charco* is produced as [ˈtʃarko] by most Mexican Spanish speakers. In *norteño* Mexican Spanish, however, this consonant may be produced either as a postalveolar affricate, [tʃ], or as a postalveolar fricative, [ʃ]. That is, *norteño* speakers may pronounce words like *charco* as either [ˈtʃarko] or [ˈʃarko]. The use of the fricative as a variant of /tʃ/ in *norteño* dialect is a process known as *shesheo* (Méndez, 2017); this term is adopted in this dissertation. This preliminary study investigates the sociophonetic variability that affects /tʃ/ and its phonetic profile in *norteño* dialect.

The presence of *shesheo* in northwestern states, such as Baja California, Sinaloa, and Sonora, has been identified as a distinctive feature of *norteño* dialect. In fact, the sociophonetic variation that affects /tʃ/ in the northwestern region of Mexico has been used to geographically identify the different dialects spoken in Mexico (Lope Blanch, 1990-2000; Martín Butragueño, 2009, 2011, 2014; Moreno de Alba, 1994; Serrano Morales, 2000, 2009). In addition to its presence in Mexico, *shesheo* has also been observed in the speech by speakers of various Spanish-speaking communities across the world such as in South and Central America

(Cedergren, 1973; Quintanilla-Aguilar, 2013), the Caribbean (Fails, 1984; Quilis & Vaquero, 1973; Vaquero, 1972), and the Iberian Peninsula (Melguizo Moreno, 2007).

Norteño speakers are likely to produce both variants in their daily speech. This, in turn, also leads speakers to be recurrently exposed to both, [tʃ] and [ʃ], on a day-to-day basis. This preliminary study is concerned with the variation that affects /tʃ/ in *norteño* Mexican Spanish and its presence in *norteño* speaker's speech. More specifically, this investigation explores the speech by *norteño* Mexican Spanish speakers, who are recurrently exposed to the variation that affects /tʃ/, and whether their speech differs from that of speakers who lack experience with *shesheo*. Participants' production is explored by means of a sentence-repetition task with two groups of speakers who differ in their dialect experience: one group of *norteño* speakers and one group of speakers of central Mexican Spanish.

2.1.1 THE PHONEMIC PROFILE OF /tʃ/ IN MEXICAN SPANISH

Dialectology studies have addressed the identification and description of the various dialects spoken in Mexico. Based mostly on impressionistic data on the use of the phonological variables of Mexican Spanish, these studies have drawn the geographic distribution of the multiple dialects found across the country. The treatment of /tʃ/ has been one of the phonological variables considered to identify the four main regional varieties of Spanish spoken in Mexico: central, coastal, northern (*norteño*), and peninsular (Lope Blanch, 1990-2000; Martín Butragueño, 2014, 2011; Moreno de Alba, 1994).

The phoneme /tʃ/ is part of the Mexican Spanish phonemic inventory. This phoneme is realized by most Mexican Spanish speakers as a voiceless, alveopalatal affricate. Studies concerned with *shesheo* have identified multiple variants derived from the variation regarding the articulation of /tʃ/ (Butragueño, 2009). The contradicting results presented by these

investigations suggest up to 13 different variants of /tʃ/. The characteristics of these variants have been defined according to manner (e.g., affricate, affricate with long obstruction, affricate with brief obstruction, fricative) and place (e.g., dentoalveolar, alveopalatal, fronted postalveolar, backed postalveolar). Variationist studies on *norteño* dialect, however, limit the list of variants to a two-way distinction, a fricative and an affricate (Brown, 1989; Carreón Serna, 2007; Casillas, 2012; Jaramillo & Bills, 1982; Méndez, 2017; Serrano Morales, 2002). The practice of distinguishing between two variants of /tʃ/, the affricate and the fricative, is adopted in this dissertation.

2.1.2 NORTEÑO MEXICAN SPANISH: THE PRESENCE OF *SHESHEO*

The dialects of Mexican Spanish are divided into four main groups: central, coastal, northern (*norteño*), and peninsular. Central Mexican Spanish is the prestige dialect in Mexico. In fact, it is the dialect that forms Standard Mexican Spanish. Central Mexican Spanish is the dialect used for most national media programming, including television, radio, and online platforms. There is considerable contact between speakers of central and *norteño* dialects. Many *norteño* speakers relocate every year to the central region of Mexico, particularly Mexico City, for professional and academic reasons. The presence of *shesheo* in the speech by *norteño* speakers is a stigmatized feature of this dialect (Casillas, 2013), and speakers are likely to become aware of this when they start interacting with speakers of central dialect.

Shesheo is one of the most distinctive features of *norteño* dialect. It is important to note, however, that *norteño* speakers use [ʃ] as a variant of /tʃ/ in free variation. This means that the use of one variant over the other is not in complementary distribution since it does not attend a phonological rule. Studies concerned with *shesheo* have suggested, nonetheless, that this variability may be strongly influenced by both linguistic and extra-linguistic factors. Only a

handful of variationist investigations concerned with the sociophonetic variation that affects /tʃ/ have been conducted—these have collected data in Sonora (Alessi Molina & Torres Díaz, 1994; Brown, 1989) and Chihuahua (Amastae, 1996; Carreón Serna, 2007; Méndez, 2017), two states located in the northwestern region of Mexico. A few more studies have investigated *shesheo* in the Spanish spoken in the southwest of the United States, including Arizona (Casillas, 2012; Noriega, 2004) and New Mexico (Jaramillo, 1986; Jaramillo & Bills, 1982). It is not surprising that due to geographical closeness, most of the same linguistic phenomena may be found in both geographical regions (Post, 1934).

2.1.3 *SHE SHEO*: THE ROLE OF LINGUISTIC CONTEXT

Previous studies concerned with the variation that affects /tʃ/ have identified phonetic context as one of the main linguistic factors involved in the triggering of *shesheo*. These studies may be classified into two main groups according to the nature of their results: Those investigations that suggest that fricative variants are like to surface in intervocalic position and those that find that the affricate variant is more likely to be produced when preceded by a consonant sound.

These studies have consistently found that the fricative variant is more likely to surface than the affricate variant when produced in between vowels. Moreover, some of these investigations have demonstrated that the acoustic properties of the Spanish vowels in which /tʃ/ is found also determines the use of the fricative variant. On one hand, there are several studies that have been concerned with the vocalic sound following /tʃ/. Casillas (2012) explored the production of Spanish by a group of female participants in Tucson, Arizona and observed they were more likely to produce the fricative variant when /tʃ/ was preceding the low vowel, [a]. In addition, Serrano (2002) found that the Spanish front vowel, [e], triggered the use of the fricative variant amongst his participants. On the other hand, some studies have demonstrated that the

acoustic properties of the preceding vocalic sound also play a major role in the use of one variant over the other. Méndez (2017) demonstrated that when preceded by a Spanish high vowel, [i] or [u], the fricative sound is also favored in production (Amastae, 1996; Brown, 1989; Casillas, 2013; Jaramillo, 1986). The results obtained from these studies demonstrate the relevance of the acoustic properties of both the preceding and following vowels in the triggering of *shesheo*.

These investigations have also found that the affricate variant is expected to appear in postconsonantal position. The evidence obtained by these studies have led to suggest the fricative variant is a lenited or reduced version of the affricate variant (Herrera Zendejas, 2006; Moreno de Alba, 1994). The retainment of the obstruction feature after a homorganic consonant is a behavior similar to that presented by the set of Spanish stops /b d g/, known as spirantization or lenition. This set of sounds goes under a process of lenition when preceded by vowels, liquids, and fricatives, which forces them to lose their obstruction feature to surface as fricative sounds. Nonetheless, when in initial position and when preceded by nasals and liquids—except for the phoneme /d/ when produced after /l/—, /b d g/ retain their obstruction (Núñez Cedeño, 2014). This is understood by many as a synchronic lenition process (see Hualde, 2005).

An investigation that reports on instrumental data examined the acoustic features of the fricative variant by *norteño* speakers. In this study, Herrera Zendejas (2006) recorded the speech of two *norteño* speakers born and raised in Sonora, Mexico. An acoustic analysis of the data revealed that the fricative variant was produced by both speakers in every instance, but the affricate would appear when preceded by /n/ and /l/. Interestingly, nonetheless, Herrera Zendejas affirms the affricate variant produced by the two speakers is not a “true” affricate, but a fricative with a brief occlusion moment that is caused by the articulatory gestures employed to produce the previous consonantal segments. By this, the author suggests that the apparent affricate

segment produced after /n/ and /l/ by the two *norteño* speakers is the result of full-contact inertia after a homorganic sound. This, in turn, is evidenced by the acoustic properties of the “affricate” sounds produced by these two speakers, which are softer and shorter than an alveopalatal affricate a speaker of Mexican central dialect would produce.

2.1.4 *SHESHEO*: EXTRA-LINGUISTIC FACTORS

Age, years of schooling, and gender are amongst the extra-linguistic factors that have been identified as important predictors of the use of [ʃ] as a variant of /tʃ/. Age has been observed to play a significant role in the variation that affects /tʃ/ (Jaramillo & Bills, 1982). Some studies have revealed that the use of [ʃ] as a variant of /tʃ/ is more likely to surface in the speech by older speakers than younger ones (Alessi Molina & Torres Díaz, 1994; Carreón Serna, 2007; Méndez, 2017). Carreón Serna (2007) explored the use of the fricative variant in the speech of three different generational groups. The results of the study showed that older speakers favored the production of fricative variants more than younger speakers do. Similar results were obtained by Casillas (2012), who found that the production of the fricative variant was favored over the affricate variant by older speakers than younger ones in his group of participants.

Level of formal education has been found to play an important role in the use of the fricative variant by speakers of these communities. Previous studies have suggested that more years of secular schooling are likely to significantly affect the use of [ʃ] as a variant of /tʃ/. Jaramillo (1986) found that participants with no postsecondary education show the most use of the fricative variant in their speech opposite to individuals with more exposure to postsecondary education, who use [ʃ] much less frequently. It is to be understood that in these communities, level of education and age are highly correlated amongst members of these communities. It is not surprising, thus, that younger speakers are more likely than older speakers to have had access to

more years of schooling. To account for these results, Jaramillo and Bills (1982) introduced the term of *variant competence*. This term suggests that younger and more educated speakers are likely to have expanded their *variant competence*. By becoming more variant competent, this group of speakers have the option to use one variant over the other according to the formality of the situation. For instance, they may use the affricate variant when in more formal situations in which the standard form is expected—this includes interviews such as those conducted by the linguists in this study. *Variant competence* also permits these speakers to use fricative variants in more informal contexts if preferred, such as when talking to friends and relatives, where non-standard forms are more likely to be used. This may not be true for speakers who are not highly variant competent; that is, older and less formally, educated speakers may use the fricative variants more frequently, regardless of the formality of the context.

The lack of *variant competence* could lead to a stronger stigmatization of the use of the fricative variants. Casillas (2013) investigated the linguistic attitudes towards the production of the fricative variant by speakers in Tucson, Arizona. The results revealed that speakers producing the fricative variant were perceived as less competent and less educated than those who favored the use of the affricate variant in their speech. It was also observed that the use of the standard variant, [tʃ], increased the speakers' level of credibility. Moreover, Alessi and Torres (1994) conducted a dialectological study across Sonora, Mexico. Their results showed that speakers of these communities tended to produce the affricate variant more often than the fricative variants. The authors argue that the failure to observe higher rates of fricativization among their speakers may be due to the participants' awareness of the formality of the task, which required a more formal use of the language, hence the use of the affricate variant. They

also concluded that the participants awareness of the stigma associated with the use of the fricative variants may have prevented their participants from producing them in their speech.

Gender has also been identified as an important predictor of the variation that affects /tʃ/. A handful of studies have suggested that females are usually the ones that favor the fricative variants more often than man (Amastae, 1996; Brown, 1989; Cedergren, 1973; Serrano, 2000). Amastae (1986), for instance, explored the use of the fricative variant in the community of Ciudad Juárez, Chihuahua. The results of the study revealed that women born between 1940 and 1950 presented the highest level of production of the fricative variant. These results, however, were contradicting by Mendez (2017), who in a replication of Amastae's study, found that male participants in his study favored the use of [ʃ] in their speech contrary to his group of female participants. Mendez (2017) concludes that the results obtained 30 years later differ strongly from those by Amastae and demonstrate a linguistic change in the community of speakers of Ciudad Juárez.

These variationist studies reveal contradicting results in the reported rates of the use of fricative variants by *norteño* speakers. In addition, the effects of the linguistic and extralinguistic factors in the triggering of *shesheo* among speakers of these communities seem to vary from study to study. It is important to note, however, that although the results from these investigations vary significantly, it is possible to claim that members of *norteño* speakers are recurrently exposed to the variation that affects /tʃ/. In fact, these studies also confirm that both variants are likely to surface in the speech produced by these speakers. This, in turn, allows one to claim that *norteño* speakers have acquired experience with *shesheo*, which is not true for speakers of other Mexican dialects. Does life-long experience with *shesheo* impact the production of /tʃ/ in their speech? If so, would individuals who have been long exposed to the

sociophonetic variability that affects /tʃ/ differ from those who have no reported experience with *shesheo*?

2.1.5 THE PRESENT STUDY

The current preliminary study focuses on the sociophonetic variability that affects /tʃ/ in *norteño* dialect, spoken in northwestern Mexico. This study explores the production of Spanish words whose initial consonant is <ch> (as in *charco* ‘puddle’) by two groups of native Spanish speakers that represent two dialectal regions in Mexico, central and northern. More specifically, the current study investigates the presence of *shesheo* in the speech produced by *norteño* speakers, who are recurrently exposed to this sociophonetic variation in their speech community. In addition, this study analyzes whether *norteño* speakers’ production patterns differ from those by a group of central Mexican Spanish speakers, who lack experience with *shesheo*.

Speakers of *norteño* dialect have life-long experience with the two variants of /tʃ/, the affricate and the fricative. This, however, is not true for speakers of central Mexican Spanish, who only possess one variant, the affricate, in their native dialect. For this reason, it is hypothesized that *norteño* speakers will produce words like *charco* with either one of the two variants of /tʃ/. In addition, it is hypothesized that the presence of *shesheo* will only be observed in the speech produced by *norteño* speakers but not in the one by the group of speakers of central Mexican Spanish.

2.2 METHODS

2.2.1 PARTICIPANTS

A total of 66 native, Mexican Spanish speakers were recruited for participation in a production task. Data were collected in two locations in Mexico: Hermosillo, Sonora and Santiago de

Querétaro, Querétaro. All 33 participants tested in Hermosillo were born and raised in the state of Sonora. Most of the participants in Sonora had lived in Hermosillo since birth. Those who were born in other municipalities of the state reported to have relocated to Hermosillo with their families during childhood or adolescence. Many of the 33 participants who completed the task in Santiago de Querétaro were born in other states located in the central highlands of Mexico (e.g., Guanajuato, Jalisco, and Puebla), and reported to have relocated to Santiago de Querétaro as children or as teenagers. Regarding the treatment of /tʃ/, including many other sounds, the central highlands of Mexico are considered one dialectal area. For this reason, Hermosillo and Santiago de Querétaro represent two different dialectal areas in Mexico, the northwest and the central highlands.

The age of the participants recruited for this study ranged from 18 to 43. Except for one participant, all 66 individuals in this study were undergraduate or graduate students at the time of testing. Because of the fact that most of the participants in the study shared a similar profile regarding their higher levels of education, this sample does not fully represent the general population of the two dialectal areas. It is important to note, however, that this sample is indeed representative of the college communities where they are located.

2.2.2 DESIGN AND MATERIALS

This study examined the production of the initial consonant sound in Spanish words like *charco* ‘puddle’. The production experiment for this study consisted of a sentence-repetition, elicited-production task. In this task, participants heard a set of phrases that were presented to them individually. Upon hearing each phrase, participants were asked to repeat what they heard. For this study, each phrase was played once. Each participant, thus, provided a sample of their speech after repeating each phrase presented to them auditorily. The materials for the sentence-

repetition task consisted of 10 target words beginning with <ch>, each one presented with both variants, the affricate, [tʃ], and the fricative, [ʃ], for a total of 20 target items. The following sound for every target item was [a]. Spanish words starting with the sequence <cha> were selected over <ch{e,i,o,u}> since a dictionary search, both online and printed, revealed this as the most frequent sound sequence. All target items were two- and three-syllable words with the stress in the second syllable.

In order to compare the production of the target segment, an additional Spanish sound was selected to serve as a control condition, Mexican Spanish [s]. There is no reason to believe that the production of Mexican Spanish [s] would pose any challenges for either one of the two groups of speakers. For this reason, no differences in the production of this segment should be expected between *norteño* and central Mexican dialect speakers. Thus, 10 words beginning with <s> were included as control items. Finally, 10 words beginning with <d> and 10 words beginning with <t> were included as distractors. Control items and distractors followed the same syllabic structure and stress patterns as the target items. The list of stimulus materials is available in APPENDIX A.

Stimuli items were embedded in the sentence “Diga _____ porque sí.” (“Say _____ just because.”) Thus, the beginning sound for all stimuli items was preceded by the Spanish vowel [a]. Participants were presented with a total of 50 trials, each one including a sentence with a different stimulus item ([tʃ]-beginning items [10]; [ʃ]-beginning items [10]; [s]-beginning items [10]; [d]-beginning items [10]; [t]-beginning items [10]).

2.2.3 AUDITORY STIMULUS

The author of this dissertation, a native speaker of *norteño* dialect and trained linguist, served as the talker. The productions were recorded in a sound-treated booth at the Arizona Applied

Phonetics Lab at the University of Arizona. The professional recording equipment used included a Shure SM10A head-mounted, dynamic microphone and a Sound Devices USBPre2 audio interface connected to a MacBook Pro laptop computer. Speech productions were digitized at 44.1 kHz, with 16-bit quantization. Sound files were normalized for intensity.

The talker produced all stimulus items embedded in the sentence “Diga _____ porque sí.” (“Say _____ just because.”). All materials were presented in random order to avoid systematic effects of list intonation or exhaustion. The talker produced all phrases three times (50 tokens \times 3 iterations = 150 items). One token for each stimulus item was selected for a total of 50 sentences. The ten target words—words beginning with <ch>—were produced by the talker with both variants, the affricate and the fricative, for a total of 20 target stimulus items.

2.2.4 PROCEDURE

Participants completed the production task individually. Participants in Santiago de Querétaro were tested in a sound-attenuated booth at the Linguistics Lab at *Universidad Autónoma de Querétaro*, while participants in Hermosillo completed the task in a quiet library room at *Universidad de Sonora*. Stimuli were presented auditorily over a set of Apple EarPods connected to a MacBook Pro laptop computer running PsychoPy2 (Peirce et al. 2019). Participants’ responses were collected through a Shure SM10A head-mounted, dynamic microphone connected to a Sound Devices USBPre2 audio interface. Each participants’ speech sample was saved as an individual file using an SD memory card.

For the completion of the experimental task, participants were instructed to listen to each phrase carefully and repeat them as naturally and clearly as possible, employing their regular rate of speech. Phrases were presented only once, and participants were informed of this during the review of the instructions before they began the task. Trials began when the participant pressed

the space bar of a Logitech G512 Lightsync RGB mechanical keyboard. Participants were not allotted a specific time frame for the completion of each trial. They were instructed to repeat each phrase and press the space bar to begin a new trial. Prior to the completion of the experimental task, the researcher provided participants with a general description of the tasks and the instructions for its completion. The conversation between the researcher and the participants took place in Spanish.

2.3 ANALYSIS

Stimulus items were embedded in the sentence “Diga _____ porque sí.” (“Say _____ just because.”). The initial consonant in all stimulus words was followed by the Spanish vowel <a>. Synchronized waveform and spectrographic displays served in order to analyze the recordings of the consonant sounds, using Praat software. A Praat script extracted vowel, consonant, and frication durations.

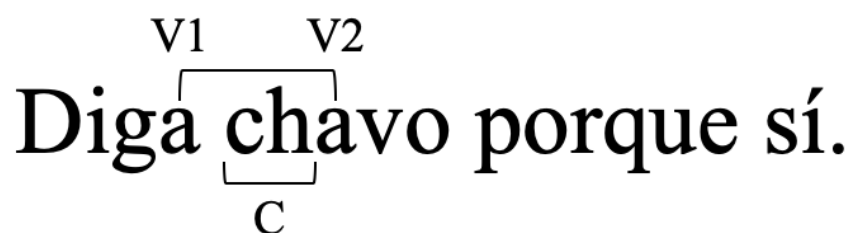


Figure 1. Structure of phonetic context followed for the stimulus materials used in production experiment.

Three main measurements were conducted: VCV-sequence duration, consonant duration, and duration of frication. The base measurement consisted in the VCV-sequence duration. Vowel onsets and offsets were manually marked to obtain the total duration of the vowels surrounding the consonant. The onset of a vowel was marked on the first pitch period in which the second formant (F2) was clearly visible or it had an intensity similar to that found in the steady state of

the vowel. A vowel offset was marked on the last pitch period in which F2 was visible. The first measurement within the VCV-sequence ranged from the onset of Vowel 1 to the offset of Vowel 2. The second measurement ranged from the offset of Vowel 1 to the onset of Vowel 2. The second main measurement consisted in duration of the consonants. Consonant sounds were produced in intervocalic position. The value of the consonant duration was obtained by subtracting the sum of the duration of the two vowels from the VCV sequence duration ($VCV \text{ minus } V + V = C$). The third measurement consisted in extracting the duration of frication (F) of the consonant sound, which was also manually marked. The proportion of time a consonant is fricativized was calculated by subtracting the duration of frication from the duration of the consonant ($C \text{ minus } F$).

For this preliminary analysis, target and control items were selected. A total of 2393 observations were collected. An exploratory and descriptive analysis on duration of the frication was conducted across the two dialectal groups.

2.4 RESULTS

The patterns of the two groups regarding their production of target and control items was explored visually by plotting the data on frication duration for each condition (<ch>- and <s>-beginning items) as a function of dialectal group (Hermosillo; Santiago de Querétaro). A visual inspection of the violin plot for <s>-beginning words suggest no difference in production mode between the two groups. In other words, speakers from Hermosillo and speakers from Santiago de Querétaro do not differ in their production of Spanish words whose initial sound is [s]. That is, both groups of speakers produce the initial consonant, [s], in words like *salsa* ('sauce') with a similar frication duration. The lack of differences in production of <s>-beginning stimulus items

between the two groups justifies the selection of this sound to be used as a control condition in this experimental task.



Figure 2. Violin plot of frication duration from the production of <s>-beginning items by both groups of speakers, Hermosillo (hmo) and Santiago de Querétaro (qro).

Differences in the production of words beginning with <ch> were found between the two groups of speakers, as evidenced in the violin plot in Figure 1.3. The exploration of the plot reveals the group of speakers in Hermosillo is bimodal in their production of /tʃ/, as two different peaks are clearly observed. That is, the group of *norteño* speakers in Hermosillo produce both variants of /tʃ/, the affricate, [tʃ], and the fricative, [ʃ], in their speech as both peaks indicate. This, however, is only partially true for speakers of central dialect in Santiago de Querétaro, who produce fewer fricative tokens than *norteño* speakers. The great majority of the tokens in the central dialect group is produced with [tʃ], as indicated in the plot where most of the production tokens concentrate on the affricate variant mode. As it is also observed, a smaller portion of the tokens is found in the fricative variant mode for participants in the Santiago de Querétaro group. As shown in the plot, nonetheless, the density of tokens in the fricative mode produced by

speakers of central Mexican dialect is much smaller than that produced by the group of *norteño* speakers.

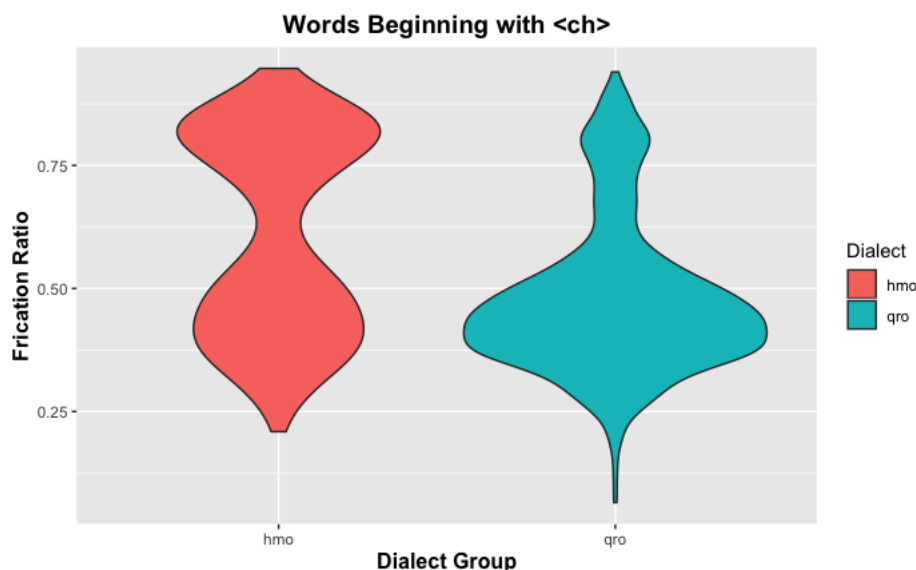


Figure 3. Violin plot of frication duration from the production of <ch>-beginning target items by both groups of speakers, Hermosillo (hmo) and Santiago de Querétaro (qro).

2.5 DISCUSSION

The present preliminary study reports on the results of a production experiment in which the effects of native dialect experience on L1 production is examined. More specifically, this investigation explores whether experience (or lack of) with *shesheo* affects the production of Spanish words whose initial consonant is <ch>. Two groups of speakers who differ in their linguistic background—one group of *norteño* speakers and one group of central Mexican dialect speakers—completed a sentence-repetition, elicited-production task. As part of the experimental task, participants repeated sentences that included <ch>-beginning words and <s>-beginning words as target and control items, respectively. A visual examination of the violin plots reveals no difference between the two groups in the duration of frication when producing the initial consonant of words beginning with <s>. This, however, is not true for words whose initial

consonant is <ch>. It is observed that *norteño* speakers, but not speakers of central dialect, have a bimodal production of words beginning with <ch> by using both variants of /tʃ/, the affricate, [tʃ], and the fricative, [ʃ].

Regarding the production of [s], speakers in both groups seem to behave similarly. It was originally hypothesized that no differences were expected between the two groups of speakers regarding the duration of the frication when producing <s>-beginning words. As observed in the plot, the great majority of the tokens produced by speakers in Hermosillo and Santiago de Querétaro are found within the fricative mode. In addition, it is shown that the two groups of speakers produce Mexican Spanish [s] with similar frication ratios in this task. The patterns shown in the plot suggest that *norteño* and central dialect speakers have similar modes of production for Mexican Spanish [s] at the beginning of a word.

The realization of the initial consonant sound in words like *charco* ‘puddle’ is visually distinct between the two groups of speakers. As hypothesized, *norteño* and central Mexican Spanish speakers in this study were expected to differ in their production of words beginning with <ch>. The visual exploration of the plot shows that *norteño* speakers in this study have two production modes for <ch>-beginning words. However, the great majority of the tokens for target items produced by Central Mexican Spanish speakers were produced in the affricate mode. Only a small portion of their tokens falls within the fricative mode, which contrasts with the production of fricative tokens by *norteño* speakers in this study. In other words, although participants in Santiago de Querétaro produce some fricative tokens when presented with words beginning with <ch>, the density of these productions is clearly smaller than that produced by participants in Hermosillo.

A predominantly unimodal production pattern is clear among central dialect speakers but the presence of the fricative in their speech is also observed. Because participants in Hermosillo have life-long experience with the variation that affects /tʃ/ and speakers in Santiago de Querétaro do not, it was expected that the latter would not produce the fricative variant in their speech. A possible explanation for these results may rely on the nature of the experimental task itself. Speakers' speech samples were collected by means of a sentence-repetition task. For this task, participants heard a series of sentences in which stimulus items were presented with both variants, the affricate and the fricative. That is, participants heard a word like *charco* 'puddle' embedded in the sentence "Diga _____ porque sí." ("Say _____ just because.") twice, one produced with the affricate variant ([ˈtʃarko]) and one with the fricative variant ([ˈʃarko]). This means that participants were given the opportunity to produce both or either one of the variants in their speech when repeating the sentence played; in other words, they had 50% chance of producing one variant or the other. The reason why one may observe fricative tokens in the speech by central dialect speakers may be due to the fact that the experimental task required participants to repeat what they had heard. It may be possible that production of fricatives by speakers in Santiago de Querétaro is the result of mere repetition of sentences containing the fricative variant. However, although participants heard the same number of phrases with both variants, contrary to speakers in Hermosillo, speakers in Santiago de Querétaro produced more affricate tokens than fricative ones.

The experimental task used in this study confirmed the presence of both variants in the speech by *norteño* speakers. It is unknown, nonetheless, whether the formality of the task may have affected their production. The great majority of participants in this study were college students at the time of testing. That is, *norteño* speakers in this study are highly educated, which

means they may have had expanded their *variant competence*. Jaramillo and Bills (1982) suggest that variant-competent speakers may opt to use one variant over the other based on the level of formality of the situation. Because of the nature of this task, it could be the case that some *norteño* speakers in this study use the affricate variant more than others and vice versa. Further analyses of the data are necessary to understand the effects of the task on the production of the two variants affecting /tʃ/ in their speech communities. In addition, this analysis should explore the correspondence between what participants heard and what they produced. This analysis would provide a better understanding of the speech by *norteño* speakers and the three possible routes of their production : a) a fricative token in production that matches the auditory stimulus containing the fricative variant; b) an affricate token matching the affricate variant presented in the stimulus; or c) a mismatch between the variant produced and the variant presented in the auditory stimulus. Finally, this analysis could reveal any inter- and/or intra-variability within this group of speakers.

The data obtained in this study could potentially contribute to the understanding of the acoustic profile of the variants of /tʃ/ in *norteño* dialect. Previous studies have claimed that the use of the fricative variant is the result of a fricativization process (Serrano Morales, 2000; 2009). Herreras Zendejas (2006), however, claims that *norteño* speakers may not produce true affricates but obstructed fricatives instead. The acoustic exploration of the affricate and fricative variants produced by the group of *norteño* speakers in this study could provide evidence that supports either one of these theoretical explanations. Furthermore, an acoustic analysis would allow the comparison between both groups' production. The results from this comparison would reveal any possible differences in the acoustic realization of the affricate and fricative variants by *norteño* and central dialect speakers and possibly the nature of these differences, as well.

2.6 CONCLUSION

The current preliminary study investigated the effects of native dialect experience on the production of L1 segments. More specifically, this study reported on the effects of experience (or lack of) with *shesheo* on the production of Spanish words beginning with <ch> by two groups of native speakers of Mexican Spanish who differ in their dialect experience. A group of central Mexican Spanish speakers was recruited in Santiago de Querétaro, Querétaro, where the local dialect—which also forms the standard Mexican dialect—only includes one variant of /tʃ/, the affricate, [tʃ]. A group of *norteño* speakers was recruited in Hermosillo, Sonora, where the local dialect includes both variants, the affricate, [tʃ], and the fricative, [ʃ]. A visual exploration of the data revealed that speakers in Hermosillo have two modes of production for <ch>-beginning words, an affricate and a fricative mode, which is absent in the speech by central dialect speakers. These results confirm that under identical laboratory conditions, people from Hermosillo, as expected, are more likely to produce postalveolar fricatives than people from Santiago de Querétaro.

CHAPTER 3

SPOKEN WORD RECOGNITION IN THE NATIVE LANGUAGE

3.1 INTRODUCTION

In the Spanish spoken by some communities in Sonora, a state located in the northwestern region of Mexico, the word-initial consonant in words such as *charco* ‘puddle’ undergoes a process of phonetic variation. In most dialects of Spanish, including those found in Mexico, the initial sound in *charco* is produced as a postalveolar affricate, [tʃ]. Speakers of Sonoran Mexican Spanish, however, may produce this consonant either as a postalveolar affricate, [tʃ], or as a postalveolar fricative, [ʃ]. That is, Sonoran speakers are likely to produce words like *charco* as both [ˈtʃarko] and [ˈʃarko] in their day-to-day speech; the practice of the use of [ʃ] as variant of /tʃ/ is a process known as *shesheo* (Méndez, 2017). In fact, the pronunciation of words like *charco* as [ˈʃarko] has been identified as a distinctive feature of this particular dialect, known in Mexico as *norteño* ‘northern’ accent (Serrano Morales, 2009). The phonetic variation that affects /tʃ/ in northwestern states, such as Sonora, has been used to geographically identify and demarcate the different dialects spoken in Mexico (Lope Blanch, 1990-2000; Martín Butragueño, 2009, 2011, 2014; Moreno de Alba, 1994; Serrano Morales, 2000, 2009). This study investigates the effects of sociophonetic variation on the patterns of spoken word recognition.

In addition to its presence in northwestern states in Mexico, *shesheo* has also been observed (although less frequently) in western states such as Colima, Jalisco, and Michoacán (cf. Moreno de Alba, 1994, p. 122 map 37). It is important to note, nonetheless, that *shesheo* is a process that has also been found in the speech of other Spanish-speaking communities around the world, including South and Central America (Cedergren, 1973; Quintanilla-Aguilar, 2013), the Caribbean (Fails, 1984; Quilis & Vaquero, 1973; Vaquero, 1972), and the Southern Iberian

peninsula (Melguizo Moreno, 2007). Spanish varieties in which *shesheo* occurs, such as *norteño* dialect, demonstrate that this process is a variable phenomenon, for its speakers are likely to use and accept both [tʃ] and [ʃ] as possible variants of /tʃ/ (Alessi Molina & Torres Díaz, 1994; Brown, 1989; Carreón Serna, 2007; López Velarde & Simonet, 2019; Méndez, 2017). The present study is concerned with the variation that affects /tʃ/ and the effect direct life-long experience with it may have on the patterns of word recognition. More specifically, this investigation explores whether *norteño* Mexican Spanish speakers, who are recurrently exposed to the variation that affects /tʃ/ differ from speakers who lack experience with *shesheo* in their patterns of recognition of written forms. This study addresses this question by means of a lexical decision task. The specific research questions of this investigation are: i) How does the phonetic variant presented in the prime affect the recognition of target words? ii) Do recognition patterns differ as a function of life-long, linguistic experience?

3.1.1 SHESHEO AND NORTEÑO MEXICAN SPANISH

Multiple variants of /tʃ/ have been identified across dialectology studies (Lope Blanch, 1990-2000; Martín Butragueño, 2009; Moreno de Alba, 1994). In fact, the number of variants may range from two to up to 13. According to the descriptions provided in such studies, these variants can be distinguished from one another as a function of manner (e.g. affricate, affricate with long obstruction, affricate with brief obstruction, fricative) and place (e.g. dentoalveolar, alveopalatal, fronted postalveolar, postalveolar, backed postalveolar) of articulation. Most studies, however, restrict this distinction to two variants, an affricate, [tʃ], and a fricative, [ʃ] (Brown, 1989; Carreón Serna, 2007; Casillas, 2012; Jaramillo & Bills, 1982; Méndez, 2017; Serrano Morales, 2002); the practice of restricting these two categories to a two-way distinction is adopted in this dissertation.

Previous investigations concerned with the variability that affects /tʃ/ across various Spanish varieties have demonstrated that both the affricate and the fricative variants find themselves in a context of “free” variation. That is, the use of one variant over the other by members of these communities does not obey a phonological rule¹. The results from these studies, however, have shed light on a set of linguistic and extra-linguistic factors that may account for this variability. Only a handful of studies have addressed the use of [ʃ] as variant of /tʃ/ in *norteño* dialect; data for these studies have been collected in the Mexican states of Sonora (Alessi Molina & Torres Díaz, 1994; Brown, 1989) and Chihuahua (Amastae, 1996; Carreón Serna, 2007; Méndez, 2017). There have been three additional studies that have investigated this phenomenon in the Spanish spoken in the Southwest of the United States; more particularly, these investigations have explored *shesheo* in the Spanish-speaking communities of Tucson, Arizona (Casillas, 2012) and Tomé, New Mexico (Jaramillo, 1986; Jaramillo & Bills, 1982). The investigations conducted in the Southwest of the United States confirm the dialectal continuity across the border that results from the geographical closeness and the linguistic similarities found among some of the communities located in the border region (Post, 1934).

Phonetic context has emerged as a strong predictor for the use of [ʃ] as variant of /tʃ/ by speakers of these communities. The studies concerned with the variation that affects /tʃ/ have consistently found that, when in between vowels, *norteño* speakers are more likely to produce the fricative variant than the affricate (Alessi Molina & Torres Díaz, 1994; Brown, 1989; Jaramillo & Bills, 1982; Méndez, 2017). The fact that [ʃ] is more prone to surface in intervocalic

¹ Although some investigations have suggested that phonetic context is a strong predictor in the production of one variant over the other, the results of these studies vary in their reported rates of variant use as a function of the specific phonetic context in which they appear. Thus, the use of the term “free variation” in this chapter is to be understood from a phonological perspective and not from a traditional sociolinguistic view. Due to the lack of conclusive results regarding the effects of phonetic context on the triggering of one variant over the other, in this study, *shesheo* is a variation process that has yet to be explored in relation to its behavior when in contact with other sounds.

position—the affricate variants are typically produced after a consonant—has led to the perception of this variant as a lenited or reduced version of the affricate (Herrera Zendejas, 2006; Moreno de Alba, 1994). The claim that the fricative is as a reduced version of /tʃ/ is rooted in the weakening process that affects the Spanish set of voiced stops /b d g/. When produced in postconsonantal position, particularly after /n/ and /l/, Spanish /b d g/ retain their obstruction. This, however, is not true when found in other phonetic contexts, which trigger a lenited version of these, [β ð ɣ], respectively (see Hualde, 2005). In a study with instrumental data, Herrera Zendejas (2006) explored the variation that affects /tʃ/ and observed that her two *norteño* speakers did not produce “real” affricates but “more obstructed” fricatives, especially when produced after /n/ and /l/. Her claim is founded on the fact that both participants in her study produced softer and shorter “affricates” than those a speaker of central Mexican Spanish would produce; that is, the two *norteño* speakers in her study produced fricatives by default that were more obstructed as a result of full-contact inertia after an homorganic consonant.

Age, level of education (years of formal schooling), and gender have been identified as significant extra-linguistic factors that modulate the variants of /tʃ/. Many of these investigations have distinguished between men and women for the analysis of the production of /tʃ/ as the alveopalatal fricative. A few of these studies have suggested that women favor the fricative variants in their speech more often than men (Amastae, 1996; Brown, 1989; Cedergren, 1973; Serrano Morales, 2000). For example, in the first investigation exploring the variability that affects /tʃ/ in Ciudad Juárez, Chihuahua, Amastae (1996) found that women presented the highest level of production of the fricative variant. In a replication of Amastae’s study 20 years later, Mendez (2017) observed, instead, that male speakers favored the use of the fricative variant in their speech. Moreover, age has been found to play a significant role in the use of [ʃ] as

a variant of /tʃ/ with some results revealing that the fricative variant is more likely to surface in the speech by older speakers than younger ones (Alessi Molina & Torres Díaz, 1994; Carreón Serna, 2007; 2017). In addition, individuals with less years of formal schooling have been observed to favor the use of [ʃ] in their speech as opposed to people with higher levels of formal education (Carreón Serna, 2007). It is important to note, however, that years of schooling and age are highly correlated in these communities, with younger individuals being more likely to have received more years of exposure to formal education than older members of the community. According to Jaramillo and Bills (1982), having received more years of schooling allows individuals to expand their *variant competence*. By this, the authors suggest that younger and more educated speakers with higher levels of education may opt to use the affricate variant when in more formal situations, where the standard form is expected, such as when interviewed by linguists. If preferred, nonetheless, these speakers may opt for the use of fricative variants in informal contexts, such as when talking to friends and relatives, where non-standard forms are more likely to surface. This may not be true for speakers who are not highly variant competent; that is, older and less educated speakers may use the fricative variants more frequently, regardless of the formality of the context.

The reported rates of the use of the fricative variant over the affricate in these communities vary significantly from study to study. Some of these investigations reveal that the use of [ʃ] is more likely to appear in their participants' speech whereas others report speakers favor the use of [tʃ] instead. Brown's results revealed that the fricative variants appeared in the speech of 81% of her participants when in between vowels. The results found by Mendez, however, show that fricative variants only account for 33% of the overall variability in his participants' speech. Regardless of the variation found in the results presented in this study, one

may certainly affirm that members of these communities are recurrently exposed to the variation that affects /tʃ/. As a result, individuals with exposure to this variation have acquired linguistic experience with *shesheo*, which members of other communities may lack. Can linguistic experience impact the patterns of word recognition? If this is the case, would people who have long been exposed to the use of two variants differ in their pattern of word recognition from people with no previous experience with this variability?

3.1.2 PHONETIC VARIATION AND SPOKEN WORD RECOGNITION

The phonetic variability that affects the production of words—resulting in multiple pronunciation variants for each word—is not only triggered by various sources such as individuals' own speech patterns but also by conventionalized phonological processes. In some varieties of Spanish, for instance, when in coda position, /s/ undergoes a process of debuccalization that results in a reduced form of this sound. This leads to a two-way phonetic distinction between a full form and other reduced forms. The process of variability affecting /tʃ/—the use of the full form, [tʃ], or the reduced form, [ʃ]—found in the speech by members of some communities located in northern Mexico, is the result of a conventionalized phonological process.

The effects of conventionalized phonetic variation on spoken word recognition and the phonological representations on the mental lexicon have been addressed by several studies. These investigations have mainly focused on specific processes of variation that occur in English, including /t/ and /d/ tapping (Connine, 2004; McLennan, Luce, & Charles-Luce 2003), word final /t/ and /d/ glottalization (Deelman & Connine, 2001; Sumner & Samuel, 2005), /t/ post-nasal deletion (Pitt, 2009; Ranbom & Connine, 2007), and schwa deletion (Connine et al., 2008; LoCasto & Connine, 2002). These studies have collectively explored the effects (if any) of

reduced and full forms on the successful recognition of spoken words. Most such studies have investigated these effects by means of lexical decision tasks employing the priming paradigm. Some of these, in turn, have designed short-term or immediate priming (Deelman & Connine, 2001; LoCasto & Connine, 2002; McLennan et al., 2003; Ranbom & Connine, 2007; Sumner & Samuel, 2005, 2009), whereas others have used long-term form priming² (McLennan et al., 2003; Sumner & Samuel, 2005, 2009). Despite the similarities regarding the methodological approaches adopted by these studies, their results are contradictory.

The evidence obtained from investigations employing both short-term and long-term priming differs significantly. Studies that explored long-term effects have consistently found that full forms are usually retained in memory in better detail and longer, even when these forms are less frequent than reduced forms found in day-to-day speech (Sumner, Kim, King & McGowan 2014; Sumner & Samuel, 2005, 2009). These studies have suggested that full forms seem to be privileged over reduced forms in the mental representation of words. Results from short-term priming experiments, however, have not yielded to such uniform conclusions. In fact, these studies have led to three possible directions for such results: i) full forms are more effective at tapping into lexical representations (LoCasto & Connine, 2002; Pitt, 2009; Ranbom & Connine, 2007); ii) reduced forms—typically the most frequent forms in daily speech—show a processing advantage (Connine, 2004; Connine et al., 2008); and iii) all word variants, including full and reduced forms, are equally effective in the recognition of spoken words (Deelman & Connine, 2001; McLennan et al., 2003; Sumner & Samuel, 2005, 2009). The evidence collected by these

² Lexical decision tasks that employ immediate priming are designed to present the target almost immediately after the prime has been shown; in other words, the latency between the prime and the target is typically around or below one second to reduce the all possible acoustic information between two stimuli. In contrast, studies that use short-term priming allow for a relatively low latency, which is typically a few minutes, and include other auditory stimuli between the two key stimuli. Opposite to lexical decision tasks with immediate and short-term priming, experiments that include long-term priming include a higher latency—that could range from 30 minutes to up to a few days—and present the listener with other auditory stimuli between the prime and the target.

investigations reveals a lack of consensus regarding phonetic variation and its effects on the patterns of word recognition.

The examples presented next demonstrate the advantage found for full forms over reduced forms by previous studies employing short-term priming. In American English, words like center have two possible pronunciations: one with a full production of the sequence [nt] (as in ce[nt]er), or another with a reduction of the /nt/ sequence where /t/ is not produced (as in ce[n̩]er). In a study employing a single-presentation auditory lexical decision task, Pitt (2009) finds an advantage for full forms (ce[nt]er) over reduced forms, even when the latter are more frequently found in daily speech. Similarly, Ranbom and Connine (2007) show that reduced forms (ce[n̩]er) delay the recognition of spoken words. These results support the claim that full forms tap into the mental representation of words forms more effectively than reduced forms. It is important to note that reduced forms, such as ce[n̩]er, although more common in daily speech, seem to delay recognition.

The findings from a few studies concerned with the variation that affects English /t/ in word final position have revealed that reduced forms can also facilitate word recognition. In American English, word-final /t/ has at least three possible variants: released, unreleased, and glottalized. By means of a cross-modal semantic priming task, Deelman and Connine (2001) observed that both released and unreleased forms presented in the auditory primes equally facilitated the recognition of visual words. Correspondingly, Sumner and Samuel (2005) found that all three variants of word-final /t/ yielded the same amount of associative priming facilitating spoken word recognition. In a study employing short-term, auditory form priming, McLennan et al. (2003) also found an advantage on lexical processing for reduced forms (bu[r]er vs. bu[t]er), demonstrating that, regardless of the fact that only the reduced form (bu[r]er) is common in daily

speech, the two variants of American English word-medial /t/ successfully activate the mental representation of this word form. These results suggest that reduced forms can also facilitate the recognition of spoken words.

Studies employing long-term and short-term priming reveal a discrepancy in their results. Long-term priming studies suggest that full, canonical forms are privileged in the mental lexicon (Sumner & Samuel, 2005, 2009). It is unclear, however, why highly-frequent phonetic variants found in daily and spontaneous speech do not seem to be privileged in mental representations of words (Sumner et al., 2014). A central issue in the debate of phonetic variability and its effects on spoken word recognition remains the explanation as to whether all word variants, reduced and full forms, are equally effective at tapping into lexical representations in the recognition of spoken words.

3.1.3 SPOKEN WORD RECOGNITION AND *SHESEHO* IN *NORTEÑO* DIALECT

The conventionalized phonetic variation that affects /tʃ/ in *norteño* Mexican Spanish has proven to also affect listeners' patterns of spoken word recognition. By means of an auditory lexical decision task, my collaborator and I (2019) investigated the effects of life-long experience with both variants, the affricate and the fricative, on the recognition of words by members of this community. We designed an auditory, lexical decision task with immediate form priming in which target words were presented with either variant as their word-initial consonant (e.g., [tʃ]arco ~ [ʃ]arco), and they were preceded by primes with a matching variant ([tʃ]arco-[tʃ]arco, [ʃ]arco-[ʃ]arco), a mismatching variant ([tʃ]arco-[ʃ]arco, [ʃ]arco-[tʃ]arco), or an unrelated prime. Our results revealed that *norteño* listeners are equally likely to accept Spanish word forms produced with either variant of /tʃ/, the affricate or the fricative. In other words, these listeners accept both variants as possible lexical forms in their Spanish variety. It was also observed that

both variants equally facilitate the efficient recognition of spoken words (that is, ['ʃarko] primes ['tʃarko] as much as ['tʃarko] does); these results suggest both variants are stored within the same representation of the Spanish word form in the mental lexicon by *norteño* listeners. A processing advantage was observed, however, for the affricate variant, [tʃ], which suggests a privilege of [tʃ] over [ʃ] at some level of representation; these results, in turn, support the claim that full forms—or prestigious forms—are privileged over reduced forms in abstract representations of mental word forms. In addition, our results confirmed that speakers with life-long exposure to the sociophonetic variation that affects /tʃ/ have included the variants of /tʃ/ found in their dialect as allophones of the same phoneme. This, in turn, suggests that *norteño* listeners may store more than one phonetic variant in their mental representation of words; that is, sociophonetic variation in an individual's speech community affects the nature of phonological representations in their mental lexicon.

3.1.4 THE PRESENT STUDY

The present study is concerned with the sociophonetic variation that affects /tʃ/ in *norteño* dialect and its effects (if any) on the patterns of word recognition. In this dialect, /tʃ/ undergoes a process of conventionalized phonetic variation, which results in two possible variants for the production of this phoneme, an affricate, [tʃ], and a fricative variant, [ʃ]. This study, thus, investigates: a) the effects of *shesheo* on the patterns of word recognition by speakers with life-long experience with this variability, and b) whether *norteño* listeners differ from a group of central Mexican Spanish speakers—with no reported experience with *shesheo*—, in their lexical processing of written Spanish words. By means of a cross-modal, lexical decision task with immediate priming, the present study explored the patterns of word recognition of Spanish word forms—preceded by primes with either one of the two variants as the initial sound—by both

groups of listeners, *norteño* and central Mexican Spanish. The main research questions for this study are as follows: 1) How does linguistic experience affect the patterns of word recognition by these two groups of listeners? and 2) are both variants of /tʃ/ equally effective at tapping into lexical representations in the mental lexicon of individuals with different linguistic experiences? It is hypothesized that the affricate variant will facilitate lexical activation for both groups of listeners. In addition, because of their extensive experience with *shesheo*, facilitation from the fricative variant is expected to be observed in the patterns of words recognition by *norteño* speakers. Facilitation from the fricative variant is not expected for central dialect speakers due to their lack of experience with *shesheo*. It is unknown, however, whether both variants will facilitate recognition equally effectively for listeners in both groups.

3.2 METHODS

3.2.1 PARTICIPANTS

Two groups of listeners of Mexican Spanish participated in this study, one group of speakers of *norteño* and one group of speakers of central Mexican Spanish. Participants in the *norteño* group were tested in Hermosillo, the capital city of the state of Sonora. The group of speakers of central dialect were tested in the city of Santiago de Querétaro, the capital of the state of Querétaro. Participants recruited in Hermosillo reported to be life-long residents of the state of Sonora. The great majority of participants in this group were natives to Hermosillo; participants that were born in different municipalities of the state reported to have relocated to Hermosillo earlier in life. Similarly, most participants recruited in Querétaro were born in the city of Santiago de Querétaro. Individuals in this group who were not natives of Querétaro were born in other central states of the country, including Guanajuato, Jalisco, Morelos, and Puebla, and relocated to

Santiago de Querétaro with their families prior to adulthood. The central region of Mexico is integrated by the states located in the central highlands. For this reason, this geographical zone is treated as one dialectal region regarding the production of /tʃ/—including the realization of many other sounds—, by speakers that comprise the communities native to this region. Sonora and Querétaro are two states located in two different geographical zones of Mexico, the northwest and the central highlands, respectively. According to their geographic location and, most importantly, their treatment of the production of /tʃ/, these two states represent, in fact, two different dialectal regions of Mexico. It is assumed, then, that: a) participants that integrate the Hermosillo group are speakers of *norteño* dialect themselves and have ample experience with *shesheo*, and b) participants recruited in Santiago de Querétaro lack experience with the variability that affects /tʃ/.

A total of 68 participants were recruited for participation in the lexical decision task. The age of participants ranged from 18 to 43. Except for one participant, all individuals in this study were undergraduate or graduate students at the time of testing. Since participants in this investigation share a similar profile in education—most of them have attained higher levels of education—, this sample is not fully representative of the population that integrates the speaking communities of these two dialectal regions. Participants were recruited in Hermosillo and Santiago de Querétaro. Prior to the completion of the experiment, the researcher, a native of Hermosillo, conducted a brief conversation in Spanish with each participant. In Hermosillo, the experimental task was conducted in a quiet library room at *Universidad Sonora*, whereas participants in Santiago de Querétaro completed the task in a sound-attenuated booth at *Universidad Autónoma de Querétaro*.

3.2.2 MATERIALS

The lexical access experiment in this study consisted of a cross-modal, lexical decision task with immediate auditory priming. In this task, participants were asked to decide, as accurately and rapidly as possible, whether the rendering of written words and nonwords presented to them on the screen was an actual word in Spanish or not. For this experimental task, target words and nonwords were presented in written form. All targets, words and nonwords, were preceded by auditory primes. Listeners were instructed to focus on the targets presented on the screen and to indicate their decision by pressing a key button. The main dependent variable in this study was the time of latency between the presentation of the target and the key press indicating the participant's lexical decisions.

The materials included 24 target words, for which the first consonant was <ch> and was located in word-initial position. The following segment for all target words was the Spanish vowel <a>—the written sequence <cha> is more frequent than the sequence <ch{e,i,o,u}> in Spanish as revealed by a dictionary search. The 24 target items were comprised by two- and three-syllable with stress in either the first or second syllable. The list of the 24 stimulus items is provided in APPENDIX B (including the glossing for all target items).

An additional set of 24 target words beginning with the sequence <sa> were included. The 24 target lemmas beginning with <s> shared the same stress and syllabic structure of the 24 critical items beginning with <cha>. All 24 target words beginning with <s> were included in the control condition. In addition, 144 filler items were included in the design. Fillers consisted on 48 real words and 96 nonwords. 36 of these fillers were <cha>-word initial items; filler items beginning with <cha> were included so not only real-word targets included this sequence, which could have an effect on the results.

For the lexical task in this study, each trial consisted in the visual presentation of a written target item preceded by a prime in auditory form. There were two types of primes that preceded the 24 critical target items: identical and unrelated primes. Four versions of each prime word were created, corresponding to the two experimental conditions. In the first condition, stimuli used as primes were produced with either the affricate, [tʃ], or the fricative variant, [ʃ]. That is, in the related condition, a critical target word such as *CHARCO* ('puddle') could be preceded by either [tʃ]arco or [ʃ]arco. For the stimuli used in the unrelated condition, critical target items could be preceded by primes whose initial sound was either [s] or [ts]. For example, *CHARCO* could be preceded by either [s]arco or [ts]arco. Unrelated primes were created by switching the initial sequence of the critical target words for either [s] or [ts].

Four counterbalanced lists were created with equal numbers of items considering each one of the four possible initial priming sounds ([tʃ], [ʃ], [s], [ts]). No prime or target item (including variants) was repeated within each list, for each list to include only one condition for each target lexical item. Each list included 12 critical pair combinations ([tʃ]arco - *CHARCO*, [ʃ]arco - *CHARCO*) and 12 unrelated control pairs ([s]arco - *CHARCO*, [ts]arco - *CHARCO*). In addition to the 24 critical and control pairs, 168 filler pairs were included. Control items consisted of 24 noncritical target words beginning with <s>, 48 real-word targets, and 96 nonword targets. The same pattern adopted for the 24 critical items was employed to create the unrelated primes preceding the 24 noncritical target words. That is, all 24 target words beginning with <s> were preceded by identical and unrelated primes, which their initial sound was either [ʃ], [tʃ], [s] or [ts]. Furthermore, of the 48 real words used as fillers, 36 were preceded by real-word primes—half of them were identical and half of them were unrelated—, and 16 of them were preceded by nonword primes. Of the 96 nonword fillers 32 were preceded by real-word

primes, and 64 were preceded by nonword primes—half of them were identical and half of them were unrelated.

3.2.3 RECORDINGS

The stimuli consisted of naturally-produced instances recorded by the researcher, who is a native speaker of *norteño* dialect and trained linguist. The talker’s productions of the stimuli were recorded in a sound-treated booth at the University of Arizona with a Shure SM10A head-mounted, dynamic microphone and a Sound Devices USBPre2 audio interface connected to a laptop computer running Praat (Boersma, 2001). The recordings were digitized at 44.1 kHz sampling rate and a 16-bit quantization.

All items used as part of the stimuli in this experiment were embedded in a constant carrier phrase and appeared in initial position, “__ es la palabra.” (__ is the word.). Each item was produced individually—one word per carrier sentence—by the speaker. In addition, all prime words to be paired with the 24 critical target words (those beginning with <cha>) and the 24 noncritical target words (those beginning with <s>) were produced by the speaker in their four versions ([tʃ], [ʃ], [s], and [ts]). As a trained linguist, the speaker is able to produce both [tʃ] and [ʃ] without difficulty. The speaker produced all lexical items three times (48 tokens × 4 versions × 3 iterations × 1 talker = 576 items). One token of each prime to be paired with either a critical or a noncritical target word was selected (avoiding disfluencies and any extraneous noise) for a total of four primes stimuli per target lexical item. Each one of the chosen auditory stimuli was saved as an individual sound file, and all individual sound files were then normalized for intensity using Vocal Toolkit (Corretge, 2019), a free plugin for Praat.

3.2.4 PROCEDURE

Participants completed the lexical decision task individually. Participants in Santiago de Querétaro were tested in a sound-attenuated room, and participants in Hermosillo were tested in a quiet library room. In a cross-modal, lexical decision task, stimuli are presented in both auditory and written form. For this task, auditory stimuli were presented, at a comfortable listening level, over a set of Audio Technica ATH-M50x closed-circumaural headphones connected to a laptop computer running PsychoPy2.

In each trial, participants were presented with an auditory prime immediately followed by a written target. They were asked to respond as quickly and accurately as possible by pressing the key ‘m’ (real word) or ‘z’ (nonword) in a Logitech G512 Lightsync RGB mechanical gaming keyboard³. Trials began by showing a red cross in the center of the screen for 500 ms, which was followed by the auditory presentation of the prime. Visual stimuli were displayed in the center of the screen in capital letters 500 ms after the onset of each auditory stimulus. Participants were allotted 2 s to enter a response. If participants did not provide a response within the allotted time, a new trial began. Prior to the completion of the experimental tasks, the researcher welcomed the participants to the testing room and provided them with a general description of the task.

3.3 ANALYSIS

All statistical analyses were run in *R* (R Development Core Team, 2016), with packages *tidyverse* (Wickham, 2017), *afex* (Singman et al., 2018), and *effsize* (Torchiano, 2018). Response latencies faster than 250 ms or slower than 1,500 ms were excluded from all analyses. The

³ A mechanical gaming board was selected over other response boxes since for the high-sensibility of key press that can accurately capture response times.

analysis was then conducted without such trials and using a data set containing observations from 68 participants, 34 from Sonora and 34 from Querétaro.

The analysis for the lexical decision task in this study was conducted in four steps. In the first preliminary analysis, the proportion of correct responses and average response times per participant in each group were obtained as a function of word lexicality (real words vs. nonwords). In order to prepare the data for the statistical analysis, data percentages were arcsine-transformed to normalize the variation within the data. In the second preliminary analysis, only real word fillers were selected. Reaction times on real word fillers were then examined as a function of prime condition (identical and unrelated). Place of origin (Hermosillo, Santiago de Querétaro) was also analyzed to observe any possible effects. For the third preliminary analysis, the subset of all real word targets beginning with <s> was selected. Reaction times to correct responses for words that begin with <s> were analyzed as a function of the initial sound of the prime ([s], [ts], [tʃ], and [ʃ]) and place of origin (Hermosillo, Santiago de Querétaro).

The fourth, and most crucial, analysis of this study consisted in analyzing the latency data on the critical, real-word target items; that is, real words beginning with <ch>. Only reaction times to correct responses on items beginning with <ch> were analyzed. The analysis included two predictors: a) type of priming ([s], [ts], [tʃ], and [ʃ]), and b) place of origin (Hermosillo, Santiago de Querétaro).

3.4 RESULTS

3.4.1 RECOGNITION RATES

The analysis on recognition rates focuses on the proportion of times a participant succeeded in the recognition of real words and nonwords. The analysis was conducted only on data from 68

participants, 34 from Sonora and 34 from Querétaro, with at least an 85% average of correct responses. It was decided that overall error rates above 15% could indicate that a participant was not engaged with the task or could have misunderstood the instructions for the successful completion of the task. For this analysis, means and standard deviations are also reported.

The arcsine-transformed accuracy scores are analyzed with a mixed-design, two-way $2 \times (2)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Target type (real word, nonword) as within-subjects factor. The ANOVA yielded no main effects of Location, $F(1,66) = 2.08, p < .15, \eta^2 = .02$, or Target type, $F(1,66) = 1.14, p < .29, \eta^2 = .009$, for accuracy scores. In other words, as shown in Table 3.1, participants in Hermosillo were similarly accurate at recognizing real words ($M = 0.94 [\pm 0.039]$) and nonwords ($M = 0.95 [\pm 0.060]$) to participants in Santiago de Querétaro when recognizing words ($M = 0.94 [\pm 0.038]$) and nonwords ($M = 0.94 [\pm 0.044]$). The two-way interaction did not reach significance, $F(1,66) = 0.48, p < .49, \eta^2 = .004$. In sum, an analysis of the word-acceptability data reveals that participants from Hermosillo and Santiago de Querétaro are equally likely to accurately recognize real words and nonwords in Spanish.

Table 1. Means (M) and standard deviations (SD) for reaction times in milliseconds on real words and nonwords, further broken down by participants region of origin in Mexico, (Hermosillo, Santiago de Querétaro).

	Real Words		Nonwords	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Hermosillo	944	039	949	060
Santiago de Querétaro	941	037	940	044

3.4.2 RESPONSE LATENCIES

The study of the response time data focused on correct responses by the 64 participants. Response times were transformed into logarithms to normalize the distribution of the data—reaction times presented in the tables are reported in milliseconds, as these are more easily interpretable. Response latencies were analyzed in four different steps: three preliminary analyses and a final analysis.

In the first preliminary analysis, logarithm-transformed response times were examined with respect to lexicality of target. A mixed-design, two-way $2 \times (2)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Target type (real word, nonword) as within-subjects factor yielded a significant effect of Target type, $F(1,66) = 268.36$, $p < .0001$, $\eta^2 = .41$, but not of Location, $F(1,66) = 1.19$, $p < .28$, $\eta^2 = .01$. No significant interaction between Location and Target type was found, $F(1,66) = 0.24$, $p < .62$, $\eta^2 = .0006$. The main effect of Target type is due to the fact that response times were longer when recognizing nonwords than when recognizing real words in Spanish, with a mean difference of 153 ms. The results from the first preliminary analysis confirmed the success of the experimental task at tapping into the participants' lexicon.

In the second preliminary analysis, response latencies for only real word fillers are selected. The logarithm-transformed response times are analyzed with a mixed-design, two-way $2 \times (2)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Condition of prime (identical, unrelated) as within-subjects factor. The ANOVA yielded a significant effect of Condition of prime, $F(1,66) = 376.26, p < .0001, \eta^2 = .44$, but not of Location, $F(1,66) = 3.57, p < .06, \eta^2 = .04$. There was no significant interaction between Location and Condition of prime, $F(1,66) = 0.10, p < .75, \eta^2 = .0002$. The main effect of Condition of prime is due to the fact that real word fillers that are preceded by identical primes are recognized more quickly than real word fillers preceded by unrelated primes, with a mean difference of 143 ms. The results from this second preliminary analysis confirm the validity of the task and its ability to tap into the lexicon of the participants.

For the third preliminary analysis, response latencies for real word targets beginning with <s> were examined with respect to the initial sound of the primes. A mixed-design, two-way $2 \times (4)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Prime sound ([s], [ts], [tʃ], and [ʃ]) as within-subjects factor yielded a main effect of Prime sound, $F(2.89, 190.81) = 7.79, p < .0001, \eta^2 = .05$, but not of Location, $F(1,66) = 0.24, p < .62, \eta^2 = .002$. No significant two-way interaction between Location and Prime sound was found, $F(2.89, 190.81) = 1.75, p < .16, \eta^2 = .01$. To investigate the main effect of Prime sound, the data on response latencies is divided into three subsets as a function of Prime sound. Since three *t*-tests are to be used, the α criterion is adjusted, $.05/3 = .0166$. The results reveal that primes beginning with either [tʃ] and [ʃ], and [ts] behave differently from those beginning with [s]: [tʃ], $t(67) = -3.98, p < .0166 [.0001], 95\% \text{ c.i. } [-.114, -.037]$; [ʃ], $t(67) = -4.48, p < .0166 [.000002], 95\% \text{ c.i. } [-.137, -.052]$. It is important to note that the difference is much small for prime items

beginning with [ts], $t(67) = -2.16, p > .0166$ [.033], 95% c.i. [-.083, -.003]. In other words, the effect size produced by primes whose initial sound is not [s] is different from that produced by primes whose initial sound is [s]. These results are further described in Table 3.2 as they are presented as a function of place of origin. Although different from [s]-beginning primes, it is unknown, however, whether the effect size produced by primes beginning with either [tʃ], [ʃ], or [ts] is different from each other.

Table 2. Means (M) and standard deviations (SD) for reaction times in milliseconds on target words beginning with <s>, further broken down by participants region of origin in Mexico, (Hermosillo, Santiago de Querétaro) and initial sound of prime item (beginning sound of prime is shown in square brackets).

	Hermosillo		Santiago de Querétaro	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
[s]	639	97	630	101
[ts]	685	126	646	103
[ʃ]	713	128	689	122
[tʃ]	672	107	702	131

An additional mixed-designed, two-way $2 \times (3)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Condition of prime ([s]-[ts] – [s]-[ʃ], ([s]-[ts] – [s]-[tʃ]), ([s]-[tʃ] – [s]-[ʃ])) as within-subjects factor was conducted. The ANOVA did not reveal main effects of Location, $F(1, 66) = 0.00, p < .97, \eta^2 = .0001$, or Condition of prime, $F(1.96, 129.30) = 2.80, p < .07, \eta^2 = .02$. The two-way interaction between Location and Condition of prime did not reach significance either, $F(1.96, 129.30) = 2.42, p < .09, \eta^2 = .01$. The results confirm no differences of effect size produced between the differences found between target-prime pairs. That is, although the effect size produced by prime items whose initial sound is not [s] differs from that produced by primes beginning with [s], no differences in

the effect size produced between these pairs was found. The results are presented in Table 3.3 as a function of participants' place of origin.

Table 3. Means and Confidence Intervals of the differences of effect size of priming pairs for words beginning with <s>, further broken down by participants' region of origin in Mexico, Hermosillo, Santiago de Querétaro).

	Hermosillo		Santiago de Querétaro	
	<i>M</i>	<i>CI</i>	<i>M</i>	<i>CI</i>
([s]-[ts] – [s]-[ʃ])	-27.80	[-83.41, 27.81]	-42.47	[-80.82, -4.12]
([s]-[ts] – [s]-[tʃ])	12.50	[-28.17, 53.19]	-55.62	[-98.15, -13.10]
([s]-[tʃ] – [s]-[ʃ])	-40.31	[-83.61, 2.99]	13.15	[-25.49, 51.80]

In the final analysis, critical target items—real words beginning with <ch>—were examined as a function of Prime sound. A mixed-design, two-way $2 \times (4)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Prime sound ([s], [ts], [tʃ], and [ʃ]) as within-subjects factor yielded a significant effect of Prime sound, $F(2.56, 169.25) = 47.62, p < .0001, \eta^2 = .20$, but not of Location, $F(1, 66) = 1.19, p < .28, \eta^2 = .01$. The two-way interaction between Location and Prime sound did not reach significance, $F(2.56, 169.25) = 1.01, p < .38, \eta^2 = .005$. To investigate the main effect of Prime sound, a battery of paired *t*-tests is conducted, and the data is divided into three subsets as a function of Prime sound. Since three *t*-tests are to be used, the α criterion is adjusted, $.05/3 = .0166$. The results reveal that primes beginning with either [ʃ], [s], and [ts] behave differently from those beginning with [tʃ]: [ʃ], $t(67) = -2.53, p < .0166$ [.0135], 95% c.i. [-.084, -.010]; [s], $t(67) = -8.68, p < .0166$ [.0001], 95% c.i. [-.252, -.157]; [ts], $t(67) = -8.40, p < .0166$ [.0001], 95% c.i. [-.206, -.126].

These results are further broken down and presented in Table 3.4 as a function of place of origin.

Table 4. Means and Standard Deviations for reaction times in milliseconds on target words beginning with <ch>, further broken down by participants region of origin in Mexico, (Hermosillo, Santiago de Querétaro) and initial sound of prime item (beginning sound of prime is shown square brackets).

	Hermosillo		Santiago de Querétaro	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
[tʃ]	643	101	598	93
[ʃ]	658	112	649	131
[s]	763	100	763	157
[ts]	749	116	722	153

The prime effect produced by prime items beginning with [ʃ], [s], and [ts] is different from the prime effect produced by [tʃ]-beginning prime items preceding target words whose initial consonant is <ch>. However, it is unknown whether the effect size produced by each prime sound is different from each other. In order to further explore the differences in the size of the effect between pairs, an additional mixed-designed, two-way $2 \times (3)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as between-subjects factor, and Condition of prime (([tʃ]-[ʃ] – [tʃ]-[s]); ([tʃ]-[ʃ] – [tʃ]-[ts]); ([tʃ]-[ts] – [tʃ]-[s])) was conducted. The ANOVA yielded a significant main effect of Prime condition, $F(1.77, 117.09) = 37.77, p < .0001, \eta^2 = .14$, but not of Location, $F(1, 66) = 1.81, p < .18, \eta^2 = .02$. The interaction between Location and Condition of prime did not reach significance, $F(1.77, 117.09) = 0.49, p < .59, \eta^2 = .002$. To explore the main effect of Condition of prime, an additional set of three *t*-tests was conducted between sets of pairs (([tʃ]-[ʃ] – [tʃ]-[s]); ([tʃ]-[ʃ] – [tʃ]-[ts]); ([tʃ]-[ts] – [tʃ]-[s])). As shown in Figure 3.2, the follow-up analysis consisted in the conduction of a set of *t*-tests designed to investigate the difference of effect size between two differences.

$$\begin{aligned}
 & (\langle \text{ch} \rangle - [\text{tj}] \textit{ minus } \langle \text{ch} \rangle - [\text{j}]) \textit{ minus } (\langle \text{ch} \rangle - [\text{tj}] \textit{ minus } \langle \text{ch} \rangle - [\text{s}]) \\
 & \quad ([\text{tj}] - [\text{j}] \textit{ minus } [\text{tj}] - [\text{s}])
 \end{aligned}$$

Figure 4. Example of follow-up analysis to calculate the difference of effect size between two differences produced between [tj]-beginning prime items preceding target words beginning with <ch> and prime items beginning with other sound than [tj] preceding <ch>-beginning target words.

This comparison is to answer the question of whether the size of the effect produced by each pair whose prime's initial sound is not [s] is different from one another. The results obtained from the battery of *t*-tests revealed that in addition to being different from [j]-beginning prime items preceding <ch> beginning target words, the effect size produced by these pairs is also different from each other. The tests revealed that the effect sizes produced by ([tj]-[j] – [tj]-[s]), $t(67) = -7.23, p < .0166 [0.0001], 95\% \text{ c.i. } [-.201, -.114]$, and ([tj]-[j] – [tj]-[ts]), are indeed different, $t(67) = -6.63, p < .0166 [0.0001], 95\% \text{ c.i. } [-.154, -.083]$. Nonetheless, no differences in the effect size produced by ([tj]-[ts] – [tj]-[s]) were found, $t(67) = -2.35, p < .0166 [0.021], 95\% \text{ c.i. } [-.071, -.005]$. That is, in addition to being different from [tj]-beginning items preceding words beginning with <ch>, the size of the priming effect produced from each pair is not the same. The significant differences in the size of the effect suggest that the difference of effect size of target words beginning with <ch> that are preceded by prime items whose initial sound is [j], although different than that produced by primes beginning with [tj], is smaller than the difference in effect size produced by target words preceded by prime items beginning with either [s] or [ts]. Table 3.4 presents these results as a function of place of origin of the participants.

Table 5. Mean and Confidence Interval of the differences of effect size of priming pairs for words beginning with <ch>, further broken down by participants' region of origin in Mexico, (Hermosillo, Santiago de Querétaro) and initial sound of prime item (beginning sound of prime is shown in column on the left).

	Hermosillo		Santiago de Querétaro	
	<i>M</i>	<i>CI</i>	<i>M</i>	<i>CI</i>
([tʃ]-[ʃ] – [tʃ]-[s])	-105.76	[-144.10, -67.41]	-114.61	[-167.34, -61.88]
([tʃ]-[ʃ] – [tʃ]-[ts])	-91.31	[-125.70, -56.93]	-73.27	[-115.50, -31.04]
([tʃ]-[ts] – [tʃ]-[s])	-14.44	[-47.18, 18.30]	-41.33	[-82.22, -0.45]

3.5 DISCUSSION

3.5.1 SUMMARY OF FINDINGS

The present study explored the sociophonetic variation that affects /tʃ/ in *norteño* Mexican Spanish—a process known as *shesheo*—, and its effects on the recognition of words by two groups of listeners, one with life-long experience with *shesheo* (Hermosillo) and a group that lacked familiarity with this variation (Santiago de Querétaro). This question was explored by means of a cross-modal, lexical decision task with auditory primes and visual targets. It was hypothesized that the affricate variant, [tʃ], would facilitate word recognition for both groups of listeners, Hermosillo and Santiago de Querétaro. In addition, it was also hypothesized that because of their ample experience with *shesheo* in their dialect, the fricative variant, [ʃ], would facilitate lexical access for the group of listeners in Hermosillo but not for listeners in Santiago de Querétaro.

Results from the lexical decision task suggest that overall the affricate variant facilitates recognition of words beginning with <ch> for both groups of listeners. It was also observed that prime items whose initial sound is either [ʃ], [s] or [ts] behave differently than [tʃ]-beginning

primes preceding words whose initial consonant is <ch>. Although different from primes beginning with [tʃ], when calculating the differences of effect size between these pairs, the results revealed they are different from each other. More specifically, the analysis comparing the difference between two differences (e.g., (<ch>-[tʃ] – <ch>-[ʃ]) *minus* (<ch>-[tʃ] – <ch>-[s])) confirmed no differences between ([tʃ] – [s] *minus* [tʃ] – [ts]). However, ([tʃ] – [ʃ] *minus* [tʃ] – [ts]) and ([tʃ] – [ʃ] *minus* [tʃ] – [s]) are indeed different. The difference of size of the effect between pairs with the fricative and those with either [s] and [ts] as the initial sound of the prime is larger with the former being closer to [tʃ]-beginning primes, revealing an advantage of [ʃ] over the two control sounds; this was true for both groups of listeners. The results of this study, thus, do not confirm the original hypotheses presented for this investigation. In the following subsection four possible interpretations for these findings are discussed.

3.5.2 INTERPRETATION AND IMPLICATIONS

The results reveal that the affricate variant facilitates recognition of words beginning with <ch> (e.g., [tʃ]arco–*CHARCO*). A possible interpretation of these findings may reside in the asymmetry in lexical activation between full forms and reduced forms found in previous investigations (Connine, 2004; Connine et al., 2008; LoCasto & Connine, 2002; 2009; Ranbom & Connine, 2007). As it is true to any other linguistic system, in Spanish, there is not direct correspondence between sounds and symbols. That is, there is not a natural relationship between the written form and the auditory form. Hence, the relationship between the grapheme <ch> and the phoneme /tʃ/ in Spanish is the result of a mere conventionalization. As it has been introduced above, however, in *norteño* Mexican Spanish /tʃ/ has two possible realizations: it may be produced either as an affricate, [tʃ], or as a fricative, [ʃ]. It has been previously suggested that the fricative variant is a reduced or lenited version of /tʃ/ (Herrera Zendejas, 2006). Thus, according

to this claim, [tʃ] could then be considered the full form of /tʃ/. The results of the present study demonstrate that full forms trigger stronger levels of lexical activation for word forms beginning with <ch> than those produced by reduced forms; this is true for both groups of listeners. It was initially expected that *norteño* listeners would not show an advantage of one variant over the other since they have had ample experience with *shesheo*. In other words, because of their daily exposure to both variants of /tʃ/, [tʃ] and [ʃ], the group of listeners in Hermosillo were expected to show facilitation from both the affricate and the fricative. The results reveal, nonetheless, that full forms lead to stronger levels of lexical activation for both groups, regardless of their linguistic experience. It could be the case, then, that despite the constant exposure to both variables, *norteño* listeners still favor full forms over reduced forms in their mental lexicon.

A second possible interpretation of the results obtained in this study is concerned with the distinction between [tʃ] and [ʃ], rooted in their social saliency: standard form vs. nonstandard form. In Mexico, central dialect, the variety spoken in the central highlands, forms the Standard dialect. Speakers of central dialect—as it is the case with most speakers of other Mexican dialects—, consistently produce the initial consonant in words like *charco* as [tʃ]; thus, *charco* is produced as [ˈtʃarko] in Standard Mexican Spanish. In fact, the production of /tʃ/ with the fricative variant [ʃ], as it is found in the speech by *norteño* dialect speakers, is a stigmatized practice (Casillas, 2012; Jaramillo & Bills, 1982). In a dialect perception study, Casillas (2012), for example, showed that individuals who produced the fricative variant were perceived as less competent and less educated than those whose speech favored the use of [tʃ]. The social stigma associated with the use of fricative variants could lead speakers to favor the use of affricate variants in their speech as well. But what are the effects of social saliency in speech perception? In a lexical decision task with semantic priming, Sumner and Kataoka (2013) had General

American (GA) exposed to primes produced with the phonetic forms found in three different dialects: GA (rhotic), New York City (NYC, nonrhotic), and Southern British English (SBE, nonrhotic). The results showed that GA and SBE word forms are equally efficient at tapping into lexical representations; this processing advantage was not found for words produced in the NYC dialect. Their results suggest no difficulties in the processing of nonrhotic forms for GA listeners, as long as these have been produced by an SBE speaker but not by a speaker of NYC dialect. The authors suggest social saliency of the SBE dialect may account for the effect found. According to these findings, it may be the case that *norteco* listeners in this investigation consider the affricate (or standard) variant to be more socially salient than the fricative—even though the nonstandard variant, [ʃ], may be as frequent as the standard form in their dialect. This, in turn, has an effect on patterns of word recognition, suggesting a processing advantage of standard forms over nonstandard forms among the group of *norteco* listeners in this study.

A third possible explanation for these results may reside on the phonetic distance between these variants and their role as possible competitors. The results of the study confirmed facilitation on the recognition of <ch>-beginning target words when preceded by primes whose initial sound is [tʃ]. Nonetheless, prime items with either ([ʃ], [s], and [ts]) as their initial sound behave different from those beginning with [tʃ] when preceding <ch>-beginning target words. In a follow-up analysis comparing the difference of the difference in effect size produced by each pair confirmed that the difference in effect size produced by ([tʃ] – [s] *minus* [tʃ] – [ts]) is greater than that produced by ([tʃ] – [ʃ] *minus* [tʃ] – [ts]) and ([tʃ] – [ʃ] *minus* [tʃ] – [s]). These findings suggest three main levels of facilitation: a) a maximum level produced by primes beginning with [tʃ]; b) a level of limited facilitation produced by primes whose initial sound is [ʃ]; c) a level of null facilitation by prime words beginning with either [s] or [ts]. Could the differences found be

rooted in the acoustic realization of these sound and the phonetic distance between them? In relation to [tʃ]—the corresponding phonetic form of <ch> in standard Mexican Spanish—, [ʃ], [s] and [ts] are phonetically different. In Spanish, [ts] differs from [tʃ] in place of articulation whereas [ʃ] differs from [tʃ] in manner of articulation. The differences between [s] and [tʃ], however, are found in both place and manner of articulation. In addition to their greater differences in phonetic articulation, [tʃ] and [s] true lexical competitors in Spanish. It may be possible, then, that the differences in effect size observed on pairs with [s]-beginning primes are larger due to the phonetic nature of this sound, which, although more phonetically distant from [tʃ], results in an actual lexical competitor in both dialects, *norteño* and central Mexican Spanish. Moreover, the results of the difference between the differences suggest that $([tʃ] - [s] \text{ minus } [tʃ] - [ts])$ produce null facilitation. It is possible that listeners find [s] and [ts] to be more phonetically close to each other; this similarity may be due to the short and almost imperceptible occlusion of [ts] produced by [t]. This, in turn, may suggest, then, that a change in place of articulation may derive in higher processing costs, whereas a change in manner of articulation with retention of place of articulation does not.

The final interpretation of these results is based on the concept of accommodation to dialect variation. As initially introduced in this chapter, in most varieties of Spanish spoken in Mexico, the initial sound in word such as *charco* ‘puddle’ is produced as [tʃ]. Speakers of *norteño* Mexican Spanish, however, may also pronounce this sound as [ʃ]. In fact, *shesheo*—the variation that affects /tʃ/—is a distinctive feature of *norteño* dialect (Serrano Morales, 2009), and it has been employed in dialectology studies to demarcate the various dialects spoken in Mexico (Lope Blanch, 1990-2000; Martín Butragueño, 2009, 2011, 2014; Moreno de Alba, 1994; Serrano Morales, 2002, 2009). According to this, an assumption can be made regarding the

possible awareness of this variation among Mexican Spanish listeners. That is, regardless of their level of experience with *shesheo*, it may be the case that listeners are not just aware of this variability—as a strong feature of dialect variation—, but they may actually accommodate and adapt to this variation. Contrary to *norteño* speakers, listeners in Santiago de Querétaro are not recurrently exposed to the variability that affects /tʃ/. However, the results show that, similarly to listeners in Hermosillo, the fricative variant is also likely to trigger word activation, regardless of their linguistic experience. It could be that because of their long exposure to *shesheo* during the experimental session, participants in Santiago de Querétaro were able to accommodate to variation affecting /tʃ/. If this is the case, it seems this exposure allows them to accept the fricative variant as a possible facilitator in the recognition of target words beginning with <ch>.

3.6 CONCLUSION

This study reported on the results of a lexical access experiment on *shesheo*—the sociophonetic variation that affects /tʃ/ in *norteño* Mexican Spanish. The results reveal that [tʃ], the affricate variant of /tʃ/, facilitates the recognition of written words for both groups of listeners, Hermosillo and Santiago de Querétaro, regardless of their linguistic experience. This, in turn, seems to suggest that lack of familiarity with variation does not prevent listeners from adapting to it during recognition. Furthermore, the results of this study demonstrate that both variants are not treated equally by either one of these groups of listeners. In other words, the affricate variant seems to be favored over the fricative variant in word recognition; this is true for Hermosillo listeners as well, who, contrary to listeners in Santiago de Querétaro, have had ample exposure to both variants, the affricate and the fricative. By this, it is then understood that regardless of their life-long experience with the two variants, *norteño* speakers still favor the affricate variant over the fricative. The results obtained in this study, thus, do not confirm the initial hypothesis that

linguistic experience modulates lexical access since no difference between these two groups was found. On a final note, it is possible to affirm, however, that *shesheo* does not prevent word recognition. Although it slightly delays lexical activation, *shesheo* still produces limited activation patterns.

CHAPTER 4

PHONOLOGICAL PROCESSING IN THE SECOND LANGUAGE

4.1 INTRODUCTION

Typically, the way people pronounce the sounds of their second language differs from that in which native speakers of the language pronounce them. In other words, most people “have an accent” when speaking a language other than their native one(s). These effects have been widely documented, and we currently have a large scientific literature describing and explaining such effects—see the following sources for reviews (Best & Tyler, 2007; Bohn, 2017; Broselow & Kang, 2013; Chang, 2018; Colantoni et al., 2015; Davidson, 2017; Eckman, 2012; Flege 1995; Piske et al., 2001; Simonet, 2016). Interestingly, “having an accent” is not restricted to speech production, but also manifested in perception; that is, the perception, encoding and processing habits of second-language learners typically differ from those of native speakers (Escudero, 2007; van Leussen & Escudero, 2015). Current models of L2 speech acquisition account for those findings by postulating some sort of interaction between native and nonnative sounds in the minds of bilinguals and L2 learners. By this, they suggest that mental categories interact with one another in the mental representational network of bilinguals (Best & Tyler, 2007; Escudero, 2005; Flege, 1995; van Leussen & Escudero, 2015). L2 learners have an “accent” in their L2, these models claim, because they already have internalized knowledge of a first language (L1). Native and nonnative sounds must find a way to co-exist, and this typically resolves in modifications to the nature of such sounds. In other words, L2 listeners “hear” the sounds of their L2 in terms of the categories that are robustly represented in their phonology by the time they are learning the L2. This study looks at the consequences of one such interaction.

In English, /tʃ/ and /ʃ/ constitute a phonemic contrast, as seen in minimal pairs such as *cheat-sheet* and *chair-share*. Spanish, on the other hand, does not have this contrast. Most varieties of Spanish have /tʃ/ in their inventory, but they do not have /ʃ/ (Hualde, 2005). In spelling, /tʃ/ is systematically represented by the digraph <ch>, as in *charco* ‘puddle’ [ˈtʃarko] and *chamarra* ‘jacket’ [tʃaˈmara]⁴, and most Spanish speakers would consistently pronounce this phoneme as a postalveolar affricate, [tʃ]. It follows that, if they are to acquire the English /tʃ/-/ʃ/ contrast successfully, native Spanish speakers who possess this particular phonological system must develop a new phoneme (/ʃ/) in opposition to one they can recycle or reuse from their native language (/tʃ/); in other words, Spanish speakers must, then, create a new contrastive category, and they must assign to it a new phonetic substance. Learning new sounds and new oppositions typically presents a significant phonological challenge (Best & Tyler, 2007; Colantoni et al., 2015; Escudero 2005).

Native speakers of some regional varieties of Spanish, on the other hand, may have an acquisitional obstacle of a different nature. In some dialects, both [tʃ] and [ʃ] are found, but they are not in phonemic opposition. One such variety is spoken in northwestern Mexico, where people are known to pronounce Spanish words that have <ch> variably, with either [ʃ] or [tʃ] (Alessi Molina & Torres Díaz, 1994; Amastae, 1996; Brown, 1989; Carreón Serna, 2007; Martín Butragueño, 2009; Méndez, 2017; Moreno de Alba, 1994; Serrano Morales, 2000, 2009). In northwestern Mexico, therefore, [ˈtʃarko] and [ˈʃarko] are common variants of the same word, *charco* ‘puddle.’ It seems to follow that, in order to acquire the English /tʃ/-/ʃ/ contrast successfully, native Spanish speakers from northwestern Mexico do not need to learn

⁴ The representation of /tʃ/ by the digraph <ch> in Spanish is also observed in word-medial position as in *hacha* ‘axe’ and *racha* ‘period of time’. This study is concerned with the perception of the /tʃ/ represented by the digraph <ch> in word-initial position.

any new sounds—they already have both [tʃ] and [ʃ] in their inventory of phonetic categories. They possess two sound categories, each with their own phonetic substance. However, what *norteño* speakers must do is learn that these two sounds are not variants of the same phoneme—as they are in their native Spanish dialect—but separate two separate categories (López Velarde & Simonet, 2019). Learning new mappings—contrary to creating a new category—between surface and underlying phonological representations presents a substantial acquisitional obstacle (Barrios et al., 2016)

The present study aims at contributing to the literature on the effects of native linguistic experience on the acquisition of L2 sounds by means of investigating the potential effects of dialectal or regional variation. It also examines the relative difficulty of developing new categories (new sounds) versus that of developing new phonemic contrasts between sounds one can reuse from one's native phonetic inventory (new mappings). More specifically, this study is concerned with categorization patterns in the perception of an English phonemic contrast, /tʃ/-/ʃ/, by two groups of L1 Spanish learners of English who speak different regional varieties of their native language. Both groups of learners are tested in their categorization of a nonnative sound pair to explore the process of acquisition of a contrast that has no obvious parallel in their native language. Does native dialect affect L2 learning? Or, more narrowly, do the specific sounds of one's native dialect impact the process of acquiring the phonology of an L2?

4.1.1 CROSS-LINGUISTIC INTERACTIONS IN L2 SPEECH ACQUISITION

The fact that native and nonnative sounds interact in the bilingual mind is illustrated with two well-known examples: that of Japanese-speaking learners of English, who tend to find the English /ɪ/-/i/ contrast difficult to acquire, and that of Spanish-speaking learners of English,

who tend to have difficulties with the English /i/-/ɪ/ and /æ/-/ɑ/ contrasts. An important body of research has demonstrated that native speakers of Japanese learning English as an L2 are likely to assimilate both the English /ɪ/ and /l/ to their native Japanese phoneme /ɾ/ (Japanese does not have /ɪ/ or /l/); this cross-linguistic assimilation pattern, in turn, creates an obstacle for the acquisition of the English /ɪ/-/l/ contrast (Aoyama et al., 2003; Goto, 1971; Guion et al., 2000; MacKain et al., 1981). For instance, Goto (1971) found that Japanese learners of English were neither able to accurately identify English /ɪ/ and /l/ in a categorization task nor to discriminate between them with any consistency. Guion et al. (2000) found that learners failed to accurately discriminate the English contrast, regardless of their linguistic experience—operationalized as “time of exposure” to their L2. In other words, the obstacle these learners face with this particular phonemic contrast of English is not surmounted easily. The evidence thus suggests that the acquisition of L2 sounds is strongly affected by the phonological inventory in the L1 or, in particular, by the patterns of cross-linguistic assimilation (or interaction) between L1 and L2 sounds.

A second example comes from English-learning native Spanish speakers. These learners find the English /i/-/ɪ/ contrast to be difficult to acquire (Barrios et al., 2016; Casillas, 2015; Escudero & Boersma, 2004; Flege et al., 1994, 1997; Flege & Bohn, 1989; Kondaurova & Francis, 2008; Morrison, 2008, 2009). Spanish has five phonemic vowels, /i e a o u/, and it has been demonstrated that Spanish-speaking learners of English tend to assimilate both English /i/ and /ɪ/ to a single native Spanish vowel, /i/ (e.g. Flege & Bohn, 1989). This two-to-one cross-linguistic assimilation pattern creates an acquisitional obstacle for this learner population because it makes the two members of the English /i/-/ɪ/ contrast difficult to discriminate from each other (e.g. Flege et al., 1994). Similarly, the English /ɑ/-/æ/ contrast

presents a challenge for Spanish-speaking learners, as both English vowels are cross-linguistically assimilated to a single Spanish vowel, /a/ (Barrios et al., 2016; Casillas & Simonet, 2016). Once again, these findings suggest that the obstacles L2 learners encounter when acquiring the phonology of their L2 are, at least in part, determined by the listeners' native language background and the cross-linguistic assimilations established between L1 and L2 sounds.

Several theoretical accounts have attempted to explain the obstacles learners face during their acquisition of the L2 phonology. Two such models are the Perceptual Assimilation Model applied to L2 learning (PAM-L2, Best & Tyler, 2007), and the Second Language Linguistic Perception model (L2LP, Escudero 2005; van Leussen & Escudero, 2015). Both of these frameworks postulate that the native and nonnative sounds of L2 learners interact (in some way), which explains the acquisitional difficulties learners face. The manner in which this interaction is modelled, however, differs in the two accounts. The PAM-L2 (PAM-L Best & Tyler, 2007) proposes that difficulties arise as a function of the assimilability of L2 contrasts to L1 categories. Cross-linguistic assimilation is claimed to rely on the phonetic (in particular, articulatory) similarity between the L2 and the L1 sounds. These are three of the possible assimilation patterns the PAM-L2 operationalizes: (i) When two L2 phones are cross-linguistically assimilated or equated to two different L1 phonemes, a two-category assimilation (TC) is said to have occurred. In a TC scenario, discrimination of the two key L2 segments is predicted to be excellent, since the discrimination of the two corresponding L1 categories is assumed to be optimal. (ii) In contrast, if two L2 sounds are cross-linguistically assimilated to the same L1 category and both are equally similar to (or equally deviant from) the L1 sound, a single-category assimilation (SC) pattern occurs. The model predicts that, in cases of SC

assimilation, the discrimination of the two key L2 phones will be poor, as the two L2 sounds will be categorized as variants of the same sound. This type of cross-linguistic assimilation pattern will, therefore, be particularly challenging for learners. (iii) A third type of assimilation pattern is called category-goodness assimilation (CG). In a CG pattern, two contrastive L2 sounds are assimilated to the same L1 category, but the cross-linguistic similarity is greater for one of the categories than for the other. In such a situation, discriminating between two key L2 categories is predicted to range from moderate to very good, depending on the category-goodness assimilation for each of the L2 segments.

The L2LP model (Escudero 2005; van Leussen & Escudero, 2015) differs from the PAM-L2 in some important ways. The L2LP claims that, at the initial stages of the L2 learning process, learners transfer or duplicate the entire L1 system. Although the L2 system begins as a duplicate of the L1 grammar (a transferred grammar), this only occurs once, and it is subsequently handled as a separate phonological grammar. The novel system is equipped with the same learning mechanisms available in the L1, and it evolves as experience with the L2 increases. Technically, therefore, the L2LP rejects that the L1 and L2 phonological systems interact, because it rejects that the two reside in a common representational network. Nevertheless, since the dedicated L2 system begins its course as an exact copy of the L1, the sound categories and mapping strategies learners developed for the L1 powerfully determine the manner in which L2 sounds are processed, perceived, produced, represented, and, ultimately, learned (or not learned). An aspect of the L2LP that resembles the PAM-L2 is that it operationalizes the existence of “cross-linguistic” comparisons in terms of L1 and L2 contrasts based on the phonetic (acoustic, in this case) similarity of L1 and L2 sounds. For instance, the cross-linguistic comparison described as single-category assimilation (SG) in the

PAM-L2 is called a new scenario in L2LP, and both models predict that learning the L2 contrast in this particular scenario is challenging. What the PAM-L2 calls a two-category (TG) assimilation pattern, the L2LP calls a similar scenario; that is, when two L2 sounds each resemble a different L1 sound, learning these two categories is predicted to be easy. In sum, while some aspects of the PAM-L2 and the L2LP make them substantially different from each other, other principles of the two models are fundamentally identical. The present study focuses on the different learning scenarios or assimilation patterns postulated by both frameworks, which are useful to predict the types of obstacles L2 learners will encounter during L2 acquisition.

To date, most empirical studies on the effects of L1 sounds on L2 speech learning seem to have focused on the acquisition of vowels, sonorants, and voicing contrasts. This is particularly true of the studies investigating the adequacy of the L2LP (Escudero 2005; van Leussen & Escudero, 2015), most of which are on vowel acoustics. The current study, however, investigates L2 obstruents, and it focuses on manner distinctions, not voicing contrasts. Only a small number of studies have explored L2 affricates or fricatives. Most of these studies home in on the perception and production of place and voicing features in such consonants. For instance, Kaufmann, Meyer, and Schmid (2010), Park and de Jong (2008), and Tsao, Liu, and Khul (2006) study cross-linguistic mapping patterns between L1 and L2 obstruents, including fricatives and affricates. Although they explore different language sets and use different experimental techniques, these studies reveal that the acquisition of L2 obstruent contrasts is determined, at least in part, by L1 obstruent categories. This confirms that there is no a priori reason to believe that the findings pertaining to vowel (or sonorant) categories do not apply to the L2 acquisition of obstruents. In fact, some of the first

applications of the PAM—from before it was employed to study L2 speech perception—focused on the cross-linguistic perception of consonants, including clicks (Best et al., 1988, 2001).

The examples synthesized above illustrate that creating a new category during L2 acquisition is particularly difficult in cases in which two contrastive categories of the L2 are cross-linguistically assimilated to a single phonemic category. A different kind of phonological obstacle presents itself when learners must develop new phonological mappings between sounds that already exist in their native inventory. For instance, Spanish has both [d] and [ð], but these are in complementary distribution—the two sounds are allophones of the same phoneme, /d/. In English, on the other hand, these two sounds are phonemic, as illustrated by the minimal pair *den-then*. It follows that Spanish-speaking learners of English must develop new mappings between surface sounds that already exist in their inventory and new underlying representations. In other words, they must learn that two sounds that are linked to a single phonemic entry in their L1 are actually contrastive in their L2—they are linked to separate phonemes in the L2. It has been hypothesized that this type of acquisitional obstacle, called *allophonic split*, is particularly challenging for L2 learners (Eckman et al., 2003; Lado, 1957). This prediction derives from the finding that (in native speech) discriminating between phonemically contrastive categories is much easier than doing so between categories that are phonetically distinct but not phonemically contrastive; in other words, sounds that are not phonemically contrastive are perceived to be more similar to each other than contrastive sounds are (Barrios et al., 2016; Johnson & Babel, 2010). The literature on this learning scenario is limited but, interestingly, a recent study has shown that an obstacle of the kind described here does not (Barrios et al., 2016, p. 14). At this point, therefore, it is not known

which of the learning scenarios presents a greater challenge for L2 learners. The present study compares the relative difficulty of two of the learning scenarios discussed above: (i) the need to acquire a new sound category (that is, a new phoneme together with a new surface allophone), and (ii) the need to acquire a new mapping between surface and underlying representations (that is, a new phoneme for an already existing surface allophone).

4.1.2 REGIONAL DIALECTS AND L2 SPEECH ACQUISITION

The present study compares the perceptual behavior of two groups of Spanish-speaking learners of English. The two groups of learners differ in their region of origin; that is, they were brought up as speakers of two different geographical dialects of Mexican Spanish. I have attempted to compare groups that do not differ in other important attributes, such as length of exposure to the L2, type of input, learning experience, or overall proficiency. The premise of this study is that the particular, specific L1 experience of L2 learners can determine, to some extent, the obstacles they encounter (and progression paths they take) when learning their L2. It follows that the phonology of the native dialect—not only that of the standard variety of the native language—can modulate the acquisition of the phonology of the L2. A handful of recent studies have examined the potential role of regional dialect on L2 development. Some have explored the acquisition of different L2 dialects; that is, how people who speak the same language but are (Baker & Smith, 2010; Escudero & Boersma, 2004). Others, on the other hand, have analyzed the potential effects of the native dialect on the acquisition of the L2; that is, how people who speak different varieties of the same language progress towards learning the same L2 (Chládková & Podlipský, 2011; Escudero et al., 2012; Mayr & Escudero, 2010).

It has been demonstrated that people who speak the same native language but are exposed to different regional varieties of their L2 can face different cross-linguistic

assimilation scenarios, leading to potentially different learning paths. For instance, Escudero and Boersma (2004) examined how two groups of Spanish-speaking learners of English perceived the English /i/-/ɪ/ contrast. One of the groups was learning English in Scotland, whereas the other was learning it in the South of England. This study found that learners in Scotland outperformed those in England. The authors attributed this to the acoustic properties of the particular English vowels involved, which led to different cross-linguistic assimilation patterns being established by the learners in the two locations. In Scotland, /i/ and /ɪ/ were being assimilated to two different Spanish vowels, since Scottish /i/ resembles Spanish /i/ and Scottish /ɪ/ resembles Spanish /e/. In England, on the other hand, /i/ and /ɪ/ were being assimilated to a single Spanish vowel, /i/. In sum, the acquisitional obstacles faced when learning an L2 may depend on the phonetic properties of the regional variety of the L2 one is mainly exposed to, as these modulate the cross-linguistic assimilation patterns one will establish.

Most significantly for the present purposes is the fact that one's native dialect also modulates the cross-linguistic assimilation patterns one will establish. For instance, Morrison (2008) tested the categorization patterns of L2 English synthetic vowels by monolingual Spanish speakers. The two groups of learners differed in their native dialect experience: one group was integrated by Mexican Spanish listeners and the second group included speakers of Peninsular Spanish. The results revealed that listeners of Mexican Spanish classified Canadian-English vowels /i/ and /ɪ/ to their native /i/. In contrast, Peninsular-Spanish listeners classified English /ɪ/ to their native Spanish /e/. These results support the claim that life-long experience with one's native dialect affects the patterns of assimilation second language learners will develop in their language acquisition process.

4.1.3 POST-ALVEOLAR OBSTRUENTS IN MEXICAN SPANISH

In dialectology studies, four main regional varieties of Spanish in Mexico have been identified: central, coastal, northern (*norteño*), and peninsular (Lope Blanch, 1990-2000; Martín Butragueño, 2014, 2011; Moreno de Alba, 1994). One of the phonological variables used to map the regional varieties of Mexican Spanish concerns the pronunciation of the first consonant in words such as *charco* ‘puddle’ and *chamarra* ‘jacket.’ In most dialects of Spanish, both in the Americas and in Iberia, this consonant is pronounced as a post-alveolar affricate, /tʃ/; this is true of most varieties of Mexican Spanish as well. Therefore, in most regions in Mexico, including the central highlands (the socially prestigious regional variety), *charco* ‘puddle’ is pronounced as [ˈtʃarko]. The speech of people born and raised in the northwestern Mexican states—including Sonora, Chihuahua, and Baja California Norte, among others—is characterized by a pattern of phonetic variation in which the post-alveolar obstruent in *charco* ‘puddle’ may be pronounced as either [tʃ], an affricate, or [ʃ], a fricative. Therefore, in northwestern Mexican speech, *charco* ‘puddle’ is pronounced sometimes as [ˈtʃarko] and sometimes as [ˈʃarko]. Although variationist studies vary significantly in their reported fricativization rates—“fricativition” refers to the practice of pronouncing <ch> as [ʃ], a diachronic innovation—found in the speech of people from these communities, what seems clear is that, in this Spanish dialect, both the fricative and affricate variants of this variable are found (Alessi Molina & Torres Díaz, 1994; Brown, 1989; Carreón Serna, 2007; Méndez, 2017). Note that the use of the two variants, or allophones, of <ch> is not determined by a phonological rule; in other words, the two variants are not in complementary distribution, but in a scenario of “free” variation.

The investigations that have explored the phonetic variation that affects /tʃ/, nonetheless, have identified a number of social factors that may modulate (to some extent) the pronunciation of /tʃ/ as [ʃ]. Among the social factors involved are age, level of education, and gender. Studies vary in their reported effects of gender (Carreón Serna, 2007; Méndez, 2017), and some claim that gender is meaningful only when it interacts with age (Jaramillo & Bills, 1982). Studies have typically found that older speakers are more likely to use the fricative variant than younger speakers are (Alessi Molina & Torres Díaz, 1994; Carreón Serna, 2007; Méndez, 2017). Moreover, these studies have found that people with higher levels of education are less likely to produce the fricative variant than people with less years of schooling (Carreón Serna, 2007; Méndez, 2017).

The constant exposure to the variation that affects <ch> has been found to affect *norteño* listeners' patterns of word recognition. In a lexical access investigation, the author and a collaborator (2019) found that *norteño* listeners are equally likely to accept Spanish word forms produced with either variant of <ch>, the fricative and the affricate. In other words, these listeners accept both variants as characteristic of “real Spanish words.” We also found that both variants are equally likely to prime listeners for the efficient recognition of spoken words, which suggests that *norteño* listeners store Spanish words with both variants within the same abstract mental representation. This study confirms that the two variants of <ch> are indeed allophones of the same phoneme. Nevertheless, we also observed that the recognition of words with the affricate variant was faster than that of those with the fricative variant, suggesting a representational (and processing) privilege of [tʃ] over [ʃ] at some level. These findings suggest that people who experience sociophonetic variability in their speech

community may store more than one phonetic variant in their mental representation of words. In other words, native dialectal experience determines native phonological representations.

4.1.4 THE PRESENT STUDY

The current study focuses on a phonemic contrast of English—that between /tʃ/, as in *cheat*, and /ʃ/, as in *sheet*—and investigates the perceptual identification and discrimination patterns pertaining to this contrast displayed by two groups of L2 learners of English whose native language is Spanish. The learner sample for this study was recruited from two dialectal regions, central and northwestern Mexico. More specifically, this study explores how speakers of northwestern Mexican Spanish (*norteño*), who are recurrently exposed to the sociophonetic variability that affects Spanish <ch> in their speech community, perceive the target English contrast (/tʃ/-/ʃ/), and how these perceptual habits differ (if at all) from those demonstrated by speakers of central Mexican Spanish, who lack experience with this specific variability pattern.

A minimal pair of English that illustrates a phonemic contrast in this language was selected. It is hypothesized that native speakers of Spanish will find this contrast challenging—i.e., the /tʃ/-/ʃ/ contrast in *cheat* and *sheet*. Even though it is hypothesized that both of the target populations of L2 learners of English—northwestern and central Mexicans—may find this phonemic contrast relatively difficult to master, it is believed that the specific learning obstacles the two populations experience are different, and this perhaps results in different learning outcomes. On the one hand, it is hypothesized that the English /tʃ/-/ʃ/ contrast will prove to be relatively difficult for central Mexican learners because [ʃ], as in *sheet*, does not correspond to any sound in their dialect of Spanish while [tʃ], as in *cheat*, does. It is possible that these learners assimilate the two phonemes of English to the same native category, /tʃ/. Nevertheless, since [tʃ] and [ʃ] are phonetically quite distinct, and since central Mexican

Spanish has both affricates (/tʃ/) and fricatives (/s, f, h/), it could be the case that (adopting PAM's terminology) the English /tʃ/-/f/ contrast presents a category-goodness pattern, one in which English /tʃ/ is assimilated to central Mexican Spanish /tʃ/ with a very high goodness of fit and English /f/ also assimilates to this central Mexican Spanish phoneme but with a lower goodness of fit. For the central Mexicans, therefore, the task consists of developing a new sound category (both a phonetic one and a phonological, underlying one).

On the other hand, *norteño* speakers, unlike people from central Mexico, are exposed to two variants of <ch> in their native dialect, [tʃ] and [ʃ]. These allophones find themselves in “free” variation, and they are both associated with the same phoneme. For this reason, it is hypothesized that speakers of *norteño* Mexican Spanish are likely to assimilate both English /tʃ/ and English /f/ to the same native phoneme, and that the goodness of fit of these two cross-linguistic assimilation patterns is likely to be similarly high. This might create (adopting PAM's terminology again) a single-category cross-linguistic assimilation pattern. Since category-goodness cross-linguistic assimilation patterns are expected to lead to better discriminability than single-category ones (Best et al., 2001; Best & Tyler, 2007), it is hypothesized that the error rates in the identification and discrimination of the target English contrast will be larger for *norteño* learners than for central Mexican learners.

An alternative way to frame the learning scenario for the *norteño* speakers is that of an allophonic split (Barrios et al., 2016). These learners must unlearn that both [tʃ] and [ʃ] are mapped onto the same phoneme (as they are in their native dialect of Spanish), and they must develop a new phoneme specific to the L2 to which only one of these two allophones must be mapped. In other words, *norteños* already possess the two target categories of English, [tʃ] and [ʃ], but they must develop a new phonological, underlying category and remap their sound

categories so that they are each assigned to a different contrastive unit. Are the *norteños* more or less likely than the central Mexicans to succeed in their discrimination of the members of English /tʃ/-/ʃ/ contrast?

To compare the acquisition of the target English phonemic contrast with a contrast about which much is known, a second phonemic contrast of English was selected to serve as a control condition, that between /i/ and /ɪ/. To illustrate this particular contrast, the English words *seat* and *sit* were selected. It is well known that native speakers of Spanish find the *seat-sit* contrast very difficult to discriminate and, therefore, learn (Casillas, 2015; Escudero & Boersma, 2004; Kondaurova & Francis, 2008; Morrison, 2008, 2009); they also find the two members of the contrast very difficult to identify against each other. Therefore, the *seat-sit* contrast, tested in these experiments alongside the target contrast, *cheat-sheet*, serves as a control condition, one that should be similarly challenging for both target learner populations.

4.2 METHOD

4.2.1 PARTICIPANTS

The data were collected in two locations in Mexico, Hermosillo and Santiago de Querétaro, which are the two largest cities in the states of Sonora and Querétaro, respectively. The participants in Hermosillo were lifelong residents of the state of Sonora. The majority of the participants had lived in Hermosillo from birth, and those born in other municipalities indicated they had migrated to the city as children. Many of the participants tested in Santiago de Querétaro were not born in the city, but they reported having moved to the city as children or as teenagers. The Santiago de Querétaro residents in the sample who were not natives to Querétaro were born in other central states of the country, such as Guanajuato, Jalisco, Morelos, and

Puebla. Particularly with respect to their treatment of /tʃ/, as well as to that of many other sounds, the central highlands of Mexico form a single dialectal area. In sum, data were collected in two dialectal areas, the northwest (exemplified by Hermosillo, Sonora) and the central highlands (exemplified by Santiago de Querétaro, Querétaro).

A total of 88 people (44 from Hermosillo, 44 from Santiago de Querétaro) participated in this study. Participants' ages ranged between 18 and 43 years old. All but five participants were college students at the time of testing, graduate or undergraduate students. Three participants had graduated with a college degree, and two had not completed college and were working in the industry. The high number of college students or college graduates in the sample is due to having recruited the participants in college settings, the *Universidad de Sonora* (Hermosillo) and the *Universidad Autónoma de Querétaro* (Santiago de Querétaro). The educational and professional profile of the participants recruited for this study is not fully representative of the population native to these locations—highly educated people are overrepresented. Importantly, however, the social profile of the two dialectal groups does not differ—both groups consist of highly educated people who are learning English as a foreign language in a school setting. All participants study (or studied) English at the college level.

All participants responded to the Bilingual Language Profile questionnaire (Birdsong et al., 2012). The questionnaire collects information regarding the listeners' linguistic background and L2 learning experience with a focus on attitudes, history, self-assessed proficiency, and usage of the two languages (an example of the BLP is available in APPENDIX C; the version adapted to PsychoPy2 used in this study is available in APPENDIX D). The questionnaire produces a language dominance score along a spectrum centered around 0 that ranges from -218 to 218. Each module produces a result, and these are summed up to provide a value of language

dominance. The extremes on the score spectrum reveal a dominance in one of the two languages. The values of the extremes are assigned arbitrarily. In this study, negative scores are associated with dominance in Spanish. The participants in this study are expected to be Spanish-dominant (violin plots for the results of the BLP are available in APPENDIX E).

In addition, an English vocabulary-size test was also administered to assess the participants' proficiency in the L2. The LexTALE (www.lextale.com) is a standardized test designed to measure vocabulary size in language learners (Lemhöfer & Broersma, 2012). To the extent that vocabulary size reflects overall knowledge of the language, the LexTALE provides an indicator of a person's proficiency in their L2. The test consists of 60 trials, comprising 40 English words and 20 nonwords, and these are presented to participants, for them to make lexical decisions on. In this study, the test was administered using PsychoPy2 (Peirce et al., 2019). The order in which trials are presented is fixed. The first three lexical items presented in the test are not counted toward the scoring since they served as practice trials. The total resulting score is reported in percent-correct units, and it is corrected for the unequal number of words and nonwords. For this study, the test was administered using PsychoPy2 (Peirce et al., 2019).

A series of Welch *t*-tests suggests that the two dialectal groups do not differ with respect to their dominance scores, $t(85.1) = -.608$, $p > .05$ [.54], 95% c.i. [-14.9, 7.9], but they do in regards to their English vocabulary-size scores, $t(82.7) = -3.63$, $p < .001$ [.0004], 95% c.i. [-11.86, -3.47]. The two scoring parameters are modestly correlated, $r = .16$. The average BLP score for the Santiago de Querétaro group is -97.3 (SD = 28.3, range [-142.2, -18.1]), and the average for the Hermosillo group is -100.8 (SD = 25.4, range [-140.1, -41.5]). This confirms that all participants are dominant in Spanish. The average LexTale score for the group of learners in Querétaro is 69.6 (SD = 10.8, range [53.7, 97.5]), and the average for the group of learners in

Sonora is 61.9 (SD = 8.9, range [42.5, 81.25]). Thus, learners in Santiago de Querétaro have, on average, higher LexTale scores than learners in Hermosillo. On average, none of the two groups are near ceiling (i.e., 90% or higher). Only two participants have scores higher than 90%, and they are both in the group of learners in Santiago de Querétaro.

4.2.2 MATERIALS

4.2.2.1 IDENTIFICATION EXPERIMENT

The perceptual data in this study were collected by means of two perception tasks, an identification experiment and a categorical discrimination experiment. In the categorical identification task, participants were presented with 96 auditory stimuli consisting of one of four English lexical items: *cheat*, *sheet*, *seat*, and *sit*. A total of 24 different iterations of each of the four words were played in random order to each participant. Listeners were asked to identify the word by indicating, from a closed list of options, the lexical item each auditory stimulus corresponded to. Four options to select from were shown on a computer screen in alphabetical order, from left to right: *cheat*, *sheet*, *seat*, *sit*. The participants, particularly Hermosillo listeners, are hypothesized to misidentify *cheat* as *sheet*, *sheet* as *cheat*, *seat* as *sit*, and *sit* as *seat*. There is no hypothesis as to whether they will also misidentify *seat* or *sit* as *cheat* or *sheet*.

4.2.2.2 DISCRIMINATION EXPERIMENT

For a second experiment, an ABX categorical discrimination task was designed to test two key contrasts: *cheat-sheet* (target) and *seat-sit* (control). In an ABX task, listeners hear a triad of auditory tokens (A, B, and X) presented in a sequence within the same trial and, upon hearing all three, they indicate whether the third token (X) matches either the first (A) or the second (B) item in the sequence. There were no “catch” trials in the version of this task prepared for this

study, which means that there always was a “correct” answer: the task was designed so that one item always matched the target and one did not. Importantly, all of the stimuli in each triad were acoustically different, including the two matching tokens, as each one of them had been recorded by a different talker—the auditory stimuli belonged to different voices. Under such conditions, sound (or word) comparisons cannot be based on acoustic memory, but must be based on phonological memory (participants are comparing abstract categories, not auditory tokens), which requires participants to access their phonological knowledge to make their decisions. This is the reason why this task is referred to as a categorical AXB—comparisons must be based on categories, not tokens.

Each participant provided 48 observations to the data set: 24 trials focused on the *seat-sit* contrast (*seat-sit-seat* [6]; *seat-sit-sit* [6]; *sit-seat-sit* [6]; *sit-seat-seat* [6]), and 24 focused on the *cheat-sheet* contrast (*cheat-sheet-cheat* [6]; *cheat-sheet-sheet* [6]; *sheet-cheat-sheet* [6]; *sheet-cheat-cheat* [6]). In 24 of the trials, the matching word was adjacent to the target word—it was in B position. In other words, the target word was always in the third position of the sequence and, in cases of adjacency, the matching word was in second position. In 24 of the trials, the matching word was not adjacent to the target, since it was presented in the first position in the sequence. Everything else being equal, matching adjacent categories is easier than (Best et al., 2001).

4.2.3 AUDITORY STIMULI

Four native English speakers, all of them women, served as talkers. Their productions were recorded in a sound-treated booth on the campus of the University of Arizona using professional recording equipment—a Shure SM10A head-mounted dynamic microphone and a Sound Devices USBPre2 audio interface connected to a laptop computer. Speech productions were

digitized at 44.1 kHz, with 16-bit quantization, and the tokens were stored in individual (Boersma, 2001).

The talkers were asked to produce the target words by embedding them in a constant carrier phrase, “__is the word.” The materials were presented in random order to avoid any possible systematic effects of list intonation or exhaustion on the same lexical items. All speakers produced all target words four times ($4 \text{ tokens} \times 4 \text{ iterations} \times 4 \text{ talkers} = 64 \text{ items}$). One token of each target word per talker was selected (avoiding disfluencies and any extraneous noise) for a total of four target stimuli per lexical item.

4.2.4 PROCEDURE

Participants completed the tasks individually. In Santiago de Querétaro, participants were tested in a sound-attenuated booth, but in Hermosillo they were tested in a quiet library room. Stimuli were presented auditorily over a set of Audio Technica ATH-M50x closed-circumaural headphones connected to a laptop computer running PsychoPy2 (Peirce et al., 2019). Participants responded by pressing a key on a Logitech G512 Lightsync RGB mechanical keyboard. Prior to the completion of the experimental tasks, the first author welcomed the participants to the testing room and provided them with a general description of the tasks and their instructions. This conversation took place in Spanish. Before participating in any of the perceptual tasks, people completed the Bilingual Language Profile questionnaire (Birdsong et al., 2012) and the LexTale (Lemhöfer & Broersma, 2012).

For the identification task, participants were instructed to listen to each stimulus word token, presented individually, and indicate their answer as quickly and accurately as possible by pressing one of four keys on the keyboard (1, 2, 3, or 4). Trials began by showing a red cross in the center of the screen for 250 ms, which was followed by a screenshot showing the four

response options: *cheat*, *sheet*, *seat*, *sit*. Words were shown in capital letters. Numbers—that is, key codes—were presented in yellow and shown below their corresponding lexical item. Visual stimuli were shown for 2500 ms. Auditory stimuli were played 500 ms from the onset of the screenshot displaying the response options. Participants were allotted 2 s to enter a response. If participants did not provide a response within the allotted time, a new trial began.

In the ABX task, participants were asked to listen to all three sounds presented in the trial and only then respond by pressing either number 1 or number 2 on the keyboard to indicate whether they believed the third sound matched the first (1) or the second (2) ones in the triad. The words ‘first’ and ‘second’ were shown on the computer screen in upper case and accompanied with their matching number, 1 or 2. Each trial began with the showing of a red cross in the center of the screen for 1000 ms. The first stimulus of the triad was played at the 1 s mark and was then followed by the second sound of the triad at the 2 s mark. The stimulus onset asynchrony of these two stimuli was thus set at 1 s. The stimulus onset asynchrony between the second and third stimuli was set at 1.5 s. Simultaneously with the playing of the third auditory stimulus in the triad, a screenshot showing the two response options was shown. Participants had 2 s to introduce their answer. If no answer was entered within this time, a new trial began.

4.3 ANALYSIS

All statistical analyses were run in *R* (R Development Core Team, 2016), with packages *tidyverse* (Wickham, 2017), *afex* (Singman et al., 2018), and *effsize* (Torchiano, 2018). Empty trials—that is, trials with no response entered by the participant—were excluded from the main analyses. These analyses were conducted without such trials and using a dataset containing only responded-to trials from 88 participants, 44 from Hermosillo and 44 from Santiago de Querétaro; this is further explained in the corresponding sections below.

4.3.1 IDENTIFICATION

The analysis for the identification task was conducted in two steps. In the first step, a proportion of correct responses per participant was obtained; that is, there was a classification of what participants heard (the lexical items the talkers had produced) as a function of what they responded (the lexical items the listeners had responded they had heard). This results in a contingency table. The original data set consisted of 8448 observations, all of them listeners' responses to auditory stimuli. Nevertheless, a number of these observations were excluded from the analysis because the listener did not respond within their allotted time. There was a total of 424 not-responded-to trials, about 5% of the observations. The analysis was then conducted without such trials, with a data set containing 8024 observations.

In a second step, the proportion of times a given participant was accurate versus the times they were inaccurate was calculated. In order to prepare the data for the statistical analysis, an arcsine transformation of the proportion-correct scores by participant and by condition was run.

4.3.2 DISCRIMINATION

The results obtained from the discrimination task were first explored for empty responses—trials that did not contain any information because the participant had failed to respond within the allotted time. The original data set comprised a total of 4224 observations, 44 (listeners) \times 2 (locations) \times 48 (responses), from which 288 (6%) were empty. An analysis of the participants' responses was then conducted after removing the empty observations from the data set, which results in a data frame of 3,936 observations. The analysis on the data set comprising responded-to-trials counted the proportion of correct responses per listener, per condition (contrast type and adjacency). Then, the accuracy scores (or proportion of correct responses) were arcsine-transformed for the statistical analysis.

4.4 RESULTS

4.4.1 IDENTIFICATION

The analysis of the identification data focused on the proportion of times the auditory stimuli were identified as each of the four lexical items. Table 4.1 shows the proportion of responses, calculated only for the trials that were responded to, as a function of stimulus played (rows) and response given (column), further broken down by region of origin of the participants.

Table 6. Proportion of times each auditorily-presented lexical item was identified as being an instance of one of four possible words (*cheat*, *sheet*, *seat*, *sit*), further broken down by region of origin, in Mexico, of the English learners (Hermosillo, Santiago de Querétaro).

	Hermosillo				Santiago de Querétaro			
	<i>cheat</i>	<i>sheet</i>	<i>seat</i>	<i>sit</i>	<i>cheat</i>	<i>sheet</i>	<i>seat</i>	<i>sit</i>
[t]eat	.51	.42	-	-	.82	.16	-	-
[ʃ]eet	.39	.57	-	-	.20	.72	-	-
s[i:]t	-	-	.32	.64	-	-	.42	.55
s[ɪ]t	-	-	.64	.32	-	-	.55	.40

Note: Rows represent the auditory stimuli played and columns represent the labels displayed on the screen, and, thus, the responses available to the participants. Responses below 5% are not shown. Within each participant group, rows add up to 1.

As it may be observed in Table 4.1, the proportion values suggest that neither *seat* nor *sit* are likely to be categorized as neither *sheet* nor *cheat*. In other words, it may be concluded that [s] is categorized as being distinct from both [tʃ] and [ʃ], and that this is true for both groups of learners. When a word begins with [s] and ends with [t], only *seat* and *sit* are viable options for these learners. Equivalently, when a word begins with a post-alveolar obstruent, either [tʃ] or [ʃ], neither *seat* nor *sit* are viable options. It is inferred that it is reasonable to treat the *cheat-sheet* and the *seat-sit* as separate contrasts in the analysis. In the following section, the discrimination of the members of these two paired contrasts is investigated separately.

The scores in Table 4.1 also suggest that the identification of both *seat* and *sit* lead to a large number of categorization errors, and that both groups of learners are likely to confuse the two words with each other. This is what the extant literature led to hypothesize for this contrast (Casillas, 2015; Escudero & Boersma, 2004; Kondaurova & Francis, 2008; Morrison, 2008, 2009). For both items, both participant groups may be slightly more likely to be wrong than right in their response, and this was unexpected.

Let me now turn the attention to *cheat* and *sheet*. It appears that the behavior of the two groups of English learners differs in their identification of these two words. In the case of the central dialect listeners, *cheat* and *sheet* do not appear to be very difficult to identify even in a task that plays these words in the context of each other—accuracy rates are relatively high, with 83% correct responses for *cheat* and 73% correct responses for *sheet*, but they can be confused with each other at rates that are perhaps not negligible. On the other hand, learners in Hermosillo display many categorization errors for *cheat* and *sheet*. Accuracy rates for learners in Sonora are relatively low—with 51% correct responses for *cheat* and 57% correct responses for *sheet*—and their categorization rates seem to be close to chance for this minimal pair.

The statistical analysis focuses on accuracy rates. Therefore, the cells that may be interpreted as displaying “correct” responses were selected: [tʃ]eat identified as *cheat*, [ʃ]eet identified as *sheet*, s[i:]t identified as *seat*, and s[ɪ]t identified as *sit*. This analysis ignores all other cells. The arcsine-transformed accuracy scores were submitted to a mixed-design, two-way $2 \times (4)$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as a between-subjects factor, and Response (*cheat*, *sheet*, *seat*, *sit*) as a within-subjects factor. The ANOVA yielded main effects of Location, $F(1, 86) = 18.2, p < .001, \eta^2 = .10$, and of Response, $F(2.1, 183.4) = 62.4, p < .001, \eta^2 = .26$. Importantly, the model detected a significant interaction between the two

factors, $F(2.1, 183.4) = 6.41, p = .002, \eta^2 = .03$. The results revealed that, as a group, learners in Hermosillo are more likely to make categorization mistakes with this closed lexical set than the group of learners in Santiago de Querétaro are, but this further depends on the lexical item itself.

To investigate the interaction between Response and Location, the data set was divided into four subsets as a function of Response. The potential effects of Location for each of the lexical items were, therefore, analyzed separately. Since four *t*-tests were to be used, the alpha criterion was adjusted, $.05/4 = .0125$. The results revealed that, for both *seat* and *sit*, accuracy rates were comparable across learner groups (*seat*: $t(66.5) = 1.97, p = .053$, Cohen $d = .42$; *sit*: $t(83.3) = 1.15, p = .25$, Cohen $d = .24$). In other words, both groups of participants were similarly likely to be accurate (or inaccurate) when identifying these two words, which suggests that the *seat-sit* contrast is similarly difficult for both groups of learners. On the other hand, accuracy rates were significantly different across learner groups for both *cheat*, $t(83.8) = 8.07, p < .001$, Cohen $d = 1.72$, and *sheet*, $t(73.02) = 3.53, p < .001$, Cohen $d = .75$. In both cases, learners in the Santiago de Querétaro group were much more likely to be accurate than the group of learners in Hermosillo.

To summarize, identifying the two members of the *seat-sit* contrast appears to be similarly challenging for both groups of Spanish-speaking learners of Spanish, whereas identifying the two members of the *cheat-sheet* contrast is more likely to lead to errors for Hermosillo listeners than for the group of listeners in Santiago de Querétaro. The results obtained in the identification task suggest the following hypotheses for the follow-up discrimination test. (i) In a discrimination task, learners in Hermosillo are just as likely to find the *seat-sit* contrast difficult to distinguish as the learners in Santiago de Querétaro. This is to be expected from the literature as well, and this contrast is used as the control condition. (ii)

Hermosillo listeners are likely to find the *cheat-sheet* contrast more difficult to discriminate than listeners in Santiago de Querétaro.

4.4.2 DISCRIMINATION

Of the total number of possible observations, approximately 5% contained empty responses ($N = 288$). Empty responses were due to participants' failure to respond within the allotted time window, 4 s. Learners in the Santiago de Querétaro group had a few more empty responses than the group of learners in Hermosillo. Importantly, however, empty responses were not affected by the lexical contrast, with each contrast having approximately half the number of empty responses in each location group. Therefore, the analysis of the participants' responses was conducted by simply removing the empty observations from the data set, which resulted in a data frame of 3,936 observations. Table 4.2 shows the untransformed proportion of correct responses by participant group and experimental condition. There are two experimental conditions in the design: (i) the lexical contrast tested in a given trial (*seat-sit*, *cheat-sheet*), and (ii) the adjacency condition between the target word and the matching one. When the matching stimulus is located in the first position in the triad, the matching and the target stimuli are not adjacent (primacy condition), whereas when the matching stimulus is found in the second position in the triad the matching and the target stimuli are adjacent to each other (recency condition). Everything else being equal, recency trials are predicted to be easier to answer accurately than primacy ones, particularly for challenging (Best et al., 2001).

Table 7. Proportion of correct responses by learner group (Hermosillo, Santiago de Querétaro), as a function of lexical contrast (*seat-sit*, /i:/-/ɪ/; *sheet-cheat*, /ʃ/-/tʃ/) and adjacency condition (primacy, recency).

	Hermosillo				Santiago de Querétaro			
	primacy	recency	diff.	<i>M</i>	primacy	recency	diff.	<i>M</i>
/ʃ/-/tʃ/	.48	.64	-.16	.56	.61	.74	-.13	.67
/i:/-/ɪ/	.79	.82	-.03	.80	.80	.85	-.05	.82

Note: Primacy stands for trials in which target and matching stimuli are not adjacent; recency stands for trials in which target and matching stimuli are adjacent.

The arcsine-transformed proportion-correct scores were submitted to a mixed-design, three-way $2 \times (4) \times 2$ ANOVA with Location (Hermosillo, Santiago de Querétaro) as a between-subjects factor, and Contrast (*cheat-sheet*, *seat-sit*) and Adjacency (primacy, recency) as within-subjects factors. The ANOVA yielded main effects of Location, $F(1, 86) = 5.7, p < .05, \eta^2 = .02$, Contrast, $F(1, 86) = 117.7, p < .001, \eta^2 = .19$, and Adjacency, $F(1, 86) = 14.7, p < .001, \eta^2 = .05$. Of these effects, the largest one is Contrast, then Adjacency. Importantly, there were two two-way interactions: Contrast by Adjacency, $F(1, 86) = 4.4, p < .05, \eta^2 = .01$, and Contrast by Location, $F(1, 86) = 6, p < .05, \eta^2 = .02$. There was no Location by Adjacency interaction and no three-way interaction.

The two two-way interactions were explored in three steps. The alpha criterion was adjusted for three comparisons, $.05/3 = .016$. Firstly, to explore the Contrast by Adjacency interaction, Location was averaged over and the effects of adjacency for the two contrasts were analyzed separately. This analysis pools the data for the two dialectal regions. Adjacency did not trigger a significant effect for the *seat-sit* contrast, $t(87) = 2.05, p = .04, \text{Cohen } d = .199$, but it did for the *cheat-sheet* one, $t(87) = 3.9, p < .001, \text{Cohen } d = .395$. That reveals that people were less accurate in primacy trials than in recency ones, but only in trials that tested the *cheat-sheet* contrast. The *seat-sit* contrast was similarly difficult across adjacency conditions. Secondly, to

explore the Contrast by Location interaction, Adjacency was averaged over and the effects of Contrast for the two learner groups were analyzed separately. For both groups, the *cheat-sheet* contrast led to significantly more response errors than the *seat-sit* contrast (Santiago de Querétaro: $t(87) = 6.3, p < .001$, Cohen $d = .594$; Hermosillo: $t(87) = 8.9, p < .001$, Cohen $d = .971$), but the effect was larger for the learners in Hermosillo than for the learners in Santiago de Querétaro, which explains the interaction. And, finally, returning once more to the Contrast by Location interaction, the potential effects of Location for the two contrasts were analyzed separately. There was no significant effect of Location for the *seat-sit* contrast, $t(172.5) = .615, p > .5$, Cohen $d = .092$, whereas the effect was statistically significant for the *cheat-sheet* contrast, $t(173.9) = 3.367, p < .001$, Cohen $d = .507$.

To summarize, both groups of English learners find both lexical contrasts relatively difficult to discriminate. Interestingly, the *cheat-sheet* contrast appears to be more challenging than the *seat-sit* contrast. Also, both groups of learners are similarly accurate in their discrimination of the *seat-sit* contrast, which we are taking to be the control condition. The most important finding is that, for the *cheat-sheet* contrast, learners in Hermosillo are more likely than the learners in Santiago de Querétaro to make discrimination errors. From these analyses, one could infer that the discrimination of the /tʃ/-/ʃ/ contrast is more challenging for learners in the Hermosillo group than it is for the learners in Santiago de Querétaro; recall, however, that, according to a vocabulary-size test, the group of learners in Santiago de Querétaro in this sample are, on average, more proficient in English than the group of learners in Hermosillo. Thus, the finding could be due to an asymmetry in English proficiency level (particularly, differences in their vocabulary size) rather than to their native dialect phonologies.

To address the possibility that vocabulary size, rather than native phonology, explains these findings, a subset of the 11 learners with the lowest LexTale scores in the Santiago de Querétaro group and the 11 learners with the highest LexTale scores in the Hermosillo sample was selected to form a subset comprising 22 learners, $\frac{1}{4}$ of the sample. In this subset, the vocabulary-size of the Hermosillo group ($M = 73.06$, $SD = 5.2$) is statistically larger than that of the group in Santiago de Querétaro ($M = 57.5$, $SD = 1.8$), according to a Welch t -test, $t(12.21) = 9.26$, $p < .0001$, 95% c.i. [11.91, 19.22], Cohen's $d = 3.951$. To the extent that vocabulary size is an indicator of proficiency, Hermosillo learners in this subset are more proficient than the learners in the Santiago de Querétaro group. A mixed-design ANOVA with arcsine-transformed accuracy scores obtained in the discrimination task yields only main effects of Contrast, $F(1, 20) = 48.02$, $p < .0001$, $\eta^2 = .30$, and Adjacency, $F(1, 20) = 10.69$, $p < .01$ [.004], $\eta^2 = .11$, but no other main effects, and no interactions. Importantly, there are no main effects of Location, $F(1, 20) = .01$, $p > .05$ [.91], $\eta^2 = .0002$, and Location does not interact with Contrast, $F(1, 20) = .54$, $p > .05$ [.47], $\eta^2 = .005$. Overall, participants are more accurate in their discrimination of the *seat-sit* contrast ($M = .83$, $SD = .17$) than of the *cheat-sheet* contrast ($M = .57$, $SD = .23$). They are also more accurate in recency trials ($M = .77$, $SD = .21$) than in primacy trials ($M = .63$, $SD = .26$). In sum, an analysis of a subset of data in which the Hermosillo learners have larger English vocabularies than the learners in Santiago de Querétaro fails to reveal any differences between the groups in regard to their discrimination of the *cheat-sheet* contrast (or the *seat-sit* one, for that matter). Apparently, for learners in Hermosillo to match those in Santiago de Querétaro in their discrimination of the *cheat-sheet* contrast, they must be of higher proficiency than them (or have larger vocabularies).

In a final analysis, the potential effects of vocabulary size on the discrimination of the target contrast was explored by means of two linear regression models. These analyses address the following question: Do learners with larger vocabularies show increased sensitivity to the target consonant contrast? To conduct these comparisons, one of the experimental conditions was selected—the most “difficult” one: the arcsine-transformed *cheat-sheet* contrast in primacy trials—so that a single accuracy score per participant is obtained, and then correlate this variable with the learners’ LexTale scores. Two regression analyses were conducted, one per participant group. Whereas the regression model analyzing the Santiago de Querétaro data yields a significant finding, $F(1, 42) = 11.2, p = .001, R^2 = .21$, the one analyzing the Hermosillo does not, $F(1, 42) = .03, p = .86, R^2 < .001$. In other words, learners in Santiago de Querétaro with larger vocabularies seem to be more sensitive to the *cheat-sheet* contrast than the ones with smaller vocabularies, whereas no such relation exists for the learners in Hermosillo. According to a series of one-sample *t*-tests, in this particular experimental condition, the Hermosillo learners (as a group) are not found to have accuracy rates higher than chance (.05 proportion-correct scores), $t(43) = -.059, p > .025$ [.55], 95% c.i. [.41, .54], unlike the Santiago de Querétaro learners, $t(43) = 3.27, p < .025$ [.0021], 95% c.i. [.54, .68].

4.5 DISCUSSION

4.5.1 SUMMARY OF FINDINGS

This study investigates the perceptual categorization patterns of nonnative contrasts. More specifically, it explores the effects of native dialect experience in the cross-linguistic assimilation patterns of the English contrast /tʃ/-/ʃ/ by two groups of Mexican Spanish speakers. Both groups of learners differ in their life-long native dialect experience—*norteño* and central—, and were

learning English as a foreign language in two different locations in Mexico, Hermosillo and Santiago de Querétaro, respectively. As hypothesized, the results from two experimental tasks, one of identification and one of discrimination, revealed that both groups of learners find the target contrast, *cheat-sheet*, challenging to discriminate. This effect, nonetheless, was stronger for *norteño* listeners in Hermosillo, whose perceptual habits have been influenced by the sociophonetic variability that affects Spanish <ch>. The results of the categorization of the control contrast pair, *seat-sit*, obtained in this study confirmed previous findings that suggest the English phonemic contrast, /i/-/ɪ/, is particularly challenging for Spanish speakers; this, in turn, confirms the value of this contrast as a control condition in this study.

4.5.2 INTERPRETATION AND IMPLICATIONS

The results from this study revealed that both groups of learners experienced difficulties in the categorization of the English contrast presented in the minimal pair *cheat* and *sheet*. However, as hypothesized, it was observed that discrimination between the *cheat-sheet* contrast was significantly more challenging for the group of *norteño* listeners in Hermosillo than for the group of speakers of central dialect in Santiago de Querétaro. On one hand, as hypothesized, listeners in Santiago de Querétaro have difficulties identifying and discriminating between *cheat* and *sheet*. Although clearly not at ceiling, the results revealed that learners tested in Santiago de Querétaro are likely to discriminate *cheat-sheet* accurately (82% and 72%, respectively). They are, however, also likely to confuse *cheat* with *sheet* and *sheet* with *cheat*. Learners tested in Hermosillo, on the other hand, find the discrimination of the two nonnative categories, *cheat-sheet*, very challenging; in fact, they are at chance level, around 57%, for the discrimination between the two English sounds. The difference in the perceptual behavior that surfaced between

listeners in each group may be attributed to the process of assimilation of the nonnative segments established by these two groups of learners.

The difficulties encountered by the two groups of learners in this investigation can be better understood under the theoretical framework presented by the Perceptual Assimilation Model for L2 (PAM-L2, Best, 1995; Best & Tyler, 2007). This theoretical account suggests that second-language learners face different challenges when acquiring the phonology of the L2 as a consequence of the cross-linguistic assimilations patterns they establish between their L1 and L2. As previously explained, based on the assumption of the existence of cross-linguistic interaction among native and nonnative categories, the PAM-L2 presents a series of possible scenarios where different types of assimilations may take place. That is, this model suggests various ways in which nonnative sounds may be assimilated, or mapped, to native categories.

The obstacles encountered by L2 English learners in Santiago de Querétaro in the categorization of the *cheat-sheet* contrasts is an example of category-goodness assimilation proposed by PAM-L2. As claimed by this model, this type of assimilation takes place when both L2 sounds are assimilated to the same L1 category. However, in this type of assimilation, one of the two nonnative sounds may be a better exemplar of the L1 phoneme, whereas the other is a deviant from the native model. As shown in the results, learners in Santiago de Querétaro are more likely to accurately discriminate *cheat* (82%) than *sheet* (72%). These results may be explained by suggesting that speakers of central dialect assimilate English /tʃ/ to their Spanish /tʃ/ with a very high goodness of fit, whereas English /ʃ/ is also being assimilated to their Spanish /tʃ/ but with a lower goodness of fit. When a scenario of category-goodness assimilation takes place, PAM-L2 predicts discrimination between the two nonnative sounds to range from moderate to very good. This is confirmed by the perceptual behavior of learners in Santiago de Querétaro,

whose accuracy results, although clearly not at ceiling, revealed an ability to discriminate between the two nonnative segments.

The categorization patterns of the *cheat-sheet* contrasts observed in the group of learners in Hermosillo is an example of single-category assimilation. According to PAM-L2, when a single-category assimilation scenario takes place, listeners map the nonnative sounds to a single native category. In this case, both segments may either be equally acceptable or equally deviant from the model form. The results of this study revealed that discrimination rates for *cheat* and *sheet* by *norteño* listeners in Hermosillo sit at chance level, with 51% and 57%, respectively. It is possible that this perceptual behavior is the result of the assimilation of both nonnative segments, English /tʃ/ and /ʃ/, to the acoustically closest, native phoneme available, /tʃ/. As suggested by PAM-L2, in the single-category assimilation scenario, discrimination of the nonnative contrasts is expected to be poor or above chance level. The results of this study support this claim by demonstrating that *norteño* listeners tested in Hermosillo are likely to confuse *cheat* with *sheet* and *sheet* with *cheat* at rates that are perhaps not negligible. This, in turn, presents a challenge to Hermosillo learners when discriminating between these two nonnative sounds.

Second-language learners' native language background plays an important role in the difficulties that arise in the assimilation of nonnative sounds. The assimilability of the English contrast to native categories observed in the two groups of learners in this study may also be explained taking into consideration the listeners' native dialect experience. It was initially hypothesized that the speakers of *norteño* and central Mexican Spanish tested in this study would differ in the obstacles they encountered in the L2 as a consequence of the assimilation patterns they establish between the phonology of their L1 and L2. As observed in the results of this study, the two groups of listeners, Hermosillo and Santiago de Querétaro, differed in their perceptual

behavior. The differences in the categorization patterns may, in fact, be the result of the obstacles presented to them when learning their L2 as a consequence of the regional variety of Spanish they were exposed to early in life.

As presented above, native speakers of most Spanish dialects, as the listeners in the Santiago de Querétaro group, include /tʃ/ in their native phonology. For this reason, when learning the English contrast between /tʃ/ and /ʃ/, learners in Santiago de Querétaro must develop a new phoneme in opposition to the one existing (and reusable) in their native dialect. That is, to successfully discriminate between English /tʃ/ and /ʃ/, native central Mexican Spanish speakers are required to create a new sound category at both levels, phonetic and phonological. It may be possible that learners in Santiago de Querétaro are more successful at discriminating *cheat* than *sheet* because *cheat* corresponds to an existing phonological category in their native sound inventory, /tʃ/, whereas the discrimination of *sheet* is not as good because /ʃ/ must first be developed as a category. In this process, however, the new category, /ʃ/, is being assimilated to the closest existing category in the native phonology, /tʃ/, but with a lower goodness of fit.

Norteño listeners in Hermosillo face different obstacles in their perception of the English contrast *cheat-sheet* than those presented to learners in Santiago de Querétaro as a consequence of their linguistic background. As described before, native speakers of *norteño* dialect, such as the group of learners in Hermosillo, are recurrently exposed to the sociophonetic variation that affects /tʃ/. In this dialect, both [tʃ] and [ʃ] are allophones of /tʃ/ and they are not found in complementary distribution. *Norteño* listeners' life-long experience with the two variants of /tʃ/, as they coexist in their dialect, present them with a different learning challenge to that faced by learners in Santiago de Querétaro: remapping the relationship between existing native sounds. Opposite to listeners in Santiago de Querétaro, in order to successfully discriminate between

English /tʃ/ and /ʃ/, *norteño* learners in Hermosillo do not only have to develop a new category but they must conduct an allophonic split of the two existing sounds in their L1 native phonology. That is, *norteño* listeners must first unlearn that [tʃ] and [ʃ] are mapped to the same category, /tʃ/, and then develop a new category for the L2 sound for which they will recycle an existing native sound, [ʃ], and will then be mapped to the recently developed category.

The consequences of the two learning paths traced by dialect experience can be observed in the results obtained in this study. The results revealed that learners in Hermosillo are less likely than central Mexicans to succeed in their discrimination between English /tʃ/ and /ʃ/. As observed in their perceptual behavior, the obstacles these two groups faced are not only the result of having internalized a knowledge of a first language, Spanish, but to their unique native language background. More specifically, these two groups of learners face different learning obstacles as a consequence of their native dialect experience, which forces their acquisition of this contrast to undergo different assimilation processes.

Unsurprisingly and as hypothesized, both groups of participants experienced difficulties discriminating between *seat* and *sit*, as has been previously documented in the literature. The English phonemic contrast /i/ and /ɪ/ has proved to be particularly difficult for native Spanish speakers (Casillas, 2015; Escudero & Boersma, 2004; Kondaurova & Francis, 2008; Morrison, 2009), and the results of this investigation contribute to these findings. As observed in the identification patterns obtained from the identification task, both groups of listeners are more likely to be wrong than right in the accurate identification of *sit* and *seat*. The degree of difficulty faced by both groups of listeners thus confirmed that *seat* and *sit* successfully served as a control condition for the target contrast selected for this study.

The results evidence different perceptual assimilation patterns by two groups of Mexican Spanish listeners in the same condition. This suggests that these two groups of listeners have developed different cross-language assimilation patterns. The perceptual development observed in these two tasks may differ not only according to the listener's linguistic experience—particularly that of dialect—, but also to their own individual phonology.

4.6 CONCLUSION

The two experiments in this investigation report on the identification and discrimination patterns of nonnative categories. The results of this study revealed that both groups of learners faced difficulties in the identification and discrimination of the lexical contrasts tested. However, speakers of *norteño* dialect, in which [tʃ] and [ʃ] are variably found as phonetic variants of /tʃ/, found the categorization of this contrast more difficult than listeners of central Mexican Spanish. These results suggest that native dialect experience—and the mental representations individuals store, including those that undergo variation—may affect the patterns of categorization of L2 sounds, and these may differ according to the linguistic experience with one's own dialect. Furthermore, this study contributes to the extensive body of research on the effects of cross-linguistic variation on second language speech perception. It particularly extends previous findings that suggest phonetic variation may impact the development of phonological representations by L2 learners in the L1 setting.

CHAPTER 5

CONCLUSION

This dissertation has presented a preliminary study that explored sociophonetic variation in the native dialect and two main studies that investigated the relationship between dialect experience on word recognition and L2 sound acquisition. Specifically, this research project analyzed the effects of sociophonetic variation on the patterns of lexical access and the phonological processing of nonnative contrasts. The population of interest for this study was integrated by two groups: a group of *norteño* speakers with life-long experience with *shesheo* and a group of native speakers of central Mexican dialect, who lack experience with this variation.

The preliminary study explored the presence of *shesheo* in the speech by the two groups of participants. This investigation analyzed the effects of native dialect experience on the production of words whose initial consonant is <ch> by the two groups of speakers, who differ in their dialectal experience. The visual exploration of the data confirmed the presence of both variants, the affricate and the fricative, in the speech produced by *norteño* speakers whereas central dialect speakers favor the production of the affricate variant only. These results may contribute to the further understanding of the effects of experience with sociophonetic variation in the native dialect on the production of native segments.

The first experiment investigated the patterns of lexical activation by the two groups of listeners. Participants completed a lexical decision task with cross-modal priming that included target words preceded by primes with either one of the two possible variants that affect /tʃ/ ([tʃ]arco-CHARCO; [ʃ]arco-CHARCO) in *norteño* Spanish. The results showed that recognition was facilitated by both variants [tʃ] and [ʃ] for both groups of listeners, regardless of their experience with *shesheo*. The facilitation produced by the two variants, the affricate and the

fricative, suggests that both are able to tap into the lexical representation of speakers of *norteño* dialect and Mexican central dialect. It was also shown, nonetheless, that these two variants are not equally effective in the process of lexical access: the affricate variant, [tʃ], lead to faster recognition of words than the fricative variant, [ʃ]. This suggests that the two variants differ from each other at some level of representation, implicating that the affricate variant is privileged over the fricative. The results also demonstrated that *shesheo*, although it delays lexical access, it does not impede word recognition. The evidence obtained from this study supports the claim that speakers who are recurrently exposed to sociophonetic variation in their native dialect store more than one phonetic variant in their abstract, lexical representations of words. It is also true of these speakers, however, that these phonetic variants do not trigger the same processing costs, revealing an advantage for one phonetic variant over the others.

The second study dealt with the phonological processing of a nonnative phonemic contrast, /tʃ/-/ʃ/, by two groups of Spanish-speaking learners of English, who differ in their linguistic experiences. The first experiment, a word-categorization task, revealed that both groups of learners, *norteño* and central, encountered difficulties in the identification of the lexical items containing the target segments. This task was particularly more challenging for *norteño* listeners, whose native dialect includes both [tʃ] and [ʃ] as two variants of the same phoneme. The second experiment, a categorical discrimination task, showed that both groups of learners, but much more so *norteño* listeners, sit at chance level when attempting to distinguish between the two segments of the nonnative contrast. The results demonstrate that learning new mappings between surface and underlying phonological representations presents an acquisitional obstacle substantially larger than creating a new category. Together, the two experiments support the claim that the perception of nonnative segments is strongly affected by the individual's own

native dialect. Most importantly, these results suggest that the phonetic variants found in one's own native phonology—as shaped by the dialect varieties of the same language an individual is exposed to—may present language learners with different obstacles when acquiring sounds in a second language.

The results of this investigation demonstrate the effects of native-dialect experience on the lexical processing in the native language as well as the acquisition of nonnative sounds. One of the most significant findings of this study is the impact native phonology has in the development of second-language contrasts. The results revealed that L1-Spanish speakers learning English as a second language encounter different obstacles when acquiring nonnative segments in English as a consequence of their dialectal experience. These findings confirm the relevance of learners' linguistic background and the role it may play in their process of second language acquisition. Implications of these results may be extended to other disciplines and fields of study, such as Second Language Acquisition and Foreign Language Learning and Instruction. More specifically, the results of this study may contribute to the better practices found in material and curriculum design, classroom instruction, teaching of pronunciation, and training of language teachers, to name a few.

Learners' linguistic experiences is a factor to be considered inside and outside the language classroom. The linguistic background of second-language learners should be known in order to anticipate and understand the possible obstacles they may encounter in their learning process. By doing so, curricula-design practices may be improved since linguistic content may be organized in a more sensitive fashion that considers individual differences at the linguistic level, particularly at the dialectal level. This, in turn, could also reinforce the instruction of pronunciation in the classroom, which is oftentimes neglected. In addition, awareness of

learners' linguistic backgrounds may promote a more student-centered approach for instruction in the classroom. That is, by understanding learners' native phonology and the differences that they may encounter with that of the L2 phonological system, the instruction of L2 sounds and the acquisition of L2 contrasts may be introduced in a more accessible way. Moreover, features of learners' own native dialect, particularly that of their native phonology system, should be taken into consideration in the design and development of language-instruction materials. These materials could present new phonological information that facilitates the development of new categories or the (re)mapping of existing segments. In addition to the implications of these results on language learning, these may also be extended to language-instructors training programs.

The training of language instructors should include the development of learners' linguistic background awareness for two main reasons. First, language instructors should understand the learning paths and obstacles learners may face when acquiring a second language, specifically L2 sounds. This study confirmed that according to dialectal experience, learners follow different assimilation patterns for the acquisition of nonnative segments: a) developing new categories or b) the remapping of existing categories. This, however, presents various challenges for these two groups of learners who, regardless of sharing the same native language, possess a different native phonology. By developing this awareness, language instructors can mediate between the novel linguistic content and learners' already-internalized native knowledge to facilitate either a) creating a new category or b) recycling and remapping existing categories. Second, the teacher's awareness of learners' own linguistic experiences may contribute to the improvement of teaching practices in the classroom. By understanding the complexity of the learners' native phonology and the features shared between the L1 and the L2 at the

phonological level, teachers may be able to design and plan lessons that include activities that aim at bridging the gaps learners can potentially encounter. For instance, an English language instructor teaching learners from Mexico with various linguistic backgrounds—such as the two groups of participants in this study—should be aware of the dialect experiences this group of learners brings into the classroom. If that were the case, the language instructor would be able to design and conduct activities that consider the challenges these learners may find when acquiring the nonnative English contrast /tʃ - ʃ/. These activities could adopt an explicit-instruction approach in which acoustic differences between native and nonnative segments are addressed, or a more implicit approach that invites students to find these differences through usage, for instance.

This investigation explored the effects of native dialect experience on patterns of lexical access in the native language and the acquisition of nonnative segments. Two groups of L1-Spanish speakers who differed in their dialectal experiences participated in this study. The results suggest that one's own native phonology does not always necessarily impact the patterns of lexical activation in the native language in systematic ways, but it does modulate the perception of nonnative sounds. These results demonstrate that individuals with different regional varieties in their native dialect may face different obstacles when learning the sounds of their second language.

APPENDIX A
PRODUCTION EXPERIMENT STIMULI

Table showing stimulus materials used in production experiment. Target items included <ch>-beginning Spanish words. Words beginning with <s> were used in the control condition. Distractors included <d>- and <t>- beginning words.

Production Experiment Stimuli		
	Two-Syllable Words	Three-Syllable Words
<ch>	chapa	chaleco
	chacra	chalupa
	charro	chamaco
	chato	chamarra
	chavo	chaparro
<s>	sabio	salado
	sable	salami
	saco	salida
	saga	saliva
	sala	sazona
<d>	chapa	chaleco
	chacra	chalupa
	charro	chamaco
	chato	chamarra
	chavo	chaparro
<t>	tabla	tacaño
	taco	tacones
	tambo	tamales
	tango	taquete
	tapa	tareas

APPENDIX B
LEXICAL PROCESSING TARGET STIMULI

Tables containing stimulus words—including their glossing— used as target items in the experiment on lexical access. The first table shows all two-syllable stimulus items beginning with <cha> used as target items. Column on the left includes words with stress in the second syllable. Words with stress in first syllable are shown in the right column.

Two-syllable Target Lemmas	
chamba work-NOM.F.SG	chacal jackal-NOM.M.SG
chancla sandal-NOM.F.SG	chalet chalet-NOM.M.SG
chango monkey-NOM.M.SG	chamán shaman-NOM.M.SG
charco puddle-NOM.M.SG	charol patent leather-NOM.M.SG

This second table shows all three-syllable target stimulus words beginning with <cha>. Words with stress in the second syllable are shown in the left and middle columns. The four words on the right column have stress in the first syllable.

Three-syllable Target Lemmas		
chamaco boy-NOM.M.SG	chaqueta jacket-NOM.M.SG	
chaparro short-ADJ.M.SG	charanga old car-NOM.M.SG	chambelán escort-NOM.M.SG
champaña champagne-NOM.F.SG	charola tray-NOM.F.SG	champiñón mushroom-NOM.M.SG
champurro hot chocolate-flavored drink-NOM.M.SG	chasquido click sound-NOM.M.SG	chapulín grasshopper-NOM.M.SG
changarro little shop-NOM.M.SG	chararra junk-NOM.F.SG	charlatán charlatan-NOM.M.SG
chantaje blackmail-NOM.M.SG	chavalo young male-NOM.M.SG	

APPENDIX C BILINGUAL LANGUAGE PROFILE

Bilingual Language Profile: Spanish-English

Nos gustaría pedir su ayuda para contestar a las siguientes preguntas sobre su historial lingüístico, uso, actitudes y competencia. Esta encuesta ha sido creada con el apoyo del 'Center for Open Educational Resources and Language Learning' de la Universidad de Texas en Austin para poder tener un mayor conocimiento sobre los perfiles de hablantes bilingües independientemente de sus diversos orígenes y en diferentes contextos. La encuesta contiene 19 preguntas y le llevará menos de 10 minutos para completar. Esto no es una prueba, por tanto no hay respuestas correctas ni incorrectas. Por favor conteste cada pregunta y responda con sinceridad, ya que solamente así se podrá garantizar el éxito de esta investigación. Muchas gracias por su ayuda.

I. Información biográfica

Nombre _____	Fecha de hoy ____/____/____
Edad _____	<input type="checkbox"/> Hombre / <input type="checkbox"/> Mujer
Lugar de residencia actual: ciudad _____ País _____	
Nivel más alto de formación académica: <input type="checkbox"/> Menos de la escuela secundaria <input type="checkbox"/> Escuela Secundaria <input type="checkbox"/> Un poco de universidad <input type="checkbox"/> Universidad (diplomatura, licenciatura.) <input type="checkbox"/> Un poco de escuela graduada <input type="checkbox"/> Máster <input type="checkbox"/> Doctorado <input type="checkbox"/> Otra: _____	

Please cite as :

Birdsong, D., Gertken, L.M., & Amengual, M. *Bilingual Language Profile: An Easy-to-Use Instrument to Assess Bilingualism*. COERLL, University of Texas at Austin. Web. 20 Jan. 2012. <<https://sites.la.utexas.edu/bilingual/>>.

III. Uso de lenguas

En esta sección, nos gustaría que contestara algunas preguntas sobre su uso de lenguas marcando la casilla apropiada. El uso total de todas las lenguas en cada pregunta debe llegar al 100%.

7. En una semana normal, ¿qué porcentaje del tiempo usa las siguientes lenguas con **sus amigos**?

Español	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inglés	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Otras lenguas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

8. En una semana normal, ¿qué porcentaje del tiempo usa las siguientes lenguas con **su familia**?

Español	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inglés	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Otras lenguas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

9. En una semana normal, ¿qué porcentaje del tiempo usa las siguientes lenguas en **la escuela/el trabajo**?

Español	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inglés	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Otras lenguas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

10. Cuando se habla a usted mismo, ¿con qué frecuencia **se habla a sí mismo** en las siguientes lenguas?

Español	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inglés	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Otras lenguas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

11. Cuando hace cálculos contando, ¿con qué frecuencia **cuenta** en las siguientes lenguas?

Español	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inglés	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Otras lenguas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

IV. Competencia

En esta sección, nos gustaría que considerara su competencia de lengua marcando la casilla de 0 a 6.

- | | 0=no muy bien | 1 | 2 | 3 | 4 | 5 | 6=muy bien |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 12. a. ¿Cómo habla en Español ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. ¿Cómo habla en Inglés ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. a. ¿Cómo entiende en Español ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. ¿Cómo entiende en Inglés ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. a. ¿Cómo lee en Español ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. ¿Cómo lee en Inglés ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. a. ¿Cómo escribe en Español ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| b. ¿Cómo escribe en Inglés ? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

V. Actitudes

En esta sección, nos gustaría que contestara a las siguientes afirmaciones sobre actitudes lingüísticas marcando las casillas de 0 a 6.

- | | 0=no estoy de acuerdo | 6=estoy de acuerdo | | | | | |
|---|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| 16. a. Me siento "yo mismo" cuando hablo en Español . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| b. Me siento "yo mismo" cuando hablo en Inglés . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| 17. a. Me identifico con una cultura Hispanohablante . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| b. Me identifico con una cultura Anglohablante . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| 18. a. Es importante para mi usar (o llegar a usar) Español como un hablante nativo. | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| b. Es importante para mi usar (o llegar a usar) Inglés como un hablante nativo. | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| 19. a. Quiero que los demás piensen que soy un hablante nativo de Español . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |
| b. Quiero que los demás piensen que soy un hablante nativo de Inglés . | <input type="checkbox"/> 0 | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> 6 |

APPENDIX D
BILINGUAL LANGUAGE PROFILE ADAPTED TO PYSCHOPY2

The PsychoPy2 implementation of the Bilingual Language Profile used in this study was based in the one designed by Joseph V. Casillas (2017).

Nos gustaría pedir su ayuda para contestar a las siguientes preguntas sobre su historial lingüístico, uso, actitudes y competencia.

Esta encuesta ha sido creada con el apoyo del 'Center for Open Educational Resources and Language Learning' de la Universidad de Texas en Austin para poder tener un mayor conocimiento sobre los perfiles de hablantes bilingües independientemente de sus diversos orígenes y en diferentes contextos.

La encuesta contiene 19 preguntas y le llevará menos de 10 minutos para completar. Esto no es una prueba, por tanto no hay respuestas correctas ni incorrectas. Por favor conteste cada pregunta y responda con sinceridad, ya que solamente así se podrá garantizar el éxito de esta investigación. Muchas gracias por su ayuda.

Historial lingüístico

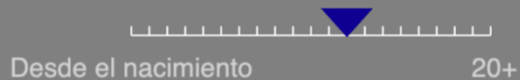
En esta sección, nos gustaría que contestara algunas preguntas sobre su historial lingüístico marcando la casilla apropiada.

1a

Historial lingüístico

¿A qué edad empezó a aprender las siguientes lenguas?

Español



12

1b

Historial lingüístico

¿A qué edad empezó a aprender las siguientes lenguas?

Inglés



17

Uso de lenguas

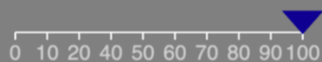
En esta sección, nos gustaría que contestara algunas preguntas sobre su uso de lenguas marcando la casilla apropiada. El uso total de todas las lenguas en cada pregunta debe llegar al 100%.

7a

Uso de lenguas

En una semana normal, ¿qué porcentaje del tiempo usa las siguientes lenguas con sus amigos?

Español



100

7b

Uso de lenguas

En una semana normal, ¿qué porcentaje del tiempo usa las siguientes lenguas con sus amigos?

Inglés



50

Competencia

En esta sección, nos gustaría que considerara su competencia de lengua marcando la casilla de 0 a 6.

12a

Competencia

¿Cómo habla en ...?

Español ?



6

12b

Competencia

¿Cómo habla en...?

Inglés ?



6

16b

Actitudes

Me siento "yo mismo" cuando hablo en Inglés.

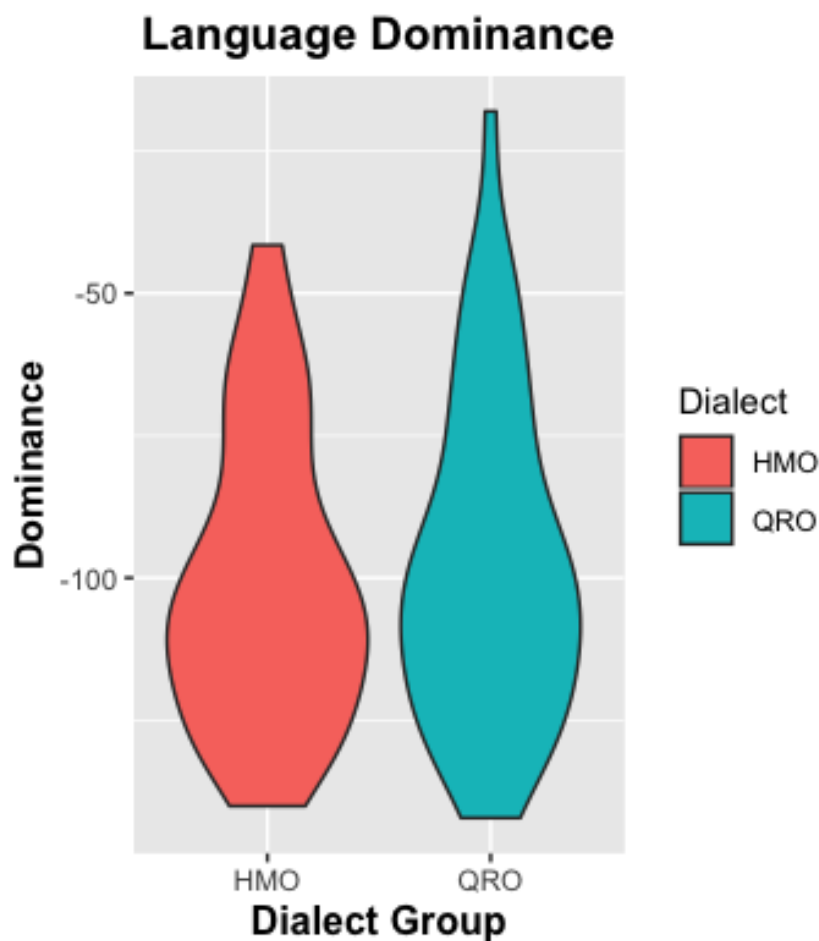


6

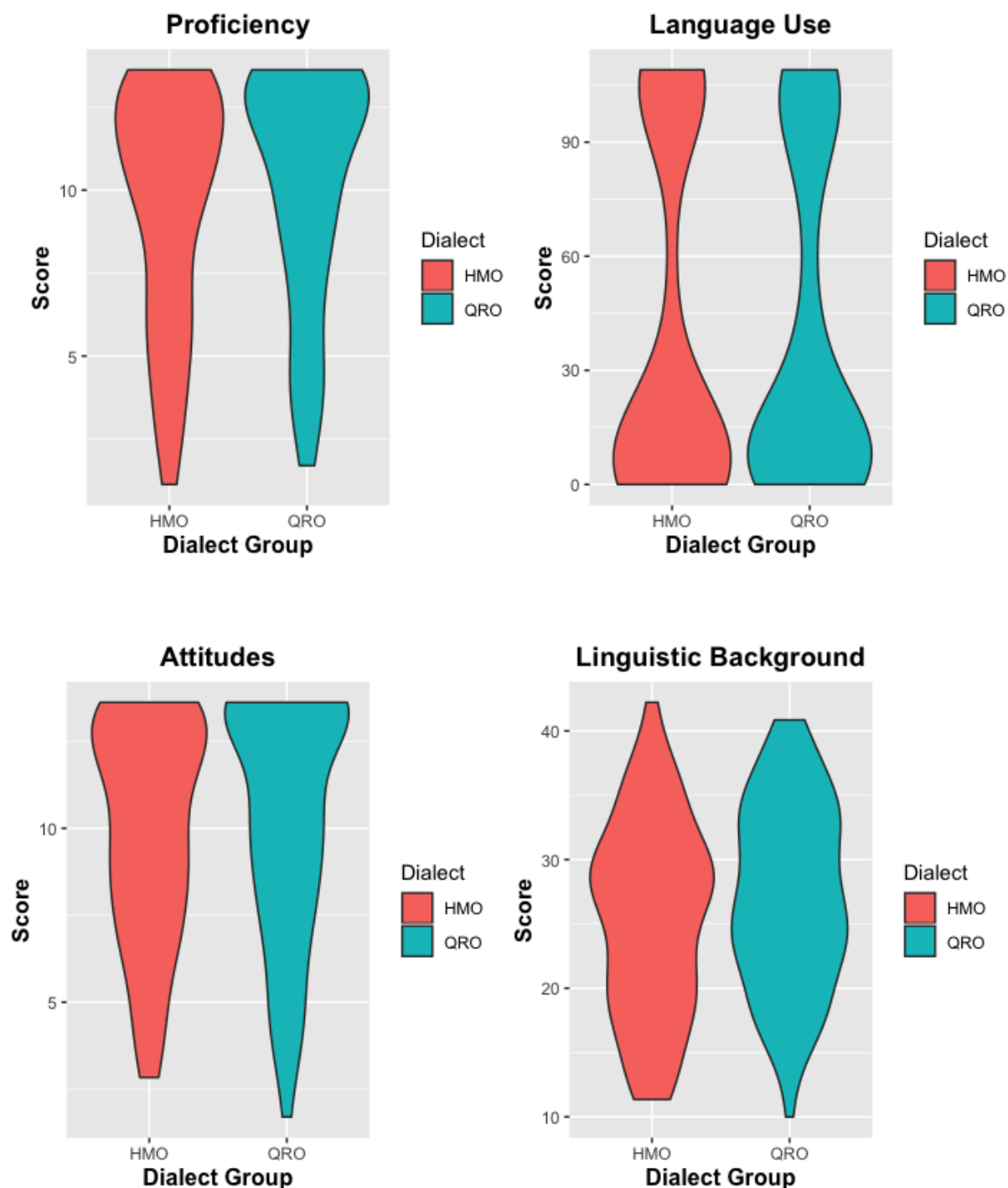
APPENDIX E RESULTS FOR BILINGUAL LANGUAGE PROFILE

The Bilingual Language Profile (BLP) questionnaire provides a measure of language dominance. Linguistic dominance is obtained by calculating scores from four different modules, which include information regarding language history, language use, language proficiency, and language attitudes. Each module provides a separate score. The scores from each module are summed and provide a total value of language dominance, which ranges from -218 to 218. The extremes on the score spectrum reveal a dominance in one of the two languages. The values of the extremes are assigned arbitrarily. In this study, negative scores are associated with dominance in Spanish. Test scores at or near zero indicate balanced bilingualism.

The violin plot below shows the results of language dominance as a function of dialectal group. As observed, most participants in this study obtained scores that concentrate in the negative extreme of the spectrum, associate with Spanish dominance. These results suggest a Spanish-language dominance for both groups of learners. That is, learners in Hermosillo and Santiago de Querétaro in this study are Spanish-dominant bilinguals.



The violin plots below further explore the results obtained by both groups of learners in the four different modules that integrate the BLP. As observed in these plots, both groups of learners behave similarly across all four modules. The results revealed that learners in Hermosillo and Santiago de Querétaro are dominant in Spanish in each one of the four modules. In other words, both two groups of bilinguals are Spanish-dominant in language proficiency, language use, language attitudes, and language history.



APPENDIX F
LEXTALE ADAPTED TO PYSCHOPY2

LexTALE materials

platory (not scored)	30. skave
denial (not scored)	31. plaintively
generic (not scored)	32. kilp
1. mensible	33. interfate
2. scornful	34. hasty
3. stoutly	35. lengthy
4. ablaze	36. fray
5. kermshaw	37. crumper
6. moonlit	38. upkeep
7. lofty	39. majestic
8. hurricane	40. magrity
9. flaw	41. nourishment
10. alberation	42. abergy
11. unkempt	43. proom
12. breeding	44. turmoil
13. festivity	45. carbohydrate
14. screech	46. scholar
15. savoury	47. turtle
16. plaudate	48. fellick
17. shin	49. destription
18. fluid	50. cylinder
19. spaunch	51. censorship
20. allied	52. celestial
21. slain	53. rascal
22. recipient	54. purrage
23. exprate	55. pulsh
24. eloquence	56. muddy
25. cleanliness	57. quirky
26. dispatch	58. pudour
27. rebondicate	59. listless
28. ingenious	60. wrought
29. bewitch	

Task instructions used for the LexTALE adapted version to PsychoPy. The PsychoPy2 implementation of the LexTALE lexical decision task used in this study was based in the one designed by Joseph V. Casillas (2017).

This is an English vocabulary test.
Este es una breve prueba sobre vocabulario del inglés.

In this experiment you will be presented 90 sequences of letter strings that look 'English'. Only some of them are real words.
En este experimento, se presentarán 90 secuencias de letras que se ven como palabras del inglés. Sin embargo, solo algunas de ellas son palabras reales.

Please select the words you know (or of which you are convinced they are English words, even though you might not be able to give their precise meaning).

Por favor selecciona las palabras que conoces (o aquellas de las que estás convencido/a que son palabras del inglés aún cuando no conoces exactamente su significado).

Be careful, however: Errors are penalized. Because of this it does not make sense to try to increase your score by adding tallies to 'words' you've never seen before!

Sin embargo, debes tener cuidado: los errores son penalizados. Por esta razón, no tiene sentido tratar de mejorar tu puntuación tratando de señalar como palabras reales aquellas que no conoces.

All you have to do is press the 'm' key if you believe it is a real English word, or press the 'z' key if you think it is a fake word.

Todo lo que tienes que hacer es presionar la tecla 'm' si crees que es una palabra real del español, o presionar la tecla 'z' si es una palabra falsa.

m = palabra real del inglés

z = palabra NO real del inglés

Let's practice a little...
¡Practiquemos un poco!

Screenshots of practice and test items used for the LexTALE adapted version to PyschoPy.

PRACTICE

platory

False

REAL

ingenious

FALSE

REAL

majestic

FALSE

REAL

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