A Lenition Continuum: Acoustic Variability of Spanish Stop Consonants

By

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Abstract

Previous work on stop consonant weakening, or lenition, in Romance languages has been discussed in terms of driving factors behind language variation and change; however, most of these studies do not provide data on the acoustic variability of stop consonants or the effects of linguistic (e.g., point of articulation, prosodic position, lexical stress) or extralinguistic (e.g., age, gender, and dialect) factors. My research acoustically and sociolinguistically analyzes Spanish's stop consonants /ptk/ and /bdg/ across multiple varieties, which generates a lenition continuum ranging from weak to strong as well as commentary on the current state of their variation across the Spanish-speaking world.

The data set used for my dissertation, extracted from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) corpus, comes from the following regions: Spain, the Canary Islands, Argentina, Chile, Mexico, the Caribbean and the Andes. Trends show that while /ptk/ and /bdg/ remain distinct categories within each variety studied, the degree of consonant occlusion varies greatly inter-dialectally. For example, Mexican Spanish /ptk/ and /bdg/ are produced with greater occlusion whereas the same segments in some Peninsular and Caribbean varieties are much more open, with /bdg/ often experiencing total deletion. The data also shows a slight overlap of the production of the most radical, less occluded /ptk/ in Caribbean Spanish with the most conservative production of /bdg/ in Mexican Spanish, yielding implications for future work on consonant perception. Concerning age and gender, younger speakers as well as male speakers tend to produce less occluded, more open stop consonants. Overall, this investigation fills existing research gaps by making suggestive points regarding diachronic language change evidenced by synchronic consonant variation, the variation across multiple Spanish varieties, sociolinguistic effects on weakening and the geographical spread of consonant lenition.

1. CHAPTER ONE: INTRODUCTION

1. Introduction and Background

The aim of this dissertation is to perform a complete acoustic analysis and comparison between occlusive consonants /ptk/ and /bdg/ across different varieties of modern Spanish with the goal of contrasting the phonetic realizations of these two stop consonant series and situating their allophonic variants on a continuum of consonant lenition, or weakening, ranging from weak to strong. Previous work on lenition in Romance languages discusses consonant lenition both diachronically and synchronically to determine the driving factors behind language change (Cravens 2002; Jungemann 1955; Martinet 1952; Tovar 1948); however, many of these studies do not provide information regarding acoustic variability of consonant production and weakening, while considering various linguistic and extralinguistic factors. My dissertation contributes an entirely acoustically-based analysis, offering concrete acoustic data on the current state of variation with respect to occlusive consonants across the Spanish-speaking world.

Previous investigation of consonant lenition in Spanish has shown that linguistic factors such as word position, lexical stress, and flanking vowels, among others, play a role in the degree of consonant weakening (Cho, McQueen & Cox 2006; Cole et al. 1999; Fivela et al. 2008; Kirchner 2004; Lavoie 2001; Lewis 2001; Lisker & Abramson 1964; Ortega Llebaria 2004; Wireback 1997). In addition to the aforementioned linguistic factors, extralinguistic factors such as age, gender, speech style, and dialect have also been shown to affect phonetic outcomes (Bayley & Tarone 2011; Labov 2001; Lewis 2001; Long 2014; Oftedal 1985). Therefore, this study investigates the acoustic properties of occlusive consonants to determine their effects on the phonetic realizations of the consonant segments in question both inter- and intra-dialectally in order to provide a clearer picture of current consonant weakening phenomena across different varieties of Spanish.

Although dialectal variation of consonant lenition has been extensively investigated in prior research (Colantoni & Marinescu 2010; Hualde, Simonet & Nadeu 2011; Martínez Celdrán 1984, 2009; Oftedal 1985; O'Neill 2010; Torreira & Ernestus 2011; Trujillo 1980), this dissertation widens the scope of our knowledge on the topic by providing data on multiple varieties of Spanish within the same study where evidence of consonant weakening is lacking. The acoustic nature of this study on synchronic lenition across different varieties of Spanish contributes to the field of Spanish Linguistics by making suggestive points regarding diachronic language change, the evolution of multiple Spanish varieties, and the geographical spread of the phenomenon of consonant lenition. The geographical coverage of my study is a major contribution to our knowledge of consonant weakening in the Spanish-speaking world by offering acoustic data analysis and cross-dialectal comparison of Spanish from Spain, the Canary Islands, Argentina, Chile, Mexico, the Caribbean and the Andean region.

The organization of this chapter will be as follows: history of lenition and causation theories, contributions of the current study, relevant acoustic variables that affect lenition, synchronic studies on lenition, and motivations and research questions.

1.1 History of Lenition within a Romance Context

1.1.1 Defining Lenition

Even though much attention has been paid to Romance consonant lenition in what is known as Western Romance (i.e., Gallo-Romance, Iberian-Romance and Northern Italian) diachronically over the past several decades, more recent analyses from a synchronic perspective reveal instances of change in Romance that remain unexplained. Consonant lenition is a process by which a consonant segment is realized with a weakened articulation, and as a result, the production of this consonant may be voiced, spirantized, or lost.[1] Historical weakening in what is traditionally known as Western Romance involves the simplification of the Latin geminate consonants, the voicing of simple voiceless occlusives and the spirantization of voiced occlusives. Simplification, as it pertains to lenition, involves reduction in consonant length from a geminate production to that of a single phoneme. Voicing refers to the process in which a voiceless consonant becomes voiced, and spirantization (also fricatization) is a process by which a voiced segment experiences assimilation to its surrounding vowels by the reduction of articulatory gestures approximating the voiced segment without full occlusion. The ultimate case of consonant lenition is deletion, where a voiced spirant is reduced to zero. Examples of these changes are presented in Table 1.1.

[1] *Spirantization* as referred to here, relates to lenition as a step in the process of consonant weakening. Voiced stop consonants become spirants, or approximants, when buccal organs approach each other, but do not touch, at times creating friction. The debate between what constitutes spirant/fricative vs. approximant will be discussed in Section 1.1.3. Spirants/fricatives and approximants are both represented by the realizations [βðɣ].

Process		**Example**
1) Simplification	geminate → simple occlusive	/kk/ > /k/
2) Voicing	voiceless occlusive→voiced occlusive	/k/ > /g/
3) Spirantization	voiced occlusive → voiced spirant	/g/ > /ɣ/
4) Deletion	voiced spirant → zero	/ɣ/ > /Ø/

Table 1.1. Consonant lenition in Romance (adapted from Penny 2002:76)

Evidence of modern consonant lenition indicates that these changes are common to Romance languages and are attributed to structural changes that occurred in Latin: spirantization of voiced occlusive segments and sonorization of voiceless occlusive segments (Walsh 1991:155). Examples of these Romance changes are included in Tables 1.2 and 1.3.

Latin	**Italian**	**French**	**Catalan**	**Castilian**	**Portuguese**
CUPPA	*coppa*	*coupe*	*copa*	*copa*	*copa*
GUTTA	*gotta*	*goutte*	*gota*	*gota*	*gota*
VACCA	*vacca*	*vache*	*vaca*	*vaca*	*vaca*

Table 1.2. Development of /ppttkk/ in Romance (Cravens 2002:76*)*

Latin	**Italian**	**French**	**Catalan**	**Castilian**	**Portuguese**
SAPERE	*sapere*	*savoir*	*saber*	*saber*	*saber*
ROTA	*ruota*	*roue*	*roda*	*rueda*	*roda*
AMICA	*amica*	*amie*	*amiga*	*amiga*	*amiga*

Table 1.3. Development of /ptk/ in Romance (Cravens 2002:76).

According to Walsh (1991:155), spirantization of intervocalic voiced occlusives and voicing of intervocalic voiceless occlusives are two productive phonetic rules already in Late Latin and thus are also applied to Proto-Romance; that is, the theoretical language variety which represents the latest common stage of Romance languages (i.e., Spanish, French, Italian, Portuguese, Romanian, etc.).[2] These productive processes occur in determined phonetic contexts, frequently ignoring word boundaries; however, phonemic geminates in intervocalic position are maintained as long consonants (see examples 1 and 2 adapted from Walsh 1991:155).

(1) a. do [dó]
 b. non do [non̪.dó]
 c. eo do [έo.ðó]

(2) a. terra [tέ.ra]
 b. en terra [en̪.tέ.ra]
 c. la terra [la.ðέ.ra]

During the Middle Ages, there was a more profound development of intervocalic occlusive phonemes in Old Spanish. Voiceless occlusives were no longer variable in word initial position, alternating between voiced allophones in intervocalic position and voiceless allophones after a pause or a consonant; however, they were invariable, conserving the voiceless phoneme in word initial position. These developments led to the modern phonemic system that we find in Spanish today as a result of changes to the Latin consonant system: geminate phonemes in intervocalic position are reduced to simple voiceless phonemes, /ppttkk/ > /ptk/; voiceless occlusive phonemes in word-internal intervocalic position are reassigned to voiced phonemes: /ptk/ > /bdg/. Consequently, according to Walsh (1991:156), spirant realizations occur only in internal position and represent independent phonemes /βðɣ/, not allophones derived from voiced segments. Walsh (1991:156) distinguishes /bdg/ from /βðɣ/, by stating that in word-internal

[2] Alkire & Rosen (2010:40) state: "Even if there were no records of the Latin language, linguists could still attempt a reconstruction based on the Romance languages. By convention, such a reconstructed language is called *Proto-Romance*."

position, these sounds create minimal pairs, that is, two words varying in only one sound with different meanings. Therefore, during this time, /βðɣ/ could not be referred to as simply phonetic variants of /bdg/ because the former represented entirely different sounds. There have been a variety of causation theories as to why these changes occurred; the following subsection will discuss one of these theories: internal structural causation.

1.1.2 Internal Structural Causation

To explain consonant weakening in Western Romance, Martinet (1952) proposes a phonemic shift that was initiated by a chain of changes, or rather, push-pull chains (see 3).

(3) /ppttkk/ → /ptk/ → /bdg/ → /βðɣ/

Veiga (1988:30) states that we can understand push-pull chains as a reaction to certain changes in the phonological system. A push-chain occurs when the phonetic realization of one segment begins to encroach on the same phonetic realization of a different segment, thus causing the latter to shift as well in order to maintain phonological distinction. A pull-chain, on the other hand, occurs when a certain segment suffers weakening or loss in a certain phonetic environment, leaving empty slots in the phonological inventory.

Related to the push-chain theory, Alarcos (1961:234-239) reasons in favor of a Latinate explanation for consonant lenition, in which the increase of geminate phonemes in Latin and the subsequent tendency to create open syllables could have been a major contributor to these chain shifts. Voiced occlusive phonemes acquired continuity, forming the voiced spirant series /bdg/ >

/βðɣ/ without affecting any other phoneme within the phonological system, and as a result, this shift creates *casillas vacías*, empty slots in the phonological inventory of consonants (see 4).

(4) /ppttkk/, /ptk/, /_ _ _/, /βðɣ/ (< /bdg/)

According to Hock (1986:156), the pull-chain shifts are "motivated by linguistic economy; since one distinctive feature is sufficient to realize a phonemic opposition, an opposition based on more than one feature is therefore redundant and tends to be reduced to one primary feature." To support this idea of pull-chains, Lloyd (1987:144) highlights a connection between lenition processes and the characterization of the phonological system of Latin. Latin distinguished continuity with only two consonants: /f/ and /s/; therefore, according to Lloyd (1987), the voiced occlusive phonemes can acquire a continuity trait, forming the spirant series but not affecting any other phoneme of the phonological system and thus creating an empty slot where /bdg/ had been realized before as [bd̪g]. These empty slots in the phonological inventory create the opportunity for additional phonological changes. Voiceless occlusive phonemes become voiced in intervocalic position through assimilation to their flanking vowels, and following this change, consonant length no longer is a distinctive phonological feature, resulting in simplification. From another perspective, Penny (2002:75) and Lloyd (1987:143) suggest that the simplification of the geminate consonants could be due to the higher articulatory force required to realize these consonants, in combination with the increase of geminate consonants in spoken Latin. They postulate that these geminate consonants would therefore be simplified due to the principle of economy of effort.

Another possible explanation for the simplification of the geminate phonemes would be the tendency to create open syllables; that is, those syllables that end in a vowel. Therefore, these reductions could be related to assimilation processes and the simplification of other consonant groups that eliminated consonants in syllable-final position. Malmberg (1959:305) explains the tendency to create open syllables in Western Romance, indicating that the simplification of the geminate phonemes is only a consequence of a general opening tendency of closed syllables, favoring a purely Structuralist explanation of the origins of historical consonant lenition. In any case, this simplification creates confusion and homonymy in intervocalic position among simple intervocalic consonants that previously contrasted geminates with simple intervocalic consonants. Therefore, the fact that these sounds are competing initiates a series of changes that affect the entire consonant system.[3]

1.1.3 Motivations for Contemporary Approaches

Within the last two decades, more recent analyses of occlusive segments in Romance, primarily Spanish and Italian, show evidence of allophonic weakening in similar linguistic contexts as occurred historically. What this evidence shows us is the abundance of variation for consonant lenition in present-day Romance. The current allophonic distribution of the occlusive stop

[3] There are instances of language development that do not conform to these patterns, namely, the phonemic merger of /ppttkk/ and /ptk/. There is evidence for conservation of voiceless occlusives in the Belsetán dialect of Aragonese in Bielsa, Spain. In this small isolated region, there is historical preservation of intervocalic /ptk/ that resulted in a phonemic merger. It is also possible to find geminated nasals and liquids in Belsetán, although the surface outcomes may vary from speaker to speaker and even within the speech of one single speaker (Badía 1950). Language pockets like Belsetán and Romanian that do not conform to the chain-shift pattern of maintaining the integrity of the phonological system, but rather collapse the two series of phonemes without problems, muddy the waters and poke holes in the neat pattern of chain-shifts. Looking at contemporary synchronic evidence and lenition patterns across Romance languages, however, could lead to stronger conclusions about the state of allophony within the phonological system at the time of the supposed chain-shifts and reveal clues about historical language change.

consonants /ptk/ and /bdg/ in Modern Spanish are included in Table 1.4, adapted from Hualde (2005:139).

Phoneme	Allophones	Context
/p/	[p]	all contexts
/t/	[t̪]	
/k/	[k]	
/b/	[b]	following pause or nasal
	[β]	elsewhere
/d/	[d̪]	following pause, nasal, lateral
	[ð]	elsewhere
/g/	[g]	following pause or nasal
	[ɣ]	elsewhere

Table 1.4. Occlusive phonemes in Modern Spanish, their allophones and conditioning contexts.

The allophones listed here can be characterized as pure or tense approximants, fricatives, or occlusives; however, the difference between what determines an approximant as compared to a fricative is a topic of great debate. For example, Quilis (1981) argues that the occlusive series /bdg/ includes both occlusive [bd̪g] and fricative [βðɣ] allophones and denies the existence of a separate category of approximant allophones. Martínez Celdrán (1984:73-74) distinguishes these two sounds, showing that fricative production includes friction or whistling when air is pushed through the buccal cavity, such as the production of [f, θ, s, x]. The approximant sounds analyzed in Martínez Celdrán (1984) do not conform to those standards; rather, they are characterized by a lack of release burst and friction as well as a lax degree of phonetic tension, that is, shorter duration and increased intensity. Current research shows, however, that the variation is much more extensive and wide-ranging than the allophonic distribution discussed here. Acoustic analyses of the phonetic realizations of stop consonants yield a range of realizations from pure/tense approximants to occlusives. Therefore, further research regarding the connection between present-day consonant weakening and historical weakening could show a more general and gradient consonant weakening process that occurs across all varieties of Spanish. Using recent studies that offer evidence of lenition through acoustic analysis of occlusive segments in Spanish, we can better create a present-day model to explain similar historical processes of consonant lenition to offer a clearer picture of diachronic language change and variation.

1.1.4 Summary

This section of the chapter has given an overview of diachronic consonant lenition and the internal causation theories and motivations behind this language change. From Late Latin to the development of the distinct Romance languages, we note several phonemic as well as phonetic developments of geminate, voiceless and voiced segments. Romance historians present structural evidence for internal language change including *casillas vacías* and economy of effort that contributed to consonant lenition processes throughout the development of the modern consonantal system.

While analyzing ancient texts can be very fruitful in acquiring knowledge about diachronic language change throughout history, the studies in this section do not provide the acoustic analysis that modern day technology can offer to better inform both current and past theories of lenition causation and language variation and change in general. More recent acoustic analyses due to modern technology have revealed great variability in stop consonant production in Spanish and other Romance languages. Acoustic analysis of variables such as relative intensity (RI), Voice Onset Time (VOT), and percent voicing (%V) of stop consonants may provide evidence of the gradient nature of consonant lenition phenomena in Spanish in order to gain more understanding of present-day lenition processes and provide clues to diachronic consonant variation and change. These variables and other acoustic studies will be discussed in depth in the coming sections. The gap in current research of stop consonant production variability across the Spanish-speaking world today, combined with available modern technology for acoustic analysis, motivate the need for the acoustic analysis and evaluation provided by my dissertation.

1.2 Contributions

Although the topic of consonant lenition has been visited and revisited throughout the last century, these previous studies, which are often not acoustically based, are grounded in theories of language variation and change. Analyzing ancient inscriptions in order to estimate diachronic phonetic production has determined causation of consonant weakening until recently with the addition of new technology and the ability to acoustically analyze and measure RI, VOT, %V, and other acoustic correlates. RI is the acoustic correlate most associated with the voiced occlusive series /bdg/ while VOT and %V relate to the voiceless occlusive series /ptk/. More recent acoustically grounded studies, therefore, are very insightful in that they provide a closer look into the mechanics of language variation and change. These acoustic correlates and others will be discussed in depth in section 1.3.

Even though the recent studies to be discussed in upcoming sections are acoustically grounded and provide a foundation for the study of consonant lenition, they do not offer us a wide range of data in different Spanish varieties. More recent works on consonant lenition focus only on one or two varieties of Spanish at one time and highlight variation of either the voiceless series /ptk/ or the voiced series /bdg/, but not both. This work needs to be expanded to offer more information on many Spanish varieties, using the same variables with identical tasks and controlling for extralinguistic factors such as gender, age, and dialect. Therefore, the primary contributions of this dissertation are to broaden the scope by analyzing multiple varieties of Spanish, adding new varieties on which there is not much data on consonant lenition, with all of the same tasks and control for participants as well as other linguistic and extralinguistic factors to compare and contrast both the voiceless *and* voiced occlusive series using a variety of acoustic techniques. I inform common notions of stop consonants in Spanish by looking at variation within each stop series, comparing them not only to phonemes within their same series, but comparing voiceless segments to voiced segments, which is something that has not been done previously, given the inherent nature of voiceless and voiced stops.

These contributions have important implications for the field of Spanish Linguistics, Phonetics and Phonology, Variation and Change, and Sociolinguistics by shedding light on the topic from both a synchronic as well as a diachronic perspective of consonant lenition in Spanish. The synchronic analysis shows the type of variation that we observe across different varieties of Spanish and which of the acoustic variables affect consonant change. The acoustic analysis of multiple varieties of Spanish provides the opportunity to build an acoustically grounded continuum of consonant weakening on which different varieties are considered either more conservative or more radical/innovative. Varieties with more occluded consonant productions are considered closer in relation to their Latinate roots, and those with more open consonant productions or loss are at a more advanced stage of language change, just as modern-day Romance languages are referred to as being more conservative (i.e., Italian varieties) or more innovative (i.e., French varieties) with respect to their similarity to Latin. Acoustic analysis of different Spanish varieties will produce similar conclusions by showing that some contemporary Spanish varieties exhibit a more conservative production of the occlusive consonants, while other varieties are more innovative in that the production of intervocalic consonants is weakened, in some instances to the point of consonant loss. This continuum has important implications for diachronic language change in that the acoustically analyzed synchronic data in turn is used to help us create a present-day model to explain similar historical processes of consonant lenition in order to offer a clearer picture of diachronic language change and variation. Analysis of the variation that exists in modern Spanish creates a snapshot of language variation at this current point in time, and by comparing these synchronic studies with what we already know about variation at different points throughout history, we can recreate a chain of information, connecting the dots through the history of the Spanish language to track the development of language variation and change through time.

1.3 Variables Affected by Lenition

1.3.1 Consonant Sonority

Given the acoustic focus of my dissertation, it is important to turn now from theoretically based causation of consonant weakening to a discussion on the many variables that come into play, from acoustic correlates to linguistic and extralinguistic factors. Lenition has been described in previous literature by movement towards deletion, increased sonority, that is, the degree of openness of a particular segment, either vocalic or consonantal, decrease in articulatory effort as well as modifications to articulatory gestural patterns (Lavoie 2001:6). However, as part of the current study on occlusive consonants in Spanish, I adopt the definition of lenition set by Lewis

(2001:3): “lenition [is] a weakening process by which a consonant becomes less strongly occluded, that is, articulatorily reduced (Browman and Goldstein 1991, 1992; Kirchner 1998), and/or more sonorous in some sense (Venneman 1988)”. Lewis also tells us that “[t]he production of a ‘weaker’ consonant assumes less articulatory effort than that put forth in a corresponding ‘stronger’ one, generally resulting in a segment which is shorter in duration, and more ‘vocalic’ and, consequently less consonantal in nature” (2001:3). Trask (1996) describes lenition processes as an increase in sonority or decrease in occlusion. Vowels and consonants are ranked in order of their openness on a sonority scale from weakest consonantality (i.e., least obstruction of airflow), to strongest consonantality (i.e., most obstruction of airflow); that is, most open or vowel-like to most closed or consonant-like (Hualde 2005:71-72). Hualde (2005) proposes the following sonority scale in Table 1.5 for Spanish.

6	low vowel	a
5	mid vowels	e o
4	high vowels	i u
3	liquids	l (ʎ) ɾ r̄
2	nasals	m n ɲ
1	obstruents	f (θ) s x ʝ t͡ʃ b d g p t k

Table 1.5. Sonority scale in Spanish (Hualde 2005:72).

The consonants within this sonority scale are also ranked according to their openness, or degree of constriction. Lass (1984:177) offers two hierarchical consonant scales (see example 5), where movement toward the right on both hierarchies indicates lenition, or consonant weakening, and movement toward the left indicates fortition, or consonant strengthening. The hierarchy seen in (5a) represents a scale of openness, where rightward movement along the scale shows less resistance to airflow within the vocal tract. Hualde (2005:300) defines a stop as a "consonant produced with total occlusion in the oral cavity," not allowing the passage of air such as /ptkbdg/. Fricatives are "consonants produced with a narrowing of the articulatory channel, resulting in turbulence or noise," such as /fθsʃxh/, while an approximant is a production where the articulatory organs in the oral cavity approach each other, but do not touch and do not have enough constriction to produce friction, thus differing from a fricative production (Hualde 2005:295, 297). Examples of approximants in Spanish include the allophones of /bdg/, [βðɣ], where the articulatory organs approach each other, allowing some constriction but no contact. Zero represents total deletion of the consonant. The hierarchy in (5b) represents a sonority scale, where rightward movement along the scale shows higher output of periodic acoustic energy, which serves as a cue to decreased obstruction of airflow (Lass 1984:177). Voiceless productions do not include vibration of the glottal folds, whereas voiced segments are produced with glottal fold vibration.

(5) a. Stop > Fricative > Approximant > Zero
b. Voiceless > Voiced

While the scales in (5) may not be appropriate for other consonant segments, such as affricates, they inform the primary purpose of this dissertation by allowing us to describe occlusive consonants with respect to their level of sonority as well as degree of constriction. I investigate the extent to which occlusive consonants assimilate in vocalic quality to their adjacent vowels (i.e., the degree of consonant lenition), and the acoustic and other linguistic variables that evidence weakening phenomena. These variables are discussed in the following three subsections on the Prosodic Hierarchy, lexical stress and prosodic position.

1.3.2 Prosodic Hierarchy

The linguistic variables that affect consonant lenition are based on levels of a suprasegmental hierarchy proposed in Autosemental-Metrical (AM) Theory, where the elements are organized from smallest to largest unit above the level of segment (i.e., phoneme). The hierarchy in (6) proposed by Gussenhoven (2004:124-125) organizes the constituents in a way that we can identify groups of segments, characterizing and comparing their acoustic correlates at different levels of the hierarchy.

(6)	U	Utterance
	IP	Intonational Phrase
	ip	Intermediate Phrase
	PW	Prosodic Word
	F	Foot
	σ	Syllable

An overview of the different prosodic domains is useful; however, the elements most relevant to this study are the segment, syllable and prosodic word levels of the hierarchy.[4] Beneath the suprasegmental hierarchy in (6), we find the smallest identifiable unit: the segments. These are the individual sounds that are used to make up the syllables, which, in turn, may have up to three parts, the necessary element being the nucleus, or "the peak of sonority" (Hualde 2005:70), represented by a vowel in Spanish. The syllable nucleus may include only one vowel, /aeiou/, or

[4] The phrasal levels of the hierarchy in (6) also play an important role in consonant lenition, due to the fact that lenition not only occurs in intervocalic position within a PW, but also across word boundaries, i.e., at the phrasal level. Therefore, phrasal level will be taken into account during the acoustic analysis in word-internal intervocalic position as well as word-initial intervocalic position, that is, when the preceding word ends in a vowel. Previous work has shown that lenition in a VCV sequence occurs at both levels of the prosodic hierarchy, both word-internally and across word boundaries (Cole, Hualde & Iskarous 1999; Hualde, Simonet & Nadeu 2011; Parrell 2011; Cabrelli Amaro 2017).

it may be accompanied by a glide before or after the “peak of sonority,” creating a diphthong, that is, two vocalic sounds realized within the same syllable. For example, the word *jue-go* (‘game’) includes a rising diphthong, where the /u/ and /e/ together form part of the syllable nucleus. Syllables may also contain either a syllable onset consonant or onset consonant cluster, a syllable coda, or both. For example, in the Spanish word *flor* (‘flower’), /o/ is the sonorous syllable nucleus; the preceding syllable onset consonant cluster is /fl/, and the syllable coda is /ɾ/. Together, these segments make up one syllable. Permissible onset clusters in Spanish can have a maximum of two consonants, but these are limited to an occlusive consonant /ptkbdg/ or the fricative /f/ plus a liquid segment, either /ɾ/ or /l/. Coda consonant clusters, albeit rare, are possible in Spanish as well; however, the second segment of the coda consonant cluster is always /s/, as in the words *pers-pec-ti-va* (‘perspective’) or *bí-ceps* (‘biceps’) (Hualde 2005:71). Syllabic division, the method of dividing a word into syllables, is also relevant to the current discussion on consonant lenition. Open syllables, which end in a vowel, are the preferred syllable type in Spanish; therefore, when a word ends in a consonant and is followed by a word beginning with a vowel, this consonant is resyllabified to form the syllable onset of the following word. Consider the example in (7).

(7)	IP:	*la ciudad es bonita.* ‘the city is beautiful’
	Syllable Division:	*la-ciu-**da-de**s-bo-ni-ta*[5]

In (7) we note an example of resyllabification of the coda consonant of *ciudad* (‘city’) to form the syllable onset of the next word *es* (‘is’). Open syllable structure is favored, with all syllables except one ending in a vowel. The coda /s/ of the word *es* (‘is’) cannot be resyllabified with the

[5] Within the larger IP, an ip boundary indicated by a pause or a drastic pitch change is one factor that would block this expected resyllabification.

following syllable because /sb/ is not a permissible onset cluster in Spanish. Syllables combine to form PWs, the next level of the prosodic hierarchy as it pertains to this dissertation.[6] Discussion and background on PWs, lexical stress and pertinent phonetic correlates that may affect consonant lenition are included in the next section of this chapter.

1.3.3 Lexical Stress

While we use words to form utterances for communication purposes, we must highlight that word-level stress is an important factor in consonant lenition. Hualde (2005:220) states that "[s]tress is the degree of relative prominence that a syllable receives in comparison with the other syllables in a given domain." Stress is concretely expressed through the phonetic correlates of fundamental frequency (f0; the perception of f0 is *pitch*), duration and/or intensity (Hualde 2005). While a higher f0 does not necessarily indicate a tonic, or stressed, syllable, an f0 rise through a tonic syllable is often essential to identifying possible cues to stress rather than other types of f0 movement or f0 peaks (Hualde 2005). Duration is also a relevant phonetic correlate to the discussion on lexical stress, given that tonic syllables generally have a longer duration than atonic, or unstressed, syllables. The third expression of lexical stress is intensity, which is one of the phonetic correlates of particular interest to my dissertation. With respect to consonant lenition, measuring RI, or the difference in decibels (dB) between the intensity of a consonant and the intensity of the following vowel informs us on the notion of relative prominence effects by providing the degree of occlusion or openness of a particular segment. Consonants with a higher RI measurement are more occluded and therefore more "consonant-like," whereas consonants with a RI measurement closer to 0dB are more open, and therefore more "vowel-

[6] Prosodic feet are not relevant to the current study and will not be discussed here.

like," with a measurement of 0dB indicating total elision of the consonant. By measuring RI, therefore, we can compare the more fully occluded voiceless stop consonant series /ptk/ to the less fully occluded voiced consonant series /bdg/, providing clues about the degree of consonant weakening or strengthening in certain Spanish varieties. More discussion on RI and how this correlate will be used in the current study will be included in subsequent sections.

Tonic syllables, therefore, use increased articulatory energy and gestures, which are manifested through enhanced f0, duration and/or intensity. These three correlates enhance the prominence of lexical stress, ultimately working against the weakening processes of lenition because more prominent syllables are shown to experience less consonant weakening than atonic syllables (Browman & Goldstein 1992; Cho, McQueen & Cox 2006; Gili Fivela et al. 2008; Keating et al. 2003).

1.3.4 Prosodic Position

At the beginning of domains, such as the syllable onset or the beginning of a prosodic word, we find strengthening, but not at the end of a domain. In a study about prosodic boundaries in two varieties of Italian, Gili Fivela et al. (2008) find domain initial strengthening in the production of consonants in initial position; that is, at the beginning of an intonational phrase as well as in smaller domains, such as the intermediate phrase. Cho, McQueen & Cox (2006) investigate word-initial strengthening of native speakers of American English, concluding that there are acoustic differences between initial position and internal position, indicating strong evidence for word-initial strengthening. In a cross-linguistic investigation between English, French, Korean and Taiwanese to compare and determine the effects of word-initial strengthening, Keating et al.

(2003) show that there are clear distinctions between initial position and internal position in each of the four languages.

Intervocalic position, or VCV is among those at the top of the list of favorable environments for lenition processes to occur (Lass 1984:181). Intervocalic context is very favorable to consonant weakening, given the sonorous quality of adjacent vowels and the assimilation processes that promote increased sonority of occlusive consonants when found in this position. While word final is also a likely position in which to find consonant weakening, the present study will only focus on consonants in intervocalic position, either word-medially or word-initially preceded by a vowel. Given previous research on domain initial strengthening, consonants in word-initial intervocalic position are expected to be more highly occluded than those in word-internal intervocalic position.

All of these studies demonstrate the need to investigate not only phonological correlates like lexical stress and flanking vowels, but also word position because in prosodically strong positions like word-initial position as well as in tonic syllables, the articulatory gestures are reinforced in many languages, telling us that this is a cross-linguistic phenomenon and is not limited to Spanish. Given this data, the current study aims to separate word-initial contexts from word-internal contexts to show the greater degree of weakening in internal position as compared to initial position.

<u>1.3.5 Acoustic Variables</u>

Previous work has shown that the phonetic realizations of /ptk/ and /bdg/ vary with respect to their degree of intensity across varieties of the same language as well as cross-linguistically, with realizations ranging from weak approximant to fully occluded stop, including voicing and even spirantization of the voiceless occlusive series. Acoustic variables such as RI, VOT, and %V may provide evidence of consonant lenition. RI of a consonant represents the difference in decibels (dB) between the consonant in question and the following vowel. This is measured by identifying the minimum intensity of the target consonant using the intensity curve in PRAAT (Boersma & Weenink 2013) as well as the maximum intensity of the following vowel and taking the difference. Figures 1.1-1.3 show the PRAAT spectrogram, blue f0 curve and the yellow intensity curve of Spanish utterances that include voiceless and voiced consonant productions. Figure 1.1 represents *Yo digo* podo *para ti* (‘I say *I prune* for you’). The minimum intensity valley and the maximum intensity peak for the initial consonant [p] are marked with two circles. The minimum intensity value of [p] is 60.3dB, and the maximum intensity value of the following vowel [o] is 71.7dB, with a RI difference between the valley and peak of 11.4dB.

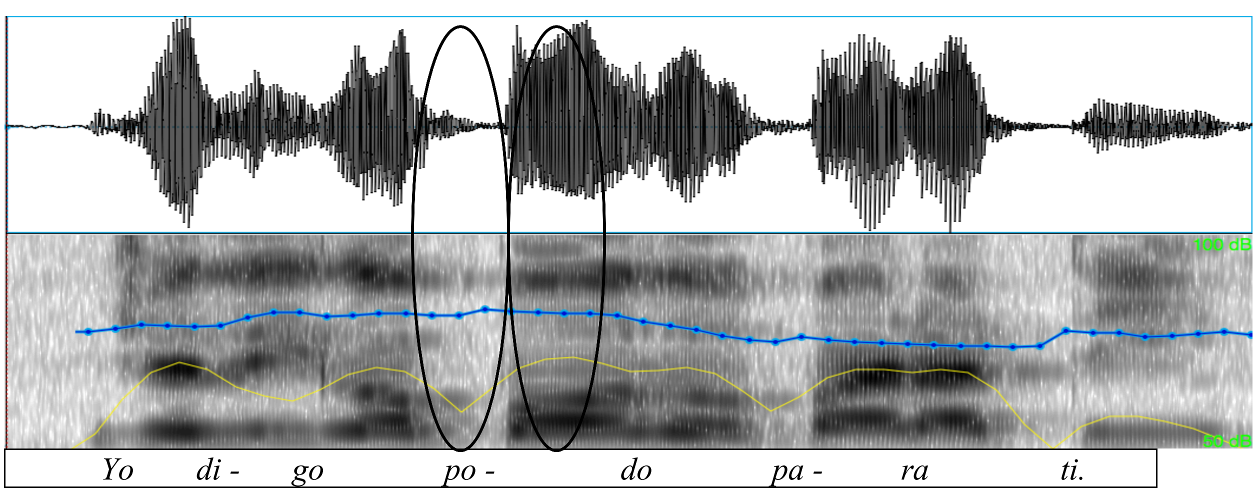

Figure 1.1. Measurement of the RI of the phrase Yo digo *podo* para ti ‘I say *I prune* for you.’

Figure 1.2 shows the spectrogram, f0 contour and intensity curve for the utterance *Yo digo* busco *para ti* (‘I say *I look for* for you’). Just like the previous figure, the minimum intensity valley and the maximum intensity peak of the voiced segment [b] are circled. The minimum intensity value of [b] is 57.6dB, and the maximum intensity value of the following vowel [u] is 66.2dB, yielding a RI difference of 8.6dB. The lower RI value of this consonant [b] indicates a more open production than the [p] analyzed in Figure 1.1.

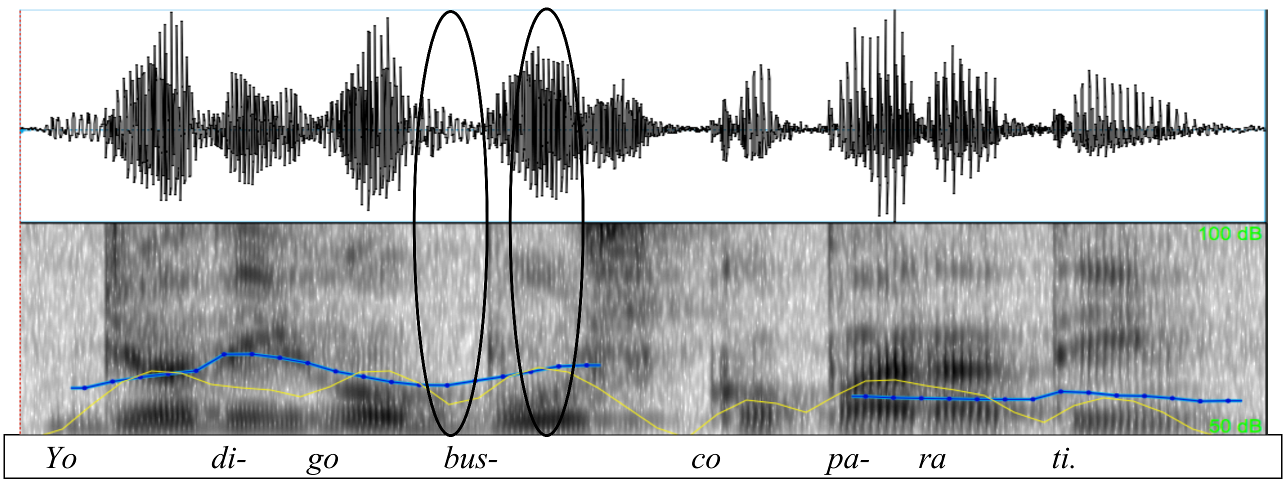

Figure 1.2. Measurement of the RI of the phrase Yo digo *busco* para ti ‘I say *I look for* for you.’

Figure 1.3 represents *Yo digo* buscó *para ti* (‘I say *he looked for* for you)’ and shows an even lower RI measurement, thus a more open, vowel-like production of the consonant [b]. The minimum intensity valley and the maximum intensity peak for the word-initial consonant [b] are marked with two circles. The minimum intensity value of [b] is 65.9dB, and the maximum intensity value of the following vowel [u] is 66.4dB, with a RI difference between the valley and peak of 0.5dB. A RI measurement this close to zero indicates the high degree of weakening that this consonant [b] has experienced in intervocalic position, almost reducing to 0, or loss. If we compare the production of [b] in Figures 1.2 and 1.3, we see the drastic difference in the consonant valleys and the vowel peaks. One contributing factor to this difference is lexical stress; that is, *busco* 'I look for' in Figure 1.2 is a paroxytone word, where the first syllable *bus-* carries lexical stress and is therefore more prominent, exhibiting less consonant weakening, while *buscó* 'he looked for' in Figure 1.3 is an oxytone word and carries lexical stress on *-có*, leaving the first syllable *bus-* less prominent, and therefore exhibiting more consonant weakening.

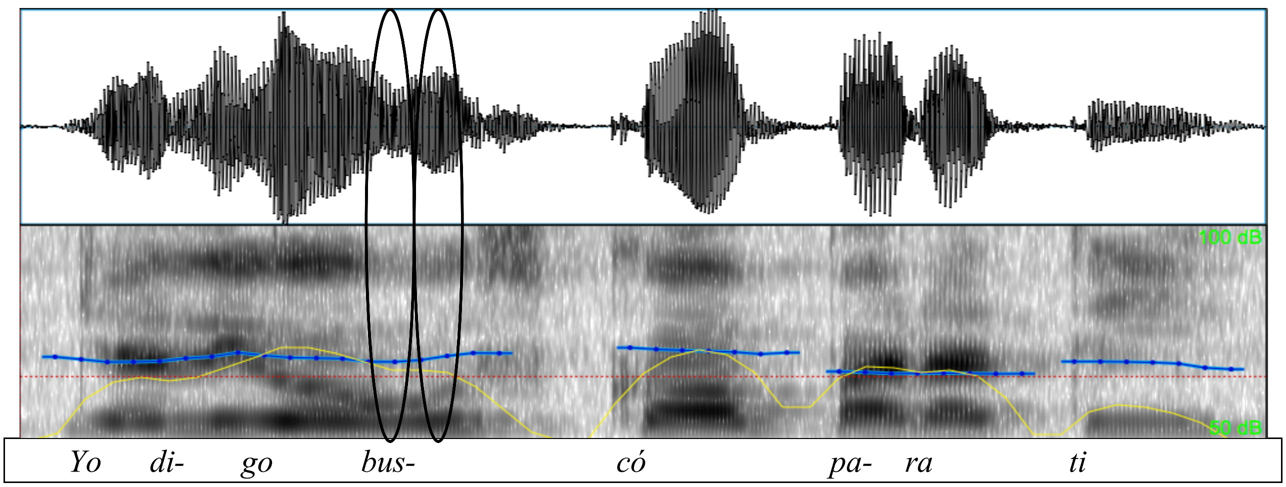

Figure 1.3. Measurement of the RI of the phrase Yo digo *buscó* para ti 'I say *he looked for* for you.'

Given the inherent nature of both of the occlusive series, the acoustic correlate of RI can be used to compare voiceless segments to their voiced counterparts, a task that is difficult to achieve with VOT, which will be discussed shortly. In intervocalic position in Spanish, we would expect to see higher RI measurements in the production of the phonemes /ptk/ and lower RI measurements in the production of the phonemes /bdg/. Other acoustic signals combine with RI to indicate the degree of closure or weakening, such as the amplitude and periodicity of the waveform, continuation of formant structure between vowels, duration, and spectrographic evidence of friction.

Another acoustic correlate that is used in the comparison of voiceless and voiced occlusive consonants is VOT. Lisker & Abramson (1964) show that VOT is one acoustic correlate that provides insight regarding the differentiation between voiceless and voiced occlusives “by fixing attention on the timing relation between voice onset and the release of occlusion” (387). To measure VOT, Lisker & Abramson (1964) say that we must identify “the interval between the release of the stop and the onset of glottal vibration, that is, voicing” (389). They identify three categories of stops based on VOT: 1) voicing lead, where voicing begins before the release of the stop—we would expect this condition and a negative VOT value for voiced segments such as /bdg/, 2) short voicing lag, with a VOT value between 0-30 milliseconds (ms), where voicing begins just shortly after the release—we would expect this condition for voiceless segments /ptk/ in Spanish, and 3) long voicing lag, with a VOT value of more than 30ms, where voicing starts considerably after the release. The latter condition would be common in voiceless segments [$p^ht^hk^h$] in English, in which case the segments are aspirated. See Figures 4 and 5. Figure 1.4 shows an example of leading lag VOT for Spanish /b/. The left side of the figure—indicated by a bracket—shows a non-periodic wave form but where voicing occurs before the moment of the release burst, indicated by the arrow. The measurement in ms from the moment the vocal folds begin to vibrate until the release burst is VOT. VOT in Figure 1.4 is -65ms; the negative value indicates leading lag VOT. On the right side of the figure, again indicated with a bracket, we see periodicity in the waveform, indicating the presence of a vowel.

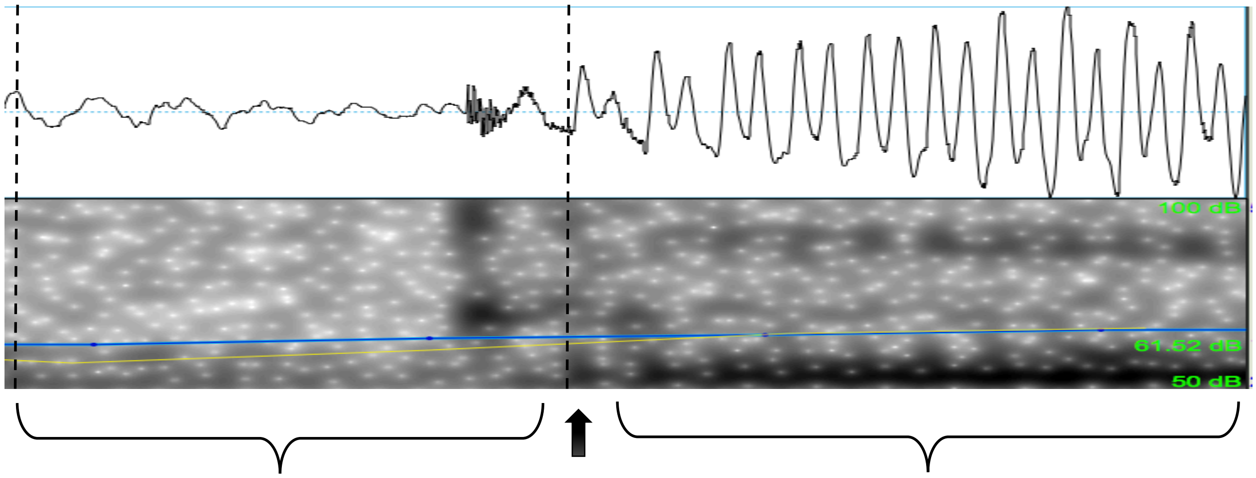

Figure 1.4. Leading lag VOT for Spanish /b/.

Figure 1.5 includes an example of short lag VOT for Spanish /p/. Before the arrow, we see that the sound wave is inactive, representing complete closure of the buccal organs. At the arrow, there is activity in the sound wave, indicating the release burst. The space between the dotted lines is VOT and represents the interval separation between the start of the release burst and the start of periodic waveform, where glottal vibration begins, signaling vowel production. The short lag in Figure 1.5 is 12ms, which is consistent with productions of /ptk/ in Spanish where VOT measurements generally fall between 0 and 30ms (Lisker & Abramson 1964).

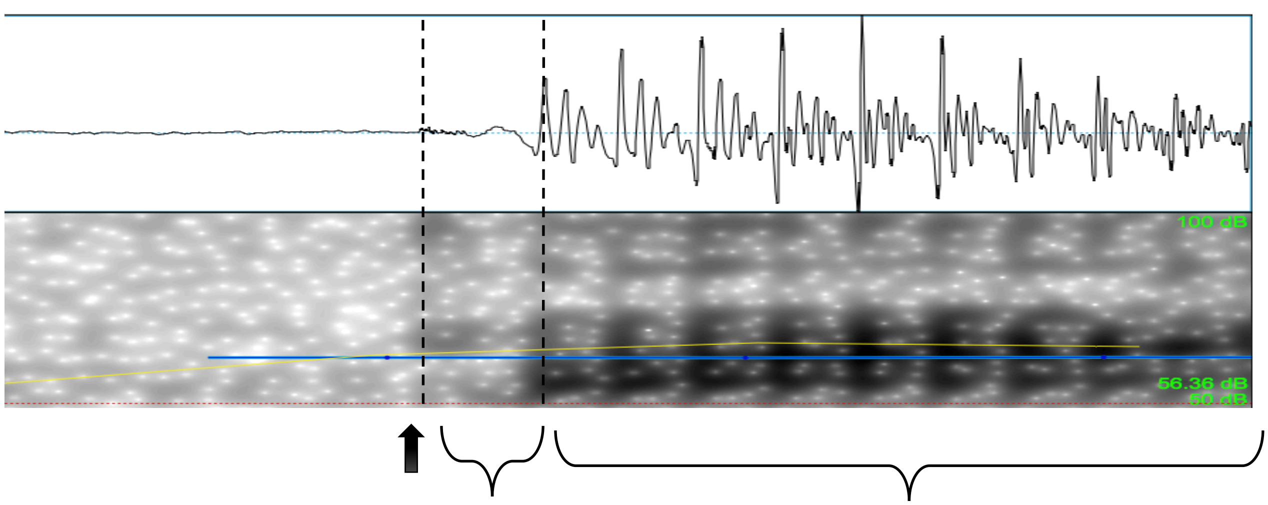

Figure 1.5. Short lag VOT for Spanish /p/.

Figure 1.6 provides an example of long lag VOT for English /t/. Before the arrow, we see that the sound wave is inactive, representing complete closure of the buccal organs. Sound wave activity begins at the arrow, indicating the release burst. The space between the dotted lines is the VOT, representing the interval separating the start of the release burst and the start of a periodic waveform, where glottal vibration begins, thus signaling vowel production. The long lag in Figure 1.6 is 62ms, which is consistent with productions of [$p^h t^h k^h$] in English, where VOT measurements are often longer than 30ms (Lisker & Abramson 1964).

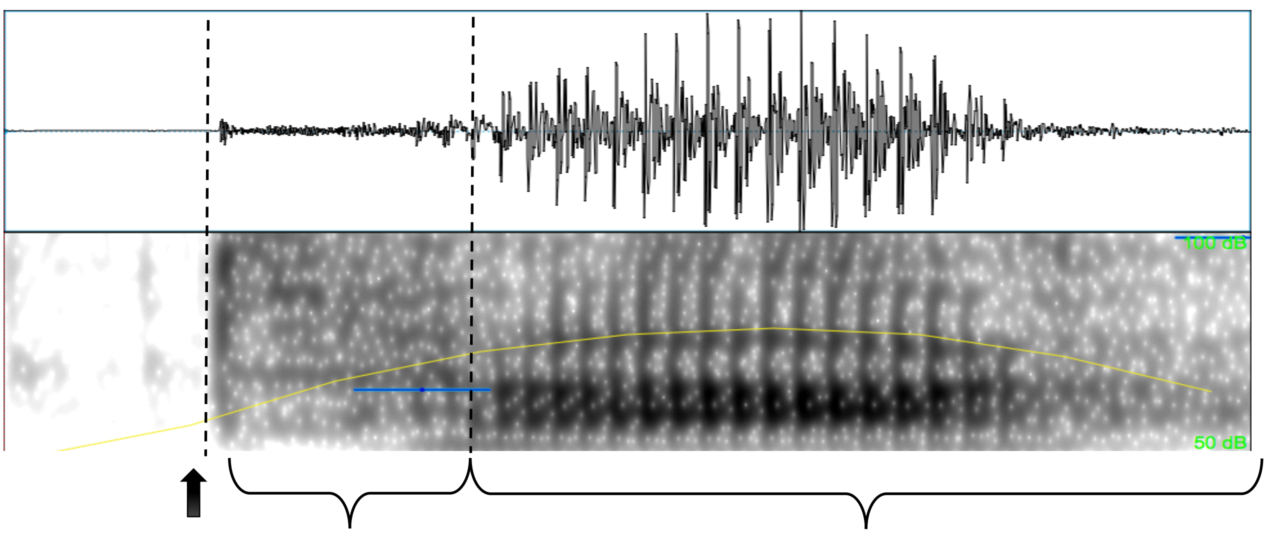

Figure 1.6. Long lag VOT for English /t/.

In addition to RI and VOT, a third acoustic correlate used to identify similarities between /ptk/ and /bdg/ production is %V. %V has been used by scholars to identify the percentage of voicing in the closure durations of voiceless stops /ptk/. Hualde, Simonet & Nadeu (2011) find that 37.5% of all /ptk/ tokens in their study on Mallorcan Spanish are partially or fully voiced, using 60%V as the threshold for partially voiced. Machuca Ayuos (1997) has a slightly higher percentage of voiced realizations of /ptk/, ranging from 34.9% to 64.6% among different speakers, but this could be contributed to her use of a lower threshold for partial voicing at 50% voiced. Lewis (2001) and O'Neill (2010) also use %V to determine the frequency of voicing of voiceless stops /ptk/ in different Spanish varieties. %V is calculated by dividing the duration of voicing present (in ms) by the total closure duration of the stop consonant (also in ms). Let us consider the example of %V analysis in Figure 1.7. The spectrogram in Figure 1.7 shows the production of voiceless stop consonant /p/. The closure duration of [p] is marked with two red lines totaling 77.5ms and decreased overall acoustic energy in the formant structure as compared to the flanking vowels on either side of [p]. The blue circle shows voicing found during the production of /p/ totaling 54.5ms. Therefore the %V of [p] in Figure 2.9 is 70.3% (voicing duration 54.5ms / closure duration 77.5ms = 0.703).

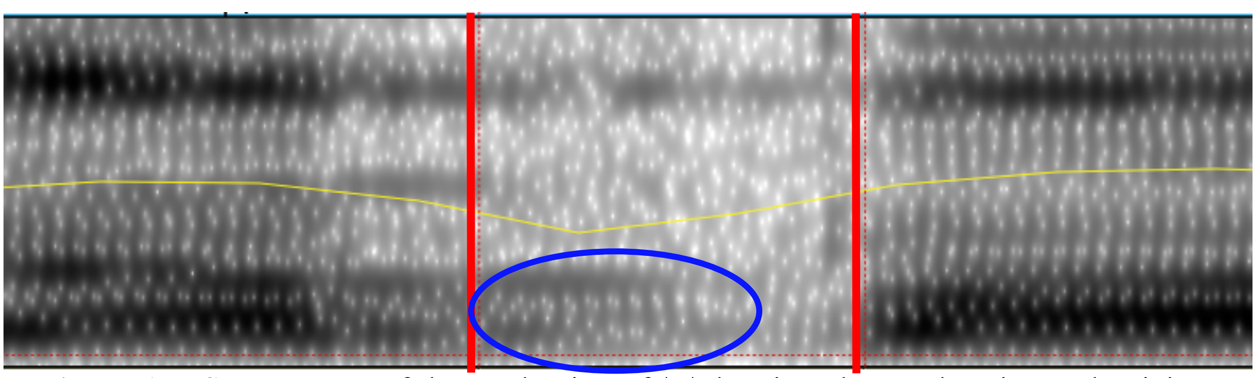

Figure 1.7. Spectrogram of the production of /p/ showing closure duration and voicing.

The acoustic variables of RI,VOT, and %V are used to provide evidence of consonant lenition and weakening by acoustically quantifying the degree of occlusion and the manner of articulation of consonant production. I examine the gradient nature of these lenition processes in Spanish in order to situate the occlusive consonants /bdg/ and /ptk/ on a lenition continuum from conservative to innovative and to determine the acoustic variability that exists among these segments both inter- and intra-dialectally.

1.3.6 Extralinguistic Factors

While acoustic correlates will be the primary tools in this investigation of stop consonant weakening, the current study also controls for various extralinguistic factors that inform our knowledge of consonant weakening across different varieties of Spanish.

Previous work shows that sociolinguistic factors such as age, gender, speech style, and dialect, among others, manifest differently for different types of features (Bayley & Tarone 2011; Labov 2001). Variables selected for the current study are chosen based on results from previous research, indicating that they may have significant effects on the degree of consonant weakening in Spanish. First, it has been shown that speakers belonging to a specific age group, either younger, middle-aged or older speakers, often prefer certain phonetic variants over others. For example, in an analysis of velar palatalization in Chilean public speech, Flores (2016) finds that the palatalized allophonic variant [ç] of the velar phoneme /x/ has higher rates of usage when at least one interlocutor is between the ages of 30 and 50. In addition, this study reports that the palatalized variant [ç] exhibits lower usage rates with younger interlocutors (i.e., younger than 30 years old), than with two older participant groups. With respect to lenition of stop consonants, it is very common to find voicing or partial voicing of /ptk/ in intervocalic position among young speakers in Canary Island Spanish (Oftedal 1985) as well as weakening and deletion phenomena of voiced stop consonants /bdg/ in Caracas speech (Long 2014). It is beneficial to the field of Phonetics and Phonology to analyze consonant lenition diachronically by looking at participant ages to determine the effects on stop consonant weakening through time. Based on this previous work, it is evident that speaker age may play a role in the selection of particular phonetic variants; therefore, the current study will account for participant age to determine if this sociolinguistic factor does indeed affect the degree of consonant weakening in intervocalic position of stop consonants in Spanish.

Gender has also been reported to affect the selection of particular allophones. Flores (2016) also codes for gender in her study on velar palatalization in Chilean Spanish. Although previous studies had reported preference of the palatalized allophone [ç] of /x/ among female speakers (Cepeda 1991), her study, based on regression and accommodation analyses, concludes that velar palatalization is "no longer affiliated with a specific sex, [and is] therefore not a gender marker" (14). In addition, still other researchers show that sociolinguistic variables, including gender, may affect speech rate, style, and prosodic patterns (Clopper & Smiljanic 2011; Jacewicz, Fox, O'Neill & Salmons 2010; Mack 2010; Major 2004). In their study of prosodic variation of American English, Clopper & Smiljanic (2011) say that there are "significant effects of dialect, gender, and passage on prosodic patterns, including pause distribution and the f0 patterns associated with prominent syllables and phrase boundaries" (11). Therefore, this work indicates existing evidence and further need for acoustic research to determine the effects of gender on production. While previous studies have not looked at the effects of gender on consonant lenition in Spanish, my dissertation will code for gender to identify the effects, if any, gender has on the degree of consonant weakening.

Speech style is also a very relevant extralinguistic factor, given that many times the Observer's Paradox (Labov 1972) hinders the collection of authentic, spontaneous and unscripted speech. In his investigation of phonetic voicing of /ptk/ Lewis (2001:43) includes an acoustic analysis of three speech styles: semi-spontaneous/conversational speech, textual reading and reading of a word list, in order from most informal to formal, respectively, which are suggested by traditional models of linguistic analysis (Labov 1966, 1972; Silva-Corvalán 1989). Lewis (2001) concludes:

> [S]peech style clearly influenced the values associated with the dependent variables so that the most conservative speech style resulted in acoustic correlates reflecting the strongest resistance to stop consonant weakening, while the least formal speech style was characterized by acoustic values indicating that intervocalic /p, t, k/ had lenited to the greatest extent under that laboratory condition (59).

Hualde, Simonet & Nadeu (2011) also find that scripted speech exhibits lesser degrees of weakening in the production of /ptk/, in line with previous research. While the speech analyzed in the current study is laboratory speech, the interview and map task methods allow for semi-spontaneous data collection (Prieto & Roseano 2009-2013). These tasks will be discussed at length in the upcoming chapter on design and methodology.

The final extralinguistic factor that will be the primary focus of my dissertation is dialect, or speech variety. In order to hypothesize about consonant lenition variation across different varieties of Spanish, data is measured from seven speech varieties including Peninsular Spanish, Canarian Spanish, Caribbean Spanish, Mexican Spanish, Andean Spanish, Chilean Spanish and Argentinian Spanish. Data is analyzed from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013), a corpus of audio and video materials with different speech tasks including a survey, semi-spontaneous speech and a video interview for each respective dialect. I will analyze speech from all of the dialects included in this corpus, which provide a wide range of variation from many different places in the Spanish-speaking world. Due to previous research that has been done on consonant lenition over the past few decades, the varieties chosen here are expected to show different degrees of weakening. Previous work to be discussed in the next section shows that certain varieties are at a more advanced stage of weakening than others (Carrasco, Hualde & Simonet 2012; Lewis 2001; Oftedal 1985). Therefore, by including these varieties and expanding the dialectal range with additional varieties where the current state of consonant weakening has not yet been reported, we can better inform our knowledge and make more concrete observations about consonant weakening across all regions of the Spanish-speaking world. By analyzing data from all of these varieties and controlling for other extralinguistic factors such as gender and age, we can gain a clear picture of the present state of consonant lenition in Spanish and an overview of consonant change through time.

1.3.7 Summary

This section of the chapter has focused on acoustic correlates that display evidence of consonant lenition (or a lack thereof), as well as linguistic and extralinguistic factors that have effects on the presence or absence of this weakening process. Lenition, as defined here, is measured by a reduction of articulatory gestures, and may be affected by sonority levels of segments, with vowels being the most sonorous, and/or degree of constriction, with obstruents being the most occluded. Among the obstruents, the voiceless stops /ptk/ are more occluded than the voiceless stops /bdg/. The linguistic variables that affect the degrees of lenition of these segments are based on levels of a suprasegmental hierarchy, where weakening can occur at different domain levels, both within a PW as well as across word boundaries. Lexical stress, or relative prominence, of a syllable is expressed through f0, duration and/or intensity and counteracts weakening processes, meaning that tonic syllables experience less lenition than atonic syllables.

At the phrasal level, previous research has found domain-initial strengthening both at the IP and ip levels not only in Spanish, but in other languages as well, such as English, French, and Korean. This evidence implies that domain-initial strengthening is a cross linguistic phenomenon. Intervocalic position is among the most favorable environments to find consonant weakening, given the sonority of flanking vowels and assimilation processes that operate on intervocalic consonants. Finally, regarding acoustic evidence, RI, VOT and %V may provide clues to the degrees of consonant lenition. VOT values for stop consonants can be difficult to compare between /ptk/ and /bdg/, given their inherently voiceless and voiced nature, respectively. Therefore, RI will be used in combination with %V to identify degrees of stop consonant occlusion in this dissertation.

Based on previous research discussed in this section, in order to keep the data set as homogeneous as possible, my data analysis will also control for extralinguistic factors such as age, gender, and dialect, which could also affect consonant lenition. The purpose, therefore, is to gain a deeper understanding of the geographical spread of consonant weakening phenomena to determine a lenition continuum where certain Spanish varieties exhibit lesser or higher degrees of weakening of consonants /ptk/ and /bdg/.

1.4 Synchronic Lenition Processes in Spanish

This section will discuss at length more recent synchronic evidence showing that consonant lenition exists today in different Spanish varieties without the possibility of substratum or adstratum influences. This data allows us to make a series of observations about synchronic lenition processes, helping us to replant questions about the historical development of consonant lenition and gain a more thorough understanding of lenition processes as they occur through time. Although more recent studies are acoustically based, few to no studies look at consonant weakening variation across multiple varieties of Spanish while controlling for extralinguistic factors such as gender, age, and dialect.

1.4.1 Lenition of /ptk/

Sonorization of voiceless occlusives has been attested in the spontaneous speech of many varieties of Spanish. Perhaps the greatest evidence of this weakening among Spanish varieties can be found in Canary Island Spanish. In a comment about the Spanish of this island chain, Trujillo (1980) indicates that the sonorization of underlying voiceless occlusive consonants is prominent:

> […] no pueda afirmarse de ningún modo que se trata de un fenómeno general y consolidado. Muy por el contrario, es esporádico y mucho más frecuente en las hablas rústicas que en las urbanas, o en la gente de escasa cultura en comparación con los más cultos.[7] Sin embargo, el fenómeno afecta a todos: sólo varían las cifras. Y no sólo es eso: la serie consonántica expresada presenta diversos grados de "modificación", según las circunstancias, si bien no se puede hablar de distribución ordenada de variantes, salvo, quizá si tenemos en cuenta el hecho de que el fenómeno que aquí tratamos se presenta con mayor regularidad en posición intervocálica. Pero, en general, se trata de una variabilidad polimórfica no sistematizada, de manifestaciones poco previsibles, aunque, sin la menor duda, indicativas de profundas alteraciones en la estructura del sistema

[7] This comparison between *la gente de escasa cultura* 'people lacking culture' and *los más cultos* 'more educated/cultured people' is simply reporting previous literature and does not in any way represent my own views on the matter.

> consonántico español, o al menos, de tendencias muy fuertes que pugnan por abrirse camino en el seno del español normativo (247).[8]

These comments strongly demonstrate evidence that weakening of occlusive consonants is a gradient process that can vary according to context, and sociolinguistic factors, including variation within the speech of a single speaker. In a quantitative study on Canary Island Spanish, Oftedal (1985) analyzes intervocalic voiceless stops in word-medial and word-initial contexts. The results show that out of 1900 tokens of /p t k tʃ/, only 6.8% are *non-lenited*, indicating that the large majority of intervocalic voiceless stops are voiced, or at least half-voiced. Oftedal (1985) states that social factors do indeed play a role: "To begin with I looked for old or middle-aged people to interview, and they all voiced their 'voiceless' stops to some extent, but after a while I began to realize that the phenomenon was as easy or even easier to find in young speakers" (11-12).

Previous studies such as those by Lewis (2001) and Colantoni & Marinescu (2010) suggest that consonant lenition is not a binary phenomenon (i.e., voiced vs. voiceless segments), but rather a gradient phenomenon where different varieties of Spanish can be considered to have either a higher or lesser degree of consonant weakening. Underlying /ptk/ can be realized phonetically as completely or partially voiced as well as an approximant (see example 8).

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[8] "cannot confirm in any way that it is about a general and established phenomenon. Much to the contrary, it is sporadic and much more frequent in rustic speech than in urban speech, or among people lacking in culture in comparison with those more cultured. However, the phenomenon affects everyone: only varying in numbers. And it is not only that: the consonant series expressed presents diverse grades of "modification", according to the circumstances, even though one cannot talk about ordered distribution of variants, except, maybe if we keep in mind the fact that the phenomenon that we treat is presented with increased regularity in intervocalic position. But, in general, it is about a nonsystematic polymorphic variability, of manifestations not very foreseeable, even though, without a doubt, indicative of the profound alternations in the structure of the Spanish consonant system, or at least, of very strong tendencies that strive to open the way to the protection of the Spanish norm." (my translation)

(8) /ptk/ → [bd̪g]
→ [βðɣ]

Lewis (2001) examines intervocalic voiceless occlusives in the speech of two participants, one that speaks a dialect from Northern Spain and the other a dialect from Central Colombia. The participants performed three separate tasks as a part of this study: 1) conversational speech 2) textual reading and 3) reading of isolated words. Lewis (2001) shows that speech style and lexical stress play an important role in the voicing and spirantization of underlying /ptk/. He also concludes that the Northern Spanish dialect seems to be at a more advanced state of change with respect to consonant lenition than the Central Colombian dialect, suggesting a continuum of consonant lenition from weak to strong.

O'Neill (2010) investigates consonant weakening of Andalusian speech, concentrating on voiceless occlusives in intervocalic position as compared to voiced occlusives in the same position, as in the example *pipa ~ piba* ('pipe'~'girl'). In this study, O'Neill (2010) provides data from the cities of Sevilla, Cádiz, Granada and Almería, and in each location four speakers were recorded, two men and two women, all of whom were eighteen years old and native to their city. The recordings were taken from the production of different words containing occlusive segments and set within a carrier phrase, *dame un __ pa mí/ti* ('give me a __ for me/you'). The participants saw a photo of an object and subsequently produced this word within the carrier phrase. The author concludes that voiceless occlusive phonemes in intervocalic position are mainly realized as voiced segments, and in turn, weakening of voiced segments can result in loss. Therefore, according to O'Neill (2010), the Spanish of Andalusia is an incipient state of change: "es forzoso notar que la diferencia entre las aproximantes cerradas y abiertas no está bien definida, ya que es una cuestión de grado que se basa en la amplitud con respecto a los sonidos vocálicos adyacentes y en la estructura formántica" (2010:32).[9]

Hualde, Simonet & Nadeu (2011) examine voiceless occlusives in intervocalic position in the Spanish of Mallorca of the Balearic Islands. One third of the data show complete voicing, or at least partial voicing, of underlying intervocalic /ptk/ in semi-spontaneous speech. The twenty speakers are native to the island and native speakers of Spanish. For this study, the speakers were divided into two groups based on gender and age. The results reveal that when underlying segments /ptk/ produced surface variants that are voiced, they are also produced with the [+continuant] trait, just as phonetic realization of the phonemes /bdg/. Total voiced productions, however, only reach about 22% in semi-spontaneous speech—37.5% if partially voiced tokens are also taken into consideration (Hualde, Simonet & Nadeu 2011:310-311).

In scripted speech, on the other hand, the percentage of voiced productions of /ptk/ are fewer. In general, the authors find a higher RI difference for the voiceless segments than for the voiced segments, which is to be expected. It is important to note, however, that RI differences also vary according to point of articulation with a progression of weakening regarding underlying voiced segments /bdg/ and surface voiced /ptk / > [bd̪g]. Realizations of velars are more sonorous, that

[9] "it is necessary to note that the difference between the closed and open approximants is not well defined, given that it is a question of grade that is based on amplitude with respect to the neighboring vocalic sounds and the formant structure." (my translation)

is, more vowel-like, than coronals, which in turn are more sonorous than labials. However, the allophones of the velar segment /k/ appear to overlap more with the voiced allophones of /g/ than the voiceless allophones of /k/. Hualde, Simonet & Nadeu (2011) make an important conclusion about this data that is relevant to the current study: “In sum, voiced realization of /ptk/ are significantly more lenited than voiceless realization of these phonemes as well as more constricted than underlyingly voiced /bdg/” (2011:312). While we can and do find voiced productions of underlyingly voiceless segments /ptk/ > [bd̪g], this does not indicate a merger of the phonemes /bdg/ with /ptk/, given that these two phoneme series differ with respect to their degree of constriction.

The authors address whether or not the lenition of voiceless occlusives could lead to a possible recategorization of voiceless segments to voiced segments (see example 9), similar to changes that occurred in the development of Latin to Old Spanish.

(9) *médico* ‘doctor’ → /mediko/ > [ˈme.ði.go]
→ /medigo/ > [ˈme.ði.go]

Hualde, Simonet & Nadeu (2011) suggest, however, that a systematic recategorization of voiceless occlusive phonemes is not likely in the future, but it is possible that a recategorization of certain lexical items might occur. As seen in example (9), recategorization of /-iko/ > /-igo/ could occur where voicing is frequent, meaning speakers acquire two possible underlying representations: /mediko/ and /medigo/. Having these two underlying representations suggests a recategorization of the variant /-iko/ to /-igo/ for some speakers. As a result, there could be confusion among words that have *-igo* in their conventional orthography. Hualde, Simonet & Nadeu (2011) conclude that lenition processes consist of two stages: first, a phonetic weakening rule and second, phonological recategorization. The second stage only affects specific lexical items and, as a result, affects internal segments differently than initial segments. While this conclusion is very appealing, it is important to take into consideration the fact that the allophonic weakening rules may not be as systematic in all varieties and that there are varieties that do not exhibit much consonant weakening at all. For example, a study by Colantoni & Marinescu (2010), which will be discussed in 1.4.3, reports very little, if any, consonant weakening of Argentine intervocalic voiceless consonants.

In a cross-linguistic study, Torreira & Ernestus (2011) investigate voiceless intervocalic consonant weakening in both conversational Spanish and French. Speakers in this study are from Madrid, Spain and Central and Northern France. The results show that voiceless occlusives in intervocalic position have shorter closures in Spanish than in French. There are also more incomplete closures and more voiced closures as well. The authors conclude that the extent of the weakening that a certain segment suffers in conversational speech can vary considerably across different languages. The following section on lenition of /bdg/ will investigate more of these acoustic studies and the effects of linguistic and extralinguistic variables on stop consonant lenition.

1.4.2 Lenition of /bdg/

The primary objective of Martínez Celdrán (1984) is to characterize the acoustic traits of approximant segments and to investigate the acoustic differences between fricative and approximant productions. The author executed an analysis of the speech of twenty male speakers of a standard variety of Spanish, where they completed a structured task with the production of each of the voiced occlusives: labials, dentals, velars and palatals. To determine acoustic differences between the segments according to point of articulation, Martínez Celdrán (1984) examined the spectrograms of all realizations, looking for the presence or absence of voicing striations, and classifying the realizations into four types, listed from least occluded/most sonorous to most occluded/least sonorous: pure approximant, tense approximant, fricative and occlusive. The results of this study indicate a lack of perceptible difference between the quantity and intensity according to pretonic or postonic position; however, there is increased duration and intensity of the dental segments with slight differences between pre- and postonic positions. Martínez Celdrán (1984:124) concludes, "la energía es inversamente proporcional a la resistencia y obstrucción de los órganos bucales, pues, si multiplicamos la cantidad por la intensidad, podemos comprobar que la energía será tanto mayor cuanto menos obstrucción encuentra el aire y viceversa."[10] This conclusion is consistent with the openness hierarchy and sonority scale by Lass (1984) discussed previously in example (5).

Previous studies that have investigated the effect of adjacent vowels on intervocalic occlusive consonants yield mixed results. Cole et al. (1999) show that the velar segment /g/ exhibits the

[10] "the energy is inversely proportional to the resistance and obstruction of the buccal organs, so, if we multiply the quantity by the intensity, we can prove that the higher the energy, the less obstruction the air will find and vice versa." (my translation)

greatest degree of weakening following a stressed vowel or with adjacent vowels /o/ and /u/. On the other hand, weakening is not as prominent when the consonant segment in question precedes a stressed vowel or with flanking vowels /i/, /e/, and /a/ (Cole et al. 1999:12). Lewis (2001) and Kirchner (2004) tell us that more open vowels favor weakening; however, in opposition to these predictions about the influence of open vowels, Cole et al. (1999) find that the same velar segment /g/ has a more complete closure when /a/ is the adjacent vowel instead of one of the more closed vowels /u/ or /i/. Ortega Llebaria (2004) also investigates the interplay between phonetic correlates and phonological constraints. As the author points out, the phonological constraints preserve contrasts within a language, while different phonetic correlates provide contexts that are favorable for weakening processes to occur (238). The results from Ortega Llebaria (2004) indeed show that the phonetic correlates of stress and vowel context have a significant effect on the degree of spirantization of Spanish and English consonants in intervocalic position. Both /b/ and /g/ are more lenited when followed by a non-stressed vowel; however, only /g/ is affected by vowel context, that is, more lenited with flanking vowels /i/ and /u/, but less lenited with flanking vowel /a/, just as Cole et al. (1999) conclude.

More investigation is needed to determine the effects of flanking vowels on consonant lenition due to the contrasting findings of Lewis (2001) or Kirchner (2004) versus those of Cole et al. (1999) or Ortega Llebaria (2004). Possible explanations of the differences across studies could include speaker demographic as well as task type. The speakers of Lewis (2001), who are from Bilbao, Spain and Central Colombia, performed three tasks: semi-spontaneous conversation, textual reading and reading of a word list. On the other hand, the speakers of Cole et al. (1999) are all from Spain and produced words set within a carrier phrase, while the speakers of Ortega

Llebaria (2004) are speakers of Caribbean Spanish and produced nonce words in the form of a game with cartoon characters. All of these studies have very different participants as well as speech tasks; therefore, the lack of continuity between these methodologies could be a contributing factor of mixed results with respect to the effects of flanking vowels on consonant lenition.

Eddington (2011) contrasts voiced approximants /βðɣ/ with their stop variants [bd̪g] to determine phonetic contexts and other acoustic correlates which affect the realization of /βðɣ/ with data from informal telephone conversations between native Spanish speakers. Eddington (2011) is unique in his assumption that the approximant productions /βðɣ/ are the underlying, abstract mental representations, and the stop productions [bd̪g] represent possible allophonic realizations, contrary to other analyses that we have seen thus far (e.g., Table 1.4). To investigate the gradient nature (MacLeod 2008) of voiced obstruents, this study performs acoustic analysis to determine effects of phonetic context, stress, word frequency and appearance of the segments in a suffix (e.g., *-ado, -aba*). Eddington (2011) does not support the traditional rule that /βðɣ/ surface alternations are determined by a single phonological rule; rather, each segment is affected differently by the acoustic variables analyzed for the study. For example, following tonic syllables, /β/ and /ð/ favor a more occluded production, in contrast with /ɣ/, which does not conform to the same pattern, with lower degrees of weakening between two tonic syllables. Also, word frequency affects /ð/, by showing higher degrees of weakening in high frequency words, but not /β/ or /ɣ/. The segment /ð/ also lenites more frequently in the past participle suffix *-ado*. Based on Eddington (2011), it is clear that /βðɣ/ alternations do not operate uniformly with respect to phonetic context, stress, word frequency or suffix appearance. Eddington (2011) makes an important observation:

> If one assumes the stop/approximant dichotomy, the post-nasal approximant in [aprenðes] would be an exception to the rule, an aberration, or phonetic undershoot – the speaker just mispronounced it. However, the majority of postnasal voiced approximants examined in the present study show no obvious breaks or weakening of formants indicative of a stop. Does this mean that nasals do not affect the pronunciation of voiced approximants? No, what it demonstrates is the need for a gradient measure of lenition rather than a binary one. (3)

I investigate precisely this claim made by Eddington (2011), by examining the production of occlusive stop consonants through a gradient lens, with the understanding that segments may yield varied productions across different varieties of Spanish with respect to the different acoustic and extralinguistic variables studied.

Carrasco, Hualde & Simonet (2012) compare allophonic patterns of occlusive consonants in two Spanish varieties: Madrid, Spain and San José, Costa Rica. This study investigates /bdg/ in postconsonantal position, that is, after liquid, sibilant or glide segments, and in postvocalic position—after /a/—in order to determine if Costa Rican Spanish differs significantly from other dialects of Spanish with respect to allophonic variation of occlusive consonants /bdg/. The data includes analysis of the speech of thirteen participants, ten of the Costa Rican variety and three of the Madrid variety; participants ranged in age from 26-47 years; they had completed post-secondary education and were comprised of five men and five women.

Similar to Lewis (2001), the participants in this study performed four different tasks: 1) sociolinguistic interview, 2) photo-identification task where the participants had to formulate three complete sentences using the word in the photo, 3) textual reading of phrases and lastly, 4) textual reading of words in isolation. The variables that were analyzed in this study included point of articulation, position in the word, lexical stress and preceding segment. The results show that the Spanish of Costa Rica has a different allophonic distribution than that of Madrid. Costa Rican Spanish shows more closed or open variants of /bdg/ according to position, whereas the allophones in the Madrid dialect do not show a clear separation of allophones in different positions. The allophones in Costa Rican Spanish are weaker in internal position as compared to initial position, and RI measures present higher values in tonic syllables. In addition, there is less weakening in textual reading tasks. Carrasco, Hualde & Simonet (2012) connect these two varieties by saying that Costa Rican Spanish represents an earlier stage of weakening than the more extensive weakening found in the Madrid variety, much like the comparison made by Lewis (2001) between Central Colombian and Northern Spanish dialects.

Long (2014) investigates voiced stop deletion in Caracas Spanish, providing a complete account of the sociolinguistic behavior of intervocalic /g/ as well as to what degree /bdg/ deletion occurs due to social and linguistic factors. Long (2014) performs an acoustic analysis of sociolinguistic interviews of native speakers of Caracas from *Estudio sociolingüístico de Caracas* 'Sociolinguistic study of Caracas' (Bentivoglio & Sedano 1993 [1987]). In this study, participants are grouped accordingly to investigate the sociolinguistic variables of age, socioeconomic status and gender. Of these three variables, Long (2014) shows that age most affects deletion of segments, followed by word position, stress and gender. Deletion of /g/ is least common when compared to /b/ and /g/, but her analysis shows that younger speakers ages 14-29, as well as male speakers prefer the deleted variant. Position within the word as well as stress are significant factors contributing to variation of deletion of /g/, showing higher degrees of deletion in word internal position, consistent with previous studies (Eddington 2011; Ortega-Llebaria 2004). Given the conclusions of Long (2014), we see that although the voiced occlusive segments /bdg/ form part of the same phonological series, they operate differently and experience higher or lower degrees of deletion due to sociolinguistic factors such as age, socioeconomic level and gender. Therefore, the inclusion of extralinguistic factors such as gender and age are motivated in the current study to compare the behavior and weakening tendencies of both /ptk/ and /bdg/.

The next section will discuss previous work that has been done to compare weakening in both stop consonant series /ptk/ and /bdg/ to further motivate the current study.

<u>1.4.3 Lenition of /ptk/ vs. /bdg/</u>

Given all the phonetic variants of occlusive consonants, both voiced and voiceless, Martínez Celdrán (2009) investigates whether there is confusion of minimal pairs between intervocalic voiceless segments and intervocalic voiced segments (see example 10). In (10), the variant realizations of the intervocalic occlusive segment can lead to possible confusion of the underlying phoneme.

(10) [ˈgo. d̪a] ~ [ˈgo.ða] → /gota/?
→ /goda/?

Martínez Celdrán (2009) investigates this intervocalic voicing of voiceless occlusives in the speech of one Murcian speaker using a semi-spontaneous text. Following the data analysis, a perceptual test with twenty-five university students from Barcelona and Murcia determined to what extent speakers have difficulty identifying the underlying segment when presented with differing phonetic variants. Participants from Barcelona interpreted the majority of the proposed voicings—both underlyingly voiced and voiceless—as voiced in 92.5% of cases. This means that participants taking the perceptual test confused *pozo* with *bozo*, for example. Participants from Murcia, however, did not quite reach the same level of voicing identification in the perceptual test. These participants only identified the segments as voiced in 69.48% of cases of proposed voicing, which is still frequent identification of the voiced segment, even though the results were not quite as categorical as those from the Barcelonan participants (Martínez Celdrán 2009:264). In sum, the results of the perceptual test show that participants favor the voiced variant when selecting among isolated words, but that confusion disappears when the words appear in context. Therefore, Martínez Celdrán (2009) concludes that due to the neutralization of voicing, tension and duration of the segments, context is what allows correct interpretation of consonant segments in intervocalic position.

Colantoni & Marinescu (2010) analyze the degree of consonant weakening in Argentine speech using acoustic analysis of a dialectological interview corpus to motivate hypotheses that would explain diachronic changes in Spanish and other Romance Languages (100). This investigation evaluates different approaches to consonant lenition through acoustic analysis. Their first hypothesis predicts a positive correlation between higher approximantization/deletion of voiced stops and higher frequency of voicing of voiceless stops (Lloyd 1993; Martinet 1952; Wireback

1997), thus explaining consonant lenition as a stage towards deletion (Colantoni & Marinescu 2010:100). The second hypothesis proposed explains consonant lenition on the effort-based hypothesis (Blevins 2004; Kirchner 2004), where lenition occurs with decreased articulatory constriction and duration. More articulatorily costly gestures will weaken more than less articulatorily costly gestures, and the degree of lenition should be affected by flanking vowels (Colantoni & Marinescu 2010:100). If the second hypothesis proves correct, the authors predict lenition of voiceless occlusives, more instances of weakening with open flanking vowels and zero effect of place of articulation. The third hypothesis tested by Colantoni & Marinescu (2010) is the perception-based hypothesis (Kingston 2008), which states that consonant lenition is a measure of the degree of perceptual separation between two segments. Following this, flanking vowels should not affect consonant weakening and voiced segments will weaken more than voiceless segments.

The six male participants in Colantoni & Marinescu's (2010) study, between 25 and 50 years of age, are from two provinces of Argentina: Corrientes and San Juan. These two provinces were selected for the study because previous research had indicated evidence of a more advanced stage of weakening in Corrientes than in San Juan (Vidal de Battini 1964). The results of this study show that there is not a correlation between weakening of intervocalic voiceless segments and intervocalic voiced segments. In addition, the results do not indicate much clear evidence in favor of any voiceless occlusive weakening in intervocalic position in this speech variety. However, it is important to note that when surface lenition of voiceless occlusives /ptk/ is observed, labial segments appear to demonstrate more lenition than coronal and velar segments, contrary to other studies that show the highest degree of lenition among velar segments (e.g., Hualde, Simonet & Nadeu 2011). When the authors observe lenition of voiced segments /bdg/, however, coronals show more weakening than labials and velars, which is inconsistent with Hualde, Simonet & Nadeu (2011) but consistent with the results from Lavoie (2001) as well as historical lenition patterns in Romance languages (Wireback 1997).

Colantoni & Marinescu (2010) also consider RI in their analysis of the Argentine data, indicating that the voiced phonemes /bdg/ are produced with a value closer to zero, that is, with a more vowel-like quality; however, the voiceless phonemes do not show voicing. The effect of flanking vowels on the degree of weakening is also taken into account, but their hypothesis that weakening would increase when the consonant is surrounded by more open vowels is only partially confirmed (2010:11). The authors conclude that "[v]oiced stops are becoming weaker; they are relatively short segments articulated with a wide constriction; and coronals show a relatively higher rate of deletion. Voiceless stops, on the other hand are consistently realized as stops, are relatively long, show very few signs of voicing and are articulated with a narrow constriction" (2010:105). The authors also conclude that tonicity plays an important role in blocking consonant lenition. Given the data presented, the authors reject the first hypothesis, finding no correlation between the weakening of voiceless and voiced stops. The second hypothesis is also rejected because voiceless stops in these Argentine varieties do not exhibit weakening. The third hypothesis proposed by Colantoni & Marinescu (2010) is only partially confirmed; voiced stops exhibit the greatest weakening, while weakening with more open adjacent vowels is not consistent (111).

1.4.4 Summary

Previous work on stop consonants in different varieties of Spanish, such as the Balearic Islands, Andalusia, Madrid, and Canary Islands among others, shows that the underlyingly voiceless /ptk/ many times surface as completely or partially voiced allophones [bd̪g]. Speech style plays an important role in the frequency of these voiced variants, with scripted speech showing lesser degrees of weakening. Differing degrees of weakening are also present with respect to point of articulation, with velar segments showing more weakening than coronals, and coronals more than labials. Some authors suggest that stop consonant lenition is not a binary phenomenon (i.e., voiced vs. voiceless), but instead more gradient in nature, where different Spanish varieties exhibit more or less consonant weakening. In addition, speaker age has been shown to affect the degree of consonant lenition, with younger speakers often using more lenited variants.

The previous work reviewed in this section shows that the allophones of /bdg/ are gradient in nature and include pure approximants, tense approximants, fricatives and occlusives, from weakest production to strongest, respectively. These allophones also vary according to language variety, with some exhibiting more weakening, such as the extreme weakening found in Madrid Spanish as compared to Costa Rican Spanish. Age as a sociolinguistic variable has proven to be a significant variable yet again; that is, younger speakers favor weakened allophones of /bdg/. Consonant weakening is also affected by point of articulation, often where the production of /g/ varies from the coronal and labial, /d/ and /b/, respectively. These studies inform our knowledge on the production of voiced stop consonants and motivate my dissertation by offering conclusions with respect to the linguistic and extralinguistic variables that affect consonant lenition.

Although not many studies have broached the topic of comparing the production of voiceless /ptk/ with voiced /bdg/, the few cited in this section show that in certain varieties there is a neutralization of voicing, tension, and duration of both voiceless and voiced segments, leaving context to be the determining factor in the correct interpretation of the underlying segment. Other varieties show that voiced stops experience high degrees of weakening and loss, but voiceless stops continue to be realized as stops and show little to no signs of surface voicing. This section highly motivates the research questions of the current dissertation, which will be discussed in the next section, by showing the extensive variability that appears in different varieties of Spanish, indicating the gradient nature of consonant lenition and a continuum of weakening from weak to strong (Lewis 2001) on which different varieties of Spanish can be situated.

1.5 Motivations and Research Questions

Consonant weakening in Romance is a topic all too familiar among historical linguistics, and on the surface, these developments seem very neat and systematic; however, upon taking a closer look at existing data, we find examples of consonant developments in Romance that do not fit nicely into the traditional East-West typology of Romance consonant development. The main objective of this thesis is to show that the changes that have been identified as chain-shifts (Martinet 1952), where consonant weakening works in tandem among members of the voiceless and voiced occlusive series, do not necessarily operate in chain-shifts; rather, these changes represent a series of more complex processes acting at different intensities, even though they appear on the surface to be intricately linked. Previous historical explanations of consonant weakening rely on theoretical principles of sound change and limited data found in ancient documents, without having access to actual speaker data (Jungemann 1955; Martinet 1952; Tovar 1948). While orthographic evidence is helpful and indicative of language change, many times the picture is not complete; therefore, the existing historical theories of consonant lenition are mainly educated speculations without concrete explanations. Because it is absolutely impossible to travel back in time with a microphone and a recorder, we must look to other methods to explain historical language development. Therefore, this dissertation uses acoustic analysis to measure RI of consonant occlusion and %V to compare productions of the voiceless phonemes /ptk/ with the voiced phonemes /bdg/ to give a synchronic snapshot of weakening processes across different varieties of Spanish that will, in turn, shed light on diachronic language change and variation. Although VOT and closure duration are relevant acoustic variables for the study of voiceless stop consonant production, I will not use them in the present study given the lack of comparability between both /bdg/ and /ptk/. In intervocalic position, the productions of /bdg/ have approximant realizations instead of occlusive realizations, meaning that the buccal organs approach but do not touch and are therefore deemed *approximants*. Since for /bdg/ we do not find a complete closure of the organs to measure closure duration or a release burst to measure VOT, I will leave these two correlates for future investigation on voiceless stop consonant weakening. The acoustic approaches here make important contributions to our knowledge on the topic of stop consonant lenition, given that an acoustic analysis of this magnitude on multiple Spanish varieties comparing both voiceless and voiced occlusive series has not been previously reported.

According to recent studies that have been mentioned thus far, we can make two main general observations: 1) voicing of voiceless occlusives is present in many varieties of Spanish today, and 2) there seems to be a continuum of consonant weakening where different varieties exhibit greater or lesser degrees of voicing and/or spirantization in intervocalic position. In this chapter, we have seen that voicing of intervocalic /ptk/ occurs in Northern Spanish dialects (e.g., Bilbao), Mallorca, Murcia and Andalusia, that there is a lesser degree of voicing of /ptk/ in Central Colombian dialects, and that there does not seem to be any voicing of /ptk/ present in Argentine Spanish. This data presents a typology of present-day consonant lenition highlighting more progressive dialects where consonant weakening is not only found, but is common practice as well as more conservative varieties in which occlusive segments are fully conserved in intervocalic position. Based on previous research that has been reviewed up to this point, I would like to propose the lenition continuum seen in (11).

(11) ←——————————————————————→

conservative non-leniting	slight/sporadic weakening	progressive weakening	innovative weakening

Using this typology and the data presented in this chapter, different varieties of Spanish can be situated on a continuum of consonant lenition where some dialects do not show any signs of intervocalic weakening and conserve intervocalic occlusives /ptk/, such as Argentine varieties (Colantoni & Marinescu 2010). Other Latin American varieties, however, do exhibit slight weakening and/or sporadic weakening, but do not present such an advanced stage of weakening as Peninsular/Insular varieties; these varieties include Central Colombian Spanish and Costa Rican Spanish (Carrasco, Hualde & Simonet 2012; Lewis 2001). Continuing along the spectrum, we find Peninsular varieties that exhibit more regular weakening; these dialects include Andalusian dialects and Northern Spanish dialects (Lewis 2001; O'Neill 2010). At the far end of the lenition continuum, we find very innovative weakening dialects where lenition is common, and at times, has phonological consequences (Oftedal 1985). This typology and continuum of consonant weakening in Spanish suggests that allophonically, consonant weakening is not a binary phenomenon.

Occlusive allophones are neither occlusive or fricative/spirant, but rather fall on a gradient scale of consonant weakening where the degree of lenition can depend on a variety of structural and sociolinguistic factors. Effects of flanking vowels on stop consonants in intervocalic position reveal mixed results (Cole et al. 1999; Lewis 2001; Kirchner 2004; Ortega Llebaria 2004). RI and %V are among the structural factors that identify and distinguish the voiced stop consonant series /bdg/ from the voiceless /ptk/, in addition to identifying point of articulation within each series. Previous studies show that higher %V proportions along with lower RI measurements indicate approximant productions whereas lower %V proportions coupled with higher RI measurements yield more occluded productions (Hualde, Simonet & Nadeu 2011; Lisker & Abramson 1964).

Work in the area of consonant lenition also indicates that socio- and extralinguistic factors such as age, gender, speech style, and dialect may affect consonant weakening (Flores 2016; Hualde Simonet & Nadeu 2011; Oftedal 1985; Lewis 2001; Long 2014). Previous research throughout this chapter on the production of /ptk/ and /bdg/ in Spanish motivate my dissertation by providing insight on the current variation that exists in modern Spanish. However, at the same time, we still notice gaps in our understanding of how consonant lenition compares across multiple varieties, how /bdg/ differ from /ptk/ with respect to phoneme, consonant sonority, prosodic position, lexical stress, %V and RI, as well as how extralinguistic factors such as age, gender, speech style, and dialect affect the degrees of weakening. In hopes of filling said gaps, I analyze data from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) to compare stop consonant production in ten varieties of Spanish while controlling for linguistic and extralinguistic factors. An acoustic analysis of this magnitude that compares both the voiced and voiced obstruent series at the same time, while controlling for the aforementioned linguistic and extralinguistic factors has not been done before, and therefore will contribute to our knowledge about stop consonant lenition in Spanish across the Spanish-speaking world.

With all that said, *how* can we explain historical language developments without having the luxury of recorded speaker data from centuries past? First of all, we can begin to fill the gap by analyzing similar developments that are observable through present-day speaker data, creating a model of the past through use of the present (Labov 1975). Since we no longer have access to speaker data from centuries past for acoustic analysis, our analyses are limited to present-day speaker data. By analyzing synchronic data with the use of modern technology to tease apart the variation that exists in different Spanish varieties and the relevant variables that affect variation, we can compare modern-day situations to similar linguistic situations of the past. Labov (1975) puts it perfectly when he says:

> We are now offered many tools for the exploration of that world which were not available to nineteenth century linguists: the instruments of acoustic analysis and acoustic recording, survey methodology, participant-observation, as well as our own techniques of structural analysis. We can use these tools to re-enter the world, with full confidence that its rational character will reward our efforts to understand it. We should have no hesitation in projecting this understanding to past events that are no longer accessible to direct observation. Granted that the world of everyday speech is rational, there is no reason to think that it was any less so in the past. If there are contradictions in the historical record, we have no

> doubt that they can be resolved: the most likely route to such a resolution is through a deeper understanding of the use of language in the ordinary world of the present. Only when we are thoroughly at home in that everyday world, can we expect to be at home in the past (308-309).

By conducting studies on diachronic stop consonant variation in conversational speech across present-day Spanish varieties, it becomes clear that despite underlying phonological structure, allophonic lenition is found to varying degrees in many Spanish varieties. Therefore, my dissertation investigates the following research questions:

(12)
a. How do linguistic factors such as sonority, phoneme, point of articulation, lexical stress, and prosodic position affect consonant lenition across different varieties of Spanish?
b. How do the sociolinguistic factors of gender, age, and dialect affect consonant lenition across different varieties of Spanish?
c. Is there a correlation of consonant lenition of /ptk/ and /bdg/ between more radical and more conservative Spanish varieties with respect to the acoustic correlates of RI and %V?

The lenition continuum of allophonic variation exposed through consonant weakening can be clouded by traditional phonological descriptions of occlusive consonants: /ptk/ vs. /bdg/. While it is not feasible to recreate an exact replica of the phonetic language patterns that occurred in Late Latin, I discuss the limitations of previous studies and expect to enhance our understanding of consonant lenition across different varieties of Spanish by offering a complete acoustic analysis of the present stage of variation with respect to both of the stop consonant series, /ptk/ and /bdg/.

In order to begin the process of addressing the objectives outlined in this section, the following chapter will discuss the experimental design of my dissertation and the results of a pilot study.

2. METHODOLOGY AND PILOT STUDY

2. Methodology

Considering the previous chapter's discussion of the history of consonant lenition, the variables affected by lenition and current synchronic lenition processes found in Spanish today, this chapter details the experimental design of my study as well as the results of a pilot study used to motivate my dissertation. After explaining the execution and results of the pilot study, this chapter will discuss the motivations for my dissertation, the Spanish varieties included in the analysis, background information about the corpus data and the participants, the tasks completed by the participants and used for this analysis on consonant lenition, and the linguistic, acoustic and extralinguistic variables controlled for in the dissertation. This study hopes to shed light on how linguistic factors such as point of articulation, phrase position, and lexical stress and extralinguistic factors such as gender, age, and dialect affect stop consonant weakening through the analysis of the acoustic correlates relative intensity (RI) and percent voicing (%V).

2.1 Pilot study

2.1.1 Overview

For decades, previous research on consonant lenition in Spanish has shown much variability of consonant production for both voiced and voiceless stop consonants /bdg/ and /ptk/, which can be affected by linguistic factors such as phoneme, sonority, point of articulation, prosodic position, lexical stress, and flanking vowels (Cho, McQueen & Cox 2006; Cole et al. 1999; Gili Fivela et al. 2008; Kirchner 2004; Lavoie 2001; Lewis 2001; Lisker & Abramson 1964; Ortega Llebaria 2004; Wireback 1997). In addition to these linguistic factors, other extralinguistic variables like age, gender, speech style and dialect have also been shown to affect the degree of consonant occlusion (Bayley & Tarone 2011; Labov 2001; Lewis 2001; Long 2014; Oftedal 1985). However, in my survey of previous work on stop consonant weakening, it became clear that many of these studies focus on either voiced stops /bdg/ or voiceless stops /ptk/ and only analyze one to two Spanish varieties at a time for side-by-side comparison. There is a lot of evidence for consonant variability across different Spanish dialects, but I began to wonder how /bdg/ and /ptk/ interacted with each other within the phonemic inventory for Spanish and how the production of these two stop series compares across multiple Spanish varieties. Therefore, before executing my study, I completed a pilot study with preliminary results to investigate the degree of consonant weakening for both /bdg/ and /ptk/, to see if there was any overlap between the phonetic realizations of these phonemes and to determine what kind of variability exists when the speech of multiple Spanish varieties is analyzed in the same way. For the pilot study, I collected data from 21 native speakers of different Spanish varieties, geographically ranging from Chile all the way to the Canary Islands and northern Spain. In order to keep the data uniform and control for linguistic and extralinguistic factors, all participants read a list of 70 words containing the consonants /ptk/ and /bdg/ set within a carrier phrase. The pilot study investigates the effects of both linguistic factors (point of articulation, lexical stress, prosodic position, following vowel) and extralinguistic factors (dialect) using the acoustic correlate of RI to draw comparison between the production of phonemes /ptk/ and /bdg/. For the pilot study, I chose to analyze /bdg/ and /ptk/ using the acoustic correlate of RI because with this measurement, it is possible to compare both voiced /bdg/ and voiceless /ptk/ at the same time. As mentioned in the previous chapter, section 1.3.5, given the voiced and voiceless nature of these two phoneme series, RI allows for an analysis of the degree of occlusion on the same scale, showing how the productions of /bdg/ and /ptk/ compare. While there are other factors that can affect the degree of consonant weakening, I organized the pilot study in this way to provide a simple overview of the phonetic contrast between /bdg/ and /ptk/ and to determine the variability across different Spanish varieties. Following the analysis of these preliminary results, I realized that the extent of variability in stop consonant production is indeed substantial, but that the degree of occlusion depends greatly on the specific varieties in question. Chilean varieties have very weak productions of /bdg/ and /ptk/, with the former weakening almost to the point of deletion, whereas Mexican varieties guard more conservative productions of /bdg/ and /ptk/. Therefore, for my dissertation, this pilot study is expanded to compare even more Spanish varieties as well as control for more variables that have been shown to affect the degree of consonant weakening, filling gaps in existing research by contributing an entirely acoustic analysis and cross-dialectal comparison of Spanish from Spain, the Canary Islands, Argentina, Chile, Mexico, the Caribbean and the Andean region using semi-spontaneous data analyzed from the corpus *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013). The following sections of this chapter will discuss the Spanish varieties included in the pilot study and outline its methodology and design, the materials and tasks used, an explanation of the data analysis and a discussion of the results and conclusions before leading into the motivations and methodology for the larger study carried out for the dissertation.

2.1.2 Spanish varieties

As discussed in the previous chapter, sections 1.4.1-1.4.3, voicing of voiceless occlusives /ptk/ has been found in many varieties of Spanish as well as extensive weakening of voiced occlusives /bdg/. Some of the most radical productions of /ptk/ can be found in the Canary Islands (Oftedal 1985; Trujillo 1980), many times showing completely voiced productions of /ptk/ > [bd̪g]. Still other previous studies have shown that consonant occlusion is gradient in nature (Colantoni & Marinescu 2010; Lewis 2001), with different varieties showing higher or lesser degrees of consonant weakening. For example, dialects in Northern Spain appear to be more innovative, that is, show higher degrees of consonant weakening, as compared to Central Colombian Spanish, where productions of /ptk/ are more conservative, or occluded (Lewis 2001). Similar variability is found in the production of /bdg/ in Carrasco, Hualde & Simonet's (2012) study on Costa Rican and Madrid varieties, where Costa Rican Spanish shows more conservative productions of /bdg/, or an earlier stage of weakening, as opposed to the more extensive weakening found in Madrid Spanish. Therefore, for the pilot study, I gathered data from a variety of native Spanish speakers from many Spanish-speaking regions to create a native speaker pool that is representative of Spanish as a whole, but that also can be used to compare stop consonant production and variation between different varieties. I made sure to collect data from speakers of Peninsular varieties of Spanish as well as Mexican, and Latin American varieties, since Peninsular varieties have been shown to exhibit more innovative consonant productions, that is, higher degrees of weakening and the others have previously yielded more conservative consonant productions, that is, lesser degrees of weakening. The varieties represented in this pilot study are grouped primarily according to country, with the exception of Spain, which I have divided into two groups based on like phonetic characterizations (Hualde 2005): North-Central Peninsular varieties and Southern & Insular Peninsular varieties. The former includes participants from cities such as Ponferrada, Lugo, Valladolid, Salamanca and Madrid, while the latter includes two southern Peninsular cities, Granada and Malaga as well as two insular varieties from Gran Canaria and Mallorca.

Although the geographic distribution of the Spanish varieties included in the pilot study is by no means exhaustive, the cities included offer a geographic range of many different varieties across the Spanish-speaking world.

2.1.3 Research questions

In analyzing data from these geographical areas and controlling for the aforementioned linguistic and acoustic variables, the goal of my pilot study was to motivate the large-scale dissertation study by investigating the following research questions and situating the Spanish varieties analyzed on a lenition continuum ranging from conservative/non-leniting varieties to innovative/leniting varieties:

(13)
a. How do linguistic factors such as point of articulation, lexical stress and following vowel affect consonant lenition across different varieties of Spanish?
b. How does the extralinguistic factor of dialect affect consonant lenition across different varieties of Spanish?
c. Is there a correlation of consonant lenition of /ptk/ and /bdg/ between more radical and more conservative Spanish varieties with respect to the acoustic correlate of RI?

Considering the first research question, (13a), this pilot study hypothesized that velar segments /k/ and /g/ would produce higher degrees of weakening than labial and dental segments (Eugenio de Bustos 1960; Marrero 1988; Quilis & Graell 1992; Salvador 1968). Consonants found in atonic syllables would produce higher degrees of weakening than those found in stress syllable contexts (Browman & Goldstein 1992; Cho, McQueen & Cox 2006; Gili Fivela et al. 2008; Keating et al. 2003). With respect to the effects of the following vowel on consonant lenition, previous work on the topic has shown mixed results. Cole et al. (1999) show more consonant weakening with flanking vowels /o/ and /u/ as opposed to vowels /e/, /i/ and /a/, whereas Lewis (2001) and Kirchner (2004) show that more open vowels such as /a/ favor weakening. Therefore, I hypothesized that vowel frontness/backness and vowel height would affect consonant lenition, yielding either less or more occluded consonants according to vowel type. With respect to the second research question (13b), by analyzing the six varieties selected for this pilot study, I hypothesized that Spanish speakers from Latin American dialects would produce more occluded occlusive segments than Peninsular and Insular speakers. Finally, considering the third research question, (13c), I hypothesized that although /ptk/ and /bdg/ show variability in the degree of weakening across different Spanish varieties, RI measurements for voiced /bdg/ and voiceless /ptk/ would never overlap within the same variety in intervocalic position given the need for phonetic contrast between voiced /bdg/ and voiceless /ptk/ that makes up the phonemic system of Spanish, even though the measurements might overlap with those of other Spanish varieties.

2.1.4 Methods

2.1.4.1 Participants

The 21 participants interviewed for this pilot study were all native speakers of a Spanish variety and represented students and faculty at an American university. The participants were recruited via personal connections. Table 2.1 organizes the participants according to gender, age, city of origin, years spent in the United States, and Spanish variety.

Speaker	Gender	Age	City of origin	Years spent in USA	Spanish variety
Col1	F	28	Medellin	3.5	Colombian Spanish
Col2	F	46	Bogota	14	
Col3	F	35	Cordoba Baranquilla	7	
Mex1	F	36	Sonora	8	Mexican Spanish
Chi1	F	29	Santiago	7	Chilean Spanish
Chi2	F	43	Santiago	15	
Chi3	F	22	Antofagasta	0.33	
Per1	M	51	Lima	20	Peruvian Spanish
Per2	F	49	Lima	22.5	
Per3	M	29	Lima	3	
NSp1	M	59	Ponferrada	28	North-Central Peninsular Spanish
NSp2	F	34	Lugo	4	
NSp3	F	24	Valladolid	0.5	
NSp4	M	40	Valladolid	2	
NSp5	F	54	Salamanca	25	
NSp6	F	47	Madrid	15	
NSp7	M	39	Madrid	0.75	
SSp1	F	29	Gran Canaria	1.5	Southern/Insular Peninsular Spanish
SSp2	M	34	Mallorca	4	
SSp3	M	35	Granada	6	
SSp4	F	52	Malaga	26	

Table 2.1. Demographic information for pilot study participants.

The 21 participants included 14 females and 7 males and ranged in age from 22-59 years of age, with a mean age of 38.8 years and a median age of 36 years. The participants had also spent varying amounts of time in the United States and other countries, with time away from their home country ranging from 4 months to 28 years with an average of 10.15 years spent in the United States. The participants in the pilot study did not complete a language dominance survey to show that they are all still Spanish dominant. However, in my personal communications with each of the participants, they expressed their continued use of Spanish in their daily lives, either at home, at work, or both despite having spent extended time away from their home country. For future work on this topic, the inclusion of a language dominance survey, such as the Bilingual Language Profile (BLP) (Birdsong, Gertken & Amengual 2012), would be used to improve the quality of the study. Other languages spoken by the participants included primarily English, although some speakers also had some knowledge of other languages such as French, Italian, Portuguese, Galician, and German. Unfortunately, data from three of the 21 speakers was removed from the data set: speakers Per1, NSp4 and NSp7, highlighted in yellow in Table 2.1. During the recording of these speakers, it was evident that their production of intervocalic /bdg/ was exaggerated and uncharacteristic of their natural speech. RI values for these three participants showed very little distinction between voiceless /ptk/ and voiced /bdg/; therefore, I have excluded their data from the upcoming tables to avoid skewing the data set. Fortunately, the origin of each of these excluded speakers is still represented in the data set by other speakers with more naturalistic and normative speech production. Therefore, the total number of speakers included in the present data set is 18, comprised of 14 females and 4 males.

While recruiting speakers for this pilot study, it was my intention to find a wide variety of speakers from all over the Spanish-speaking world, while trying to have at least a couple of speakers from each general variety. However, as seen in Table 2.1, there is only one speaker that is representative of a Mexican Spanish variety. Therefore, in the case of Mexican Spanish, I will consider individual speaker differences in the results and discussion sections of the pilot study since this one speaker may exhibit phonetic tendencies that do not perfectly align with other Mexican speakers.

2.1.4.2 Materials and tasks

The above-mentioned participants completed two tasks as a part of the pilot study: a brief demographic questionnaire and a phrase-reading task. The demographic questionnaire asked for the participants' age, gender, level of education, city of origin, language background including Spanish as well as other languages and time spent in the United States (see Appendix I). Following the completion of the demographic questionnaire, the participants recorded a set of phrases in a quiet room using a Blue Snowflake USB Recorder. The phrases were read via PowerPoint presentation, with one phrase per slide. The task included words replicated from Casteñada Vicente (1986), with the interested segments /ptk/ and /bdg/ set within the carrier phrase *Yo digo* ____ *para ti* 'I say ____ for you'. See examples in (14) below and Appendix I for a complete list of all words analyzed for the pilot study. The segments investigated here are limited to initial position only, leaving the comparison of stop consonant production between initial and internal position for the current dissertation study to be discussed in coming sections.

(14) a. Yo digo *paso* para ti. 'I say *I pass* for you'
b. Yo digo *pasó* para ti. 'I say *he passed* for you'
c. Yo digo *bajo* para ti. 'I say *I remove* for you'
d. Yo digo *bajó* para ti. 'I say *he removed* for you'

In order to represent all of the variables in question (to be discussed in the following section), the task included 10 words for each phoneme /ptk/ and /bdg/, 5 in tonic position followed by each of the 5 Spanish vowels /aeiou/ and 5 in atonic position followed by each vowel as well. The 60 phrases were included randomly in the PowerPoint presentation, along with 10 distractor phrases, totaling 70 with 2 additional phrases at the beginning to practice the format of the task.

The participants read each phrase twice. This task included the production of 120 total phrases multiplied by 18 participants (120 x 18 = 2,160 tokens).

2.1.4.3 Analysis

2.1.4.3.1 Linguistic variables. As previously covered in depth in Chapter 1, sections 1.3 and 1.4, this pilot study was designed to control for consonant sonority, place of articulation, lexical stress, prosodic position, and following vowel. Both sets of stop consonants were included in the data set, voiceless /ptk/ as well as their voiced counterparts /bdg/, with their members representing three distinct points of articulation: labial, dental and velar, respectively. Example (15) shows a consonant sonority contrast between voiceless stop consonant /t/ and voiced stop consonant /d/. Example (16) shows the place of articulation contrast between labial /p/, dental /t/ and velar /k/.

(15) Yo digo ***t****alo* para ti. 'I say *I cut down* for you'
Yo digo ***d****ejo* para ti. 'I say *flavor* for you'

(16) Yo digo ***p****illo* para ti. 'I say *thief* for you'
Yo digo ***t****oco* para ti. 'I say *I play* for you'
Yo digo ***c****asa* para ti. 'I say *home* for you'

For each consonant segment, the task included the segment both in tonic as well as atonic position, to determine the effects of lexical stress on the degree of consonant weakening. All the consonant segments included were in word-initial position. As discussed in the previous chapter, section 1.3.4 on prosodic position, word-initial position exhibits strengthening as compared to word-internal position (Cho, McQueen & Cox 2006, Gili Fivela et al. 2008, Keating et al. 2003). This pilot study, therefore, limited the scope to include only stop consonants in word-initial position, assuming that more extensive degrees of weakening would be present in word-internal position. Example (17) shows a contrast between a tonic syllable ***ga****no* 'I win' and an atonic syllable ***ga****nó* 'she won'. Prosodic position was a controlled variable in the pilot study since all of the consonants analyzed were in word-initial, phrase internal, intervocalic position.

(17) Yo digo ***ga****no* para ti. 'I say *I win* for you'
Yo digo ***ga****nó* para ti. 'I say *she won* for you'

Finally, the words in the task also controlled for flanking vowels, evenly distributing all five vowels after each stop consonant, both in tonic and atonic position. Example (18) shows the voiced velar segment /g/ followed by each of the five Spanish vowels, /aeiou/. The preceding vowel was kept constant in the carrier phrase: /o/.

(18) Yo digo ***ga****no* para ti. 'I say *I win* for you'
Yo digo ***gue****rra* para ti. 'I say *war* for you'
Yo digo ***gui****so* para ti. 'I say *stew* for you'[11]
Yo digo ***go****zo* para ti. 'I say *joy* for you'
Yo digo ***gu****sto* para ti. 'I say *taste* for you'

2.1.4.3.2 Acoustic correlates. After recruiting the participants, interviewing them and recording their sentence productions, I analyzed each of the tokens using PRAAT (Boersma & Weenink 2013). The primary acoustic correlate analyzed for the pilot study is RI. As referenced in the previous chapter, section 1.3.5 on acoustic variables, RI of a consonant is the difference in decibels (dB) between a consonant segment and the following vowel. Refer back to section 1.3.5 on acoustic variables, specifically to Figures 1.1-1.3, for examples of PRAAT spectrograms with

[11] It is important to note that the 'u' of *guerra* and *guiso* in example (18) is not pronounced.

different measurements of RI. A total of 2,160 tokens were analyzed in this way by recording the RI of each token, including occlusive consonants in both tonic and atonic position and taking into account the following vowel. A RI measurement closer to 0dB indicates a more vocalic production, that is, a weakened, pure approximant, whereas a higher RI measurement is indicative of a strengthened, more consonant-like production. Figures 2.1 and 2.2 include PRAAT (Boersma & Weenink 2013) images of a highly open consonant and a highly occluded consonant, respectively. These images show the PRAAT spectrogram as well as the yellow intensity curve of two utterances extracted from the current data set for the pilot study: *Yo digo* buscó *para ti* 'I say *he looked for* for you' and *Yo digo* podo *para ti* 'I say *I prune* for you'. The minimum and maximum intensity values for the production of /b/ and /p/ in these two utterances is marked with two black circles. In Figure 2.1, we notice that there is not much contrast between the minimum intensity and maximum intensity surrounding the production of /b/. Therefore, the RI difference of this segment is relatively low (maximum intensity 66.4dB – minimum intensity 65.9dB = RI 0.5dB). Figure 2.2, on the other hand, shows a great contrast between the minimum and maximum intensity values surrounding the production of /p/. The RI difference of [p], therefore is much higher, indicating a more occluded production (maximum intensity 71.7dB – minimum intensity 60.3dB = RI 11.4dB).

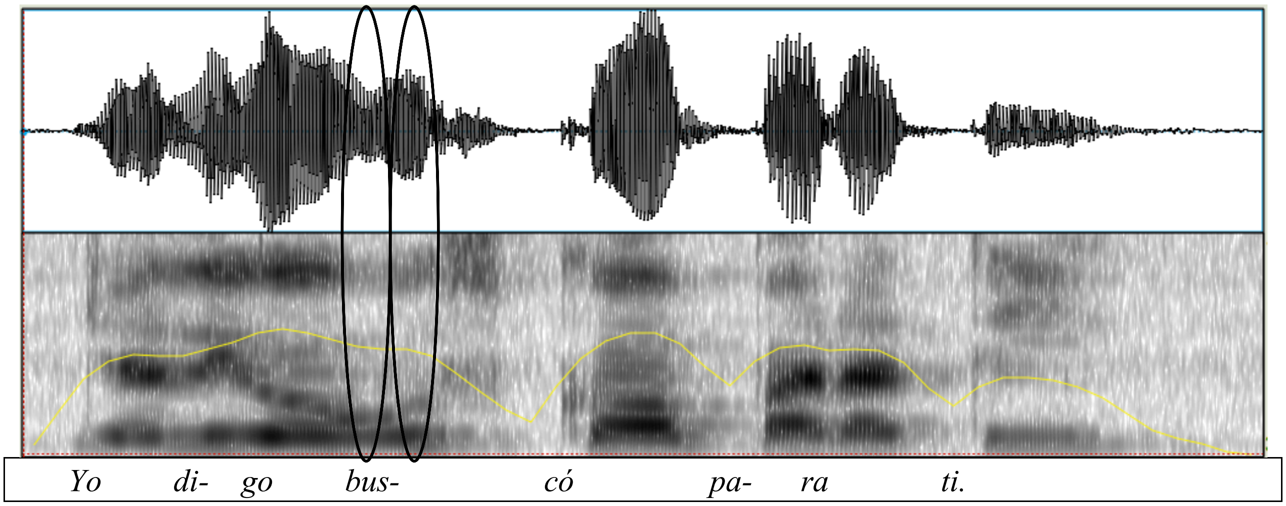

Figure 2.1. Measurement of the RI of the phrase Yo digo *buscó* para ti 'I say *he looked for* for you.'

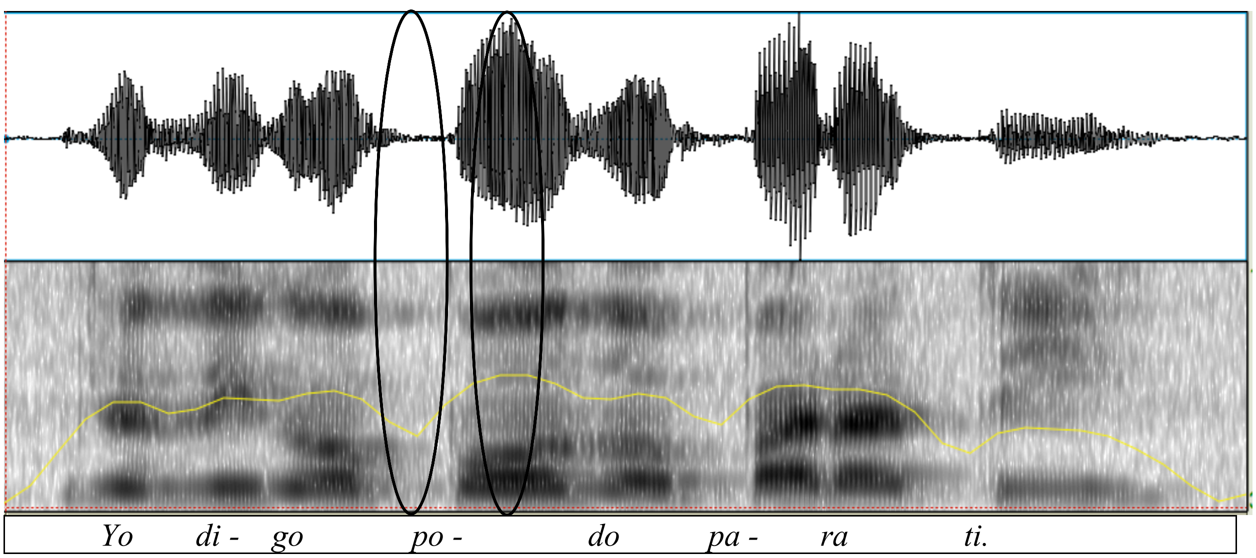

Figure 2.2. Measurement of the RI of the phrase Yo digo *podo* para ti 'I say *I prune* for you.'

Specific values and averages for all Spanish varieties of the current data set will be presented in the upcoming section 2.1.5 on results.

2.1.5 Results

2.1.5.1 Relative intensity of /ptk/ and /bdg/

Table 2.2 shows the RI measurements according to place of articulation for all six Spanish varieties analyzed for the pilot study. It is noteworthy that the values in Table 2.2 are purely descriptive in nature and that for the pilot study there has been no statistical tests performed on this data set. Values with the highest RI are marked in red, indicating a more occluded stop consonant production; values with the lowest RI are marked in green, indicating a more open stop consonant production, and RI values in between are marked in yellow. This color scheme will be used throughout the chapter for all RI tables to easily identify higher/lower RI values. At first glance, we notice a clear divide between the Mexican, Peruvian and Colombian varieties (Group 1) and the North-Central Peninsular and Southern/Insular Peninsular and Chilean varieties (Group 2) with respect to RI. Group 1 varieties show higher RI differences for both voiceless and voiced stop consonant series. Let me illustrate this point with two PRAAT images of the same utterance, *Yo digo quitó para ti* ‘I say *he took* for you’, produced by a Mexican speaker in Figure 2.3 and a Chilean speaker in Figure 2.4. The valleys and peaks surrounding the production of the segment /k/ in atonic position are marked with black circles. In Figure 2.3 the RI of [k] is 19.8dB, a value indicative of a more consonant-like production. In Figure 2.4, however, the RI of [k] produced by the Chilean speaker has a value of 3.1dB, which is much closer to 0dB, indicative of a more vowel-like production.

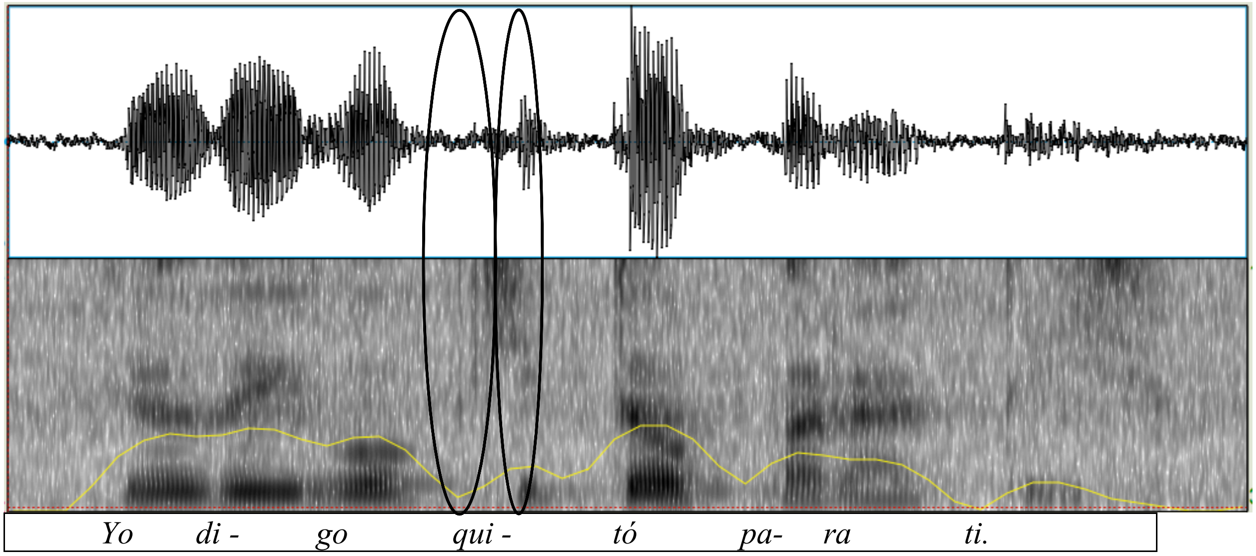

Figure 2.3. Measurement of the RI of the phrase Yo digo *quitó* para ti 'I say *he took* for you' produced by Mexican speaker (Mex1) from Sonora, Mexico.

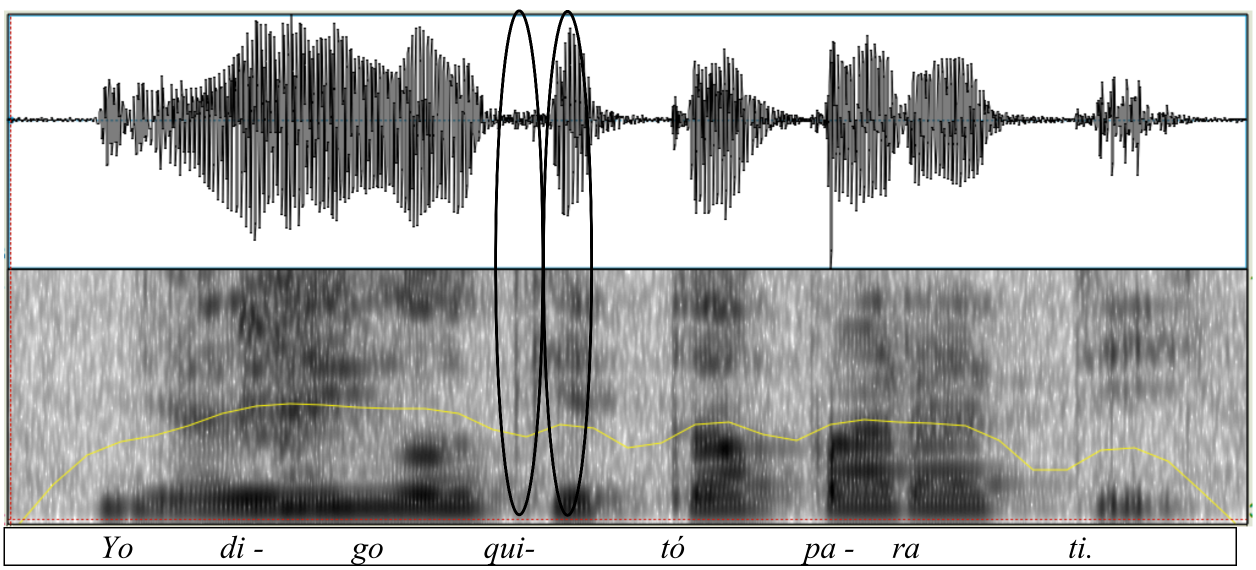

Figure 2.4. Measurement of the RI of the phrase Yo digo *quitó* para ti 'I say *he took* for you' produced by Chilean speaker (Chi1) from Santiago, Chile.

While previous research has suggested differing degrees of lenition according to point of articulation (Colantoni & Marinescu 2010), the data presented in Table 2.2 does not show consistency across Spanish varieties. For example, in the Mexican variety analyzed here, dental occlusive segments /t/ and /d/ exhibit lower RI values as compared with labial and velar points of articulation. This is not the case however in Southern/Insular Peninsular Spanish varieties, where the labial /p/ and velar /g/ have the lowest RI values as compared to the other segments. Therefore, we can see by looking at the RI data in Table 2.2 that the degree of consonant lenition according to point of articulation is variable. However, apart from Southern/Insular Peninsular varieties, the last row of Table 2.2 shows that the voiced velar segment /g/ is the most strongly occluded of the voiced stops in all remaining varieties.

	Mexican	**Peruvian**	**Colombian**	**North-Central Peninsular**	**Southern/Insular Peninsular**	**Chilean**
/p/	15.7	16.7	16.2	11.2	9.7	10.2
/t/	15	14.8	16	12	10	9
/k/	17.4	14.9	15.8	11.4	10	10
/b/	7.1	7.2	6.5	4.1	3.7	3.4
/d/	5.3	5.7	7.6	3.8	3	3.8
/g/	9.7	8.6	8.5	5	2.9	4.2

Table 2.2. Relative intensity measurements according to Spanish variety and point of articulation.

Combining the results from Table 2.2 yields the average RI of /ptk/ and /bdg/ in each of the six Spanish varieties analyzed for my pilot study. These results are presented in Table 2.3. Row 1 of Table 2.3 shows that the average RI of /ptk/ ranges from 9.7-16dB, while row 2 of Table 2.3 shows that the average RI of /bdg/ ranges from 3.2-7.5dB. While there is no overlap between the average production of the voiced and voiceless stop consonants in the six varieties of Spanish, we do notice that all varieties do maintain a distinction between the voiced and voiceless series to avoid confusion since there is at least a 5.9dB RI difference (= IntDiff) separating the two, shown in row 3 of Table 2.3.

	Mexican	Peruvian	Colombian	North-Central Peninsular	Southern/Insular Peninsular	Chilean
/ptk/	16	15.5	16	11.5	9.9	9.7
/bdg/	7.4	7.1	7.5	4.3	3.2	3.8
IntDiff	8.6	8.4	8.5	7.2	6.7	5.9

Table 2.3. Decibel distinction between /ptk/ and /bdg/.

The graphic in Figure 2.5 illustrates the information from Table 2.3 in a more visual way, showing a RI scale ranging from 0-20dB where 0dB represents less occlusion and more vowel-like sounds whereas a RI value closer to 20dB is indicative of a higher degree of occlusion and more consonant-like sound. The six Spanish varieties included here are labeled and color coordinated: Colombian Spanish (Col = green), Mexican Spanish (Mex = blue), Peruvian Spanish (Per = red), North-Central Peninsular Spanish (NCP = purple), Southern and Insular Peninsular Spanish (S/IP = orange), and Chilean Spanish (Chi = yellow). We can see from the figure that within each variety, there is a distinct separation between the production of the voiced and voiceless segments, that is, /bdg/ are consistently less occluded than their voiceless counterparts, /ptk/, and that speakers are not conflating phoneme groups, ultimately maintaining a phonemic distinction between voiced /bdg/ and voiceless /ptk/. As I mentioned previously in reference to Table 2.3, there does not occur any direct overlap between different Spanish varieties; however, Colombian /bdg/ with an average RI value of 7.5dB does approach the average RI value for /ptk/ in Chilean varieties. The proximity in RI values indicates that the voiceless /ptk/ in Chilean Spanish has a similar production to Colombian /bdg/, which we know are two independent sets of phonemes, separated by the vibration of the vocal folds, or lack thereof.

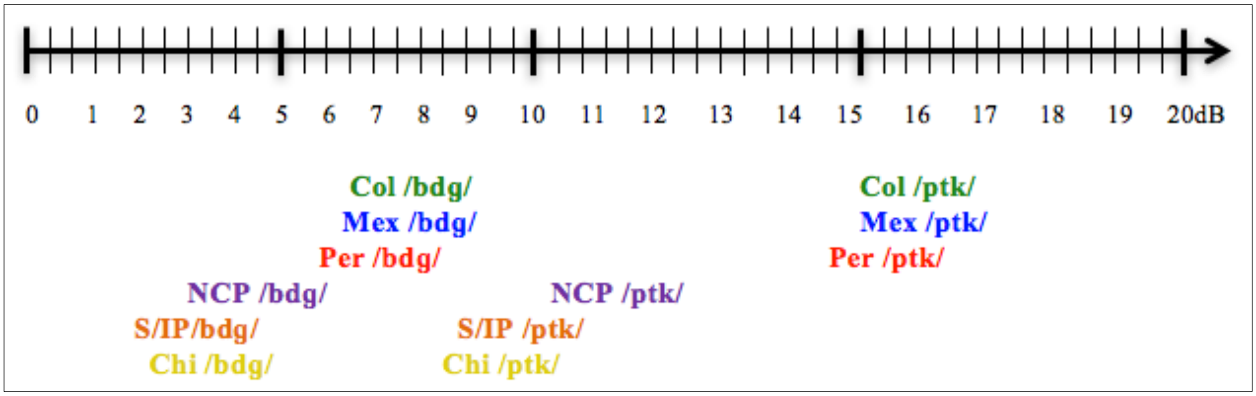

Figure 2.5. Visual representation of average RI values (dB) according to variety.

2.1.5.2 Relative intensity according to lexical stress

As discussed in previous sections, studies on consonant lenition in Spanish have shown that consonants in tonic syllables exhibit less consonant weakening than those in atonic syllables. I illustrate this phenomenon in the following two PRAAT images taken from a Chilean speaker from the current data set. The speaker produces the word *quito* 'I take' where word initial /k/ is in tonic position as well as the word *quitó* 'he took' where word initial /k/ is in atonic position. Figure 2.6 and Figure 2.7 illustrate the contrast between the production of *quito* 'I take' and *quitó* 'he took' by the same speaker, with the yellow intensity curve and with the corresponding peaks and valleys of [k] marked with black circles. The production of /k/ in Figure 2.6 shows a RI measurement of 12.4dB in tonic position, whereas the production of /k/ in Figure 2.7 shows a RI measurement of 3.1dB in atonic position. In addition, we notice a higher amplitude waveform and longer duration of segments and syllables in the tonic context in Figure 2.6, which is to be expected.

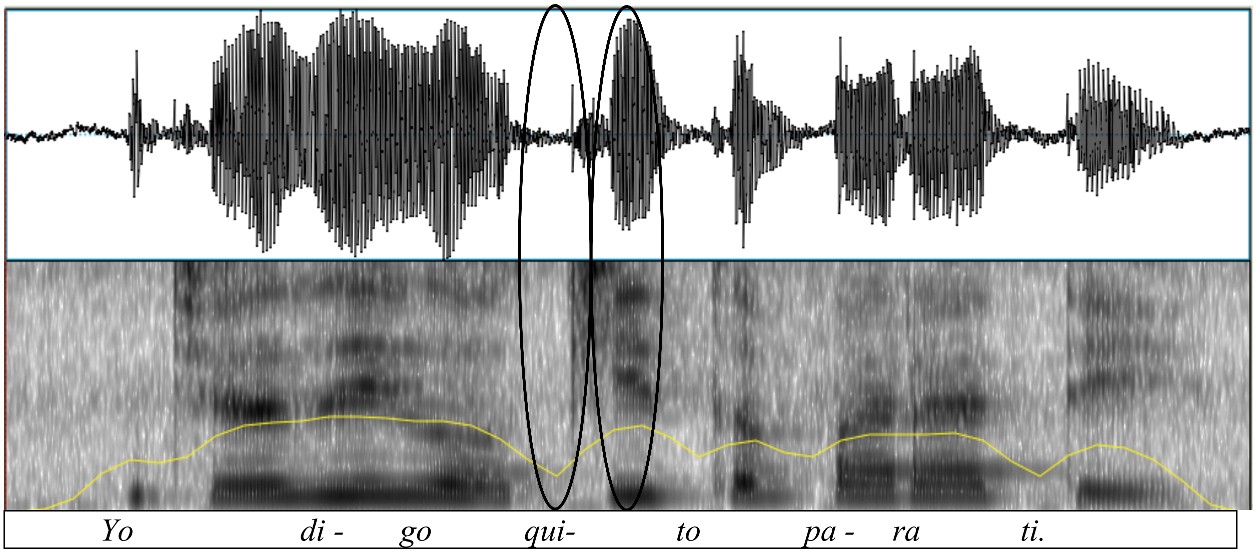

Figure 2.6. Measurement of the RI of the phrase Yo digo *quito* para ti ‘I say *I take* for you’ produced by Chilean speaker (Chi1) from Santiago, Chile.

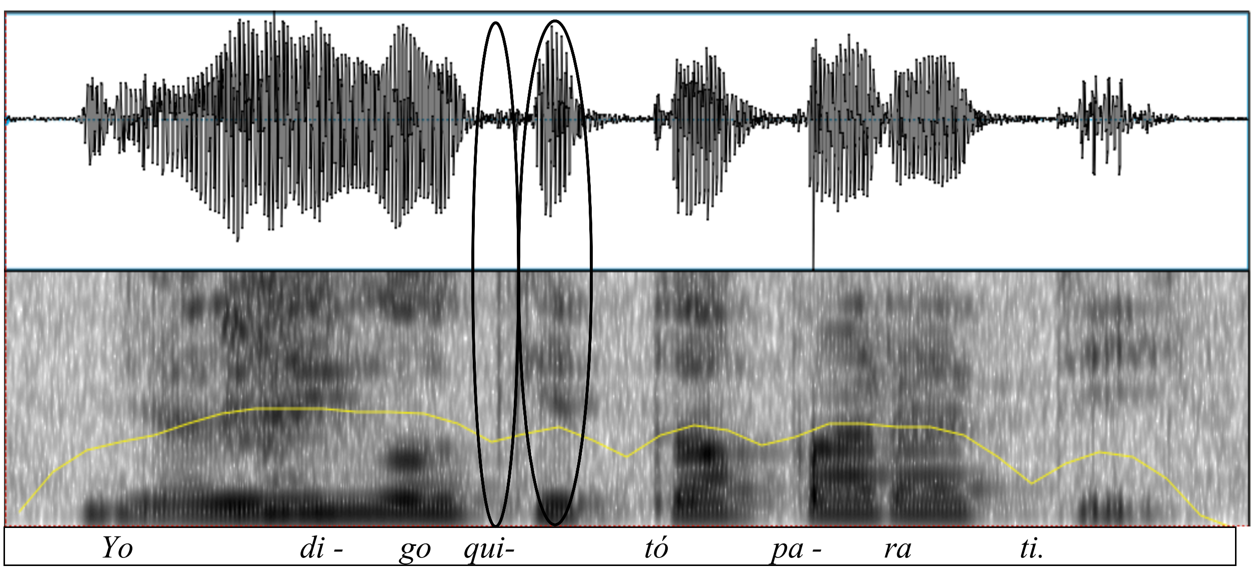

Figure 2.7. Measurement of the RI of the phrase Yo digo *quitó* para ti ‘I say *he took* for you’ produced by Chilean speaker (Chi1) from Santiago, Chile.

The data presented in Table 2.4 presents the RI measurements according to Spanish variety and lexical stress. It is clear from the data in Table 2.4 as well as previous research on stop consonant lenition in Spanish that an intervocalic stop consonant followed by a tonic syllable is more occluded than an intervocalic stop consonant followed by an atonic syllable. Refer back to example (14) as a reference. Segments in (14b) and (14d) would be considered an atonic context, or followed by a tonic syllable, whereas (14a) and (14c) would be labeled as tonic, where the consonant is at the onset of a tonic syllable. While the RI ranges vary for each Spanish variety, it is important to note that the tonic context, no matter the variety, is significantly more occluded than the atonic context. The difference between the tonic and atonic context is listed in the third row of Table 2.4. Here we notice that the average RI in atonic and tonic positions range from 2.9dB in Chilean Spanish to 5.7dB in Peruvian Spanish. This is to be expected given previous research on lexical stress and consonant lenition.

	Mexican	**Peruvian**	**Colombian**	**North-Central Peninsular**	**Southern/Insular Peninsular**	**Chilean**
tonic	14.3	14.1	13.6	9.9	8.9	8.2
atonic	9.1	8.4	10	5.9	4.3	5.3
IntDiff	5.2	5.7	3.6	4	4.6	2.9

Table 2.4. Relative intensity measurements according to Spanish variety and lexical stress.

2.1.5.3 Relative intensity according to following vowel

Previous research yields mixed results regarding the effects of flanking vowels on the degree of lenition of voiced and voiceless obstruents. Table 2.5 shows the average RI measurements of voiceless /ptk/ and voiced /bdg/ according to the following vowel, organized by horizontal position in the buccal cavity. The vowels according to their position are displayed in Figure 2.8.

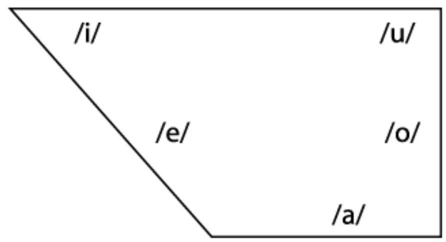

Figure 2.8. Spanish vowels in the buccal cavity (Gasser 2009: http://www.indiana.edu/~hlw/PhonUnits/vowels.html)

The results for the current data set are mixed, not showing a very clear pattern across all six different varieties of Spanish; however, it does appear that voiceless /ptk/ tends to be more occluded when followed by a posterior vowel /o, u/ and less occluded when followed by an anterior vowel /e, i/ in most of the varieties analyzed here. The results of the effect of the following vowel on voiced obstruents /bdg/ are even more varied. Four of the six varieties show less occlusion when followed by an anterior vowel and more occlusion when followed by the central vowel /a/.

	Mexican	Peruvian	Colombian	North-Central Peninsular	Southern/Insular Peninsular	Chilean
/bdg/ + e, i	6.2	6.4	7.5	3.8	3.2	3.6
/bdg/ + a	7.2	8	7	4.7	3.5	5
/bdg/ + o, u	8.6	7.5	7.9	4.6	3.3	3.3
/ptk/ + e, i	14.4	14.5	16.1	10.3	9.4	8.8
/ptk/ + a	16.1	16.2	14.9	11.7	9.5	9.8
/ptk/ + o, u	17.6	16	16.5	11.7	10.4	10.5

Table 2.5. Relative intensity measurements as an effect of following vowel according to horizontal position.

If we analyze the data from the vertical axis, however, we notice different patterns. Table 2.6 shows the average RI measurements of the two obstruent series and the effects of the following vowel on the occlusion/lenition of the consonants in question, organized by vertical position in the buccal cavity. As in Table 2.5, there are no clear patterns present that indicate a concrete effect of vertical vowel position on consonant lenition. However, there do appear to be some tendencies across at least five of the six Spanish varieties studied. When /bdg/ is followed by a high vowel /i, u/, there is less occlusion as compared to /bdg/ followed by a mid-vowel /e, o/ where RI values are higher. This same tendency is true for the voiceless series /ptk/ as well, less occlusion when followed by an anterior vowel and more when followed by a mid-vowel.

	Mexican	**Peruvian**	**Colombian**	**North-Central Peninsular**	**Southern/Insular Peninsular**	**Chilean**
/bdg/ + i, u	7.6	5.7	6.7	3.8	2.9	3.1
/bdg/ + e, o	7.2	8.2	8.6	4.7	3.5	3.9
/bdg/ + a	7.2	8	7	4.7	3.5	5
/ptk/ + i, u	15.9	13	15.3	11.3	9.5	9.4
/ptk/ + e, o	16.2	17.5	17.3	11.8	10.5	10
/ptk/ + a	16.1	16.2	14.9	11.7	9.5	9.8

Table 2.6. Relative intensity measurements as an effect of following vowel according to vertical position.

The results from both Tables 2.5 and 2.6 show that there is much variation with respect to the effect of the following vowel on the degree of occlusion of both voiceless and voiced intervocalic obstruents. However, a tendency emerges across most varieties: high and anterior vowels favor less occluded productions of both voiceless /ptk/ and voiced /bdg/ while posterior and mid vowels tend to favor more occluded productions. This is exhibited in Table 2.7.

	Mexican	Peruvian	Colombian	North-Central Peninsular	Southern/Insular Peninsular	Chilean
anterior	10.3	10.4	11.8	7.1	6.3	6.2
central	11.7	12.1	11	7.9	6.5	7.4
posterior	13.1	11.7	13.4	8.7	6.9	6.9
high	11.7	9.4	11	7.6	6.2	6.2
mid	11.7	12.8	13	8.2	7	6.9
low	11.7	12.1	11	7.9	6.5	7.4

Table 2.7. Relative intensity measurements according to vowel position.

2.1.6 Discussion and conclusions

The results of the pilot study presented in the previous section show much variation in the degree of consonant occlusion according to the geographical location of the Spanish varieties analyzed here. This section discusses the results within the context of the research questions of the pilot study, repeated in (19).

(19) a. How do linguistic factors such as point of articulation, lexical stress, and following vowel affect consonant lenition across different varieties of Spanish?

b. How does the extralinguistic factor of dialect affect consonant lenition across different varieties of Spanish?

c. Is there a correlation of consonant lenition of /ptk/ and /bdg/ between more radical and more conservative Spanish varieties with respect to the acoustic correlate of RI?

Degree of occlusion was measured with respect to point of articulation, lexical stress and the following vowel. Results for point of articulation show variation across the six Spanish varieties investigated for this pilot study. It is not clear by this data which point of articulation favors more lenited stop consonant productions. Dental segments /t/ and /d/ are more lenited than labial or velar segments in the Mexican and Peruvian data; however, this is not the case for other varieties. Therefore, the hypothesis that velar segments would produce higher degrees of weakening when compared with labial and dental segments is not confirmed. Since the pilot study only analyzed RI values of /ptk/ and /bdg/, it is possible that this single acoustic correlate is not sufficient to determine effects of point of articulation on consonant weakening. In fact, Lewis (2001:160) states that "[t]he influence of place of articulation on RI differences was not statistically significant." Therefore, in transforming the pilot study to the larger dissertation study, the additional acoustic correlate of %V will be used to determine place of articulation effects on consonant lenition. What is clear across all dialects is the higher degree of occlusion for voiceless segments /ptk/ when compared to voiced segments /bdg/. A higher degree of occlusion, however, is a relative description when discussing the different Spanish varieties, since a higher degree of occlusion of /bdg/ in Colombian varieties is comparable to the lower degree of occlusion of /ptk/ in Chilean varieties. Although there is no overlap between varieties, this data shows that the distinction made between /ptk/ and /bdg/ is always present, even though particular Spanish varieties might be considered overall higher-leniting dialects or lesser-leniting dialects. Also important to note is the result that within each variety, the production of /bdg/ never reached/overlapped with the production of /ptk/. This indicates that within each variety, even if the variety is considered a high-leniting variety, speakers always distinguish between the two phoneme series. This is interesting considering the push-pull chain and Structuralist model of language change discussed in Chapter One (Alarcos 1961; Martinet 1952; Veiga 1988). Speakers consider these two sets of segments /ptk/ and /bdg/ to be different and despite language evolution and increased lenition in some varieties, the distinction is consistently maintained, and a weaker production of /ptk/ will not threaten the existence of /bdg/. This simply indicates that production of /bdg/ will also be weaker.

In agreement with previous research on consonant lenition, this pilot study finds that stop consonant productions are more lenited when followed by an atonic, or lexically unstressed, syllable as opposed to a tonic, or lexically stressed syllable (Browman & Goldstein 1992; Cho, McQueen & Cox 2006; Gili Fivela et al. 2008; Keating et al. 2003). This is to be expected, confirming the hypothesis stated in section 2.1.3 that higher degrees of weakening would be found in atonic syllables when compared to their tonic. However, it is important to note that we still do find consonant weakening in prosodically strong positions, albeit to a lesser degree. As I previously mentioned, my pilot study limited the analysis to only voiceless and voiced stop consonants in initial position. Although previous work tells us that consonant lenition in Spanish occurs both within words as well as across word boundaries, we would expect to see higher degrees of lenition in word internal position as compared to word initial position, which is the sole position used for the purposes of this pilot study simply to gain a preliminary understanding of the variation that can occur across different varieties of Spanish. In addition, the results of the pilot study show that not all varieties present such a stark difference between the production of consonants in tonic or atonic positions. For example, stop consonants in tonic syllables show only slightly more occlusion than in atonic syllables; however, Mexican and Peruvian varieties show much more occlusion in tonic syllables.

The results of the pilot study indicate that high and anterior vowels favor lenition. That is, consonants followed by /i/ tend to experience more lenition than the mid and posterior vowel /o/, which tends to be more occluded in comparison. This finding is consistent across the majority of the Spanish varieties investigated here, except for the Colombian varieties, where the central, low vowel /a/ exhibited greater weakening. Therefore, the hypothesis that vowel frontness/backness as well as vowel height is confirmed: vowel type does indeed yield differences in weakening for all Spanish varieties analyzed for the pilot study. It is noteworthy that this pilot study only analyzed the results of the following vowel on consonant production, keeping constant the preceding vowel as part of the carrier phrase, *Yo digo* ____ *para ti* 'I say ____ for you'. The preceding vowel in all cases was /o/. Considering the second and third research questions, let us refer to the lenition continuum proposed in Chapter One, repeated here in (20) for reference:

(20) ←————————————————————————→

conservative non-leniting	slight/sporadic weakening	progressive weakening	innovative weakening

The results of this pilot study show that Chilean varieties as well as Peninsular and Insular varieties are more progressive and innovative, exhibiting lower RI measurements, with stop consonant productions realized with more vowel-like qualities, even in word initial position. Mexican, Peruvian and Colombian varieties, on the other hand, tend to show more conservative, occluded productions of stop consonants, with only slight and sporadic weakening. Concerning the varieties analyzed for this pilot study, the data shows a continuum of consonant production, instead of consistent productions of like-sounding consonants. This finding is quite interesting and relevant to the current study as a whole since after analyzing all the data, some conclusions emerge that motivate the large-scale dissertation study. Through the use of this pilot study, preliminary findings indicate that there indeed exists the possibility of a correlation of consonant production of /ptk/ and /bdg/ between more radical and more conservative Spanish varieties with respect to RI. Therefore, my dissertation study incorporates additional linguistic and acoustic variables in order to further investigate these hypotheses. The next section of this chapter will be dedicated to these additional linguistic and acoustic variables as they relate to the methodology of my study and transforming the pilot study into the larger dissertation study.

2.2 From pilot study to dissertation

The preliminary results of the pilot study indicate a need for more investigation and therefore motivate the larger dissertation study by offering insight regarding the gradient nature of stop consonant production across the Spanish-speaking world. Although the pilot study controls for many variables and limits the analysis to consonants in word-initial position, the variation exhibited tells us that there are more factors that may play a role in the degree of consonant weakening. From the pilot study, I gained useful insight into the processes of consonant lenition in different Spanish varieties. The conclusions that surfaced from the pilot study results were indispensable in the design of the larger dissertation study, and therefore motivated the inclusion/exclusion of certain variables and the use of a pre-prepared corpus in my methodological design. For example, the pilot study results show that the linguistic variable of flanking vowels on consonant lenition yielded highly inconsistent results across the different Spanish varieties. This conclusion from the pilot study motivated the exclusion of this linguistic variable from the larger study; it was not useful to include flanking vowels again as one of the independent variables given the inconsistency of the pilot study results. In addition, for the pilot study I separated North-Central Peninsular Spanish and Southern Peninsular and Insular (i.e., Canary Islands) Spanish into two distinct regions; however, the results indicated that the Southern Peninsular was not radically different from the Northern Peninsular varieties. Due to these results, I elected to combine these into one single Peninsular variety for the larger study. As mentioned previously in Section 2.1.4.1 regarding the participants for the pilot study, many reported having spent many years away from their home country living in the United States. This environment of English-Spanish contact could have ultimately affected the overall pilot study results since some of the participants had only spent four months in the United States while others had lived in the United States for almost thirty years. Research has shown that extended periods of time in an immigrant country can have linguistic effects on the L1; therefore, the circumstances of participant bilingualism could have had an effect due to English contact, where lenition is not as strong. This motivated the use of a pre-prepared corpus for the larger study, which allowed me to analyze data from speakers who grew up and still resided in their hometown/home country and had minimal to no contact with English. The following sections will discuss the methodology and variables included in the larger-scale study in order to further explore the linguistic and extralinguistic factors at play in the degree of consonant weakening.

The larger dissertation study expands the number of Spanish varieties investigated to gain a wider geographical range and to create a clear picture of the state of consonant lenition across the Spanish-speaking world as it exists today. Furthermore, the study adds additional linguistic and extralinguistic variables to explore possible correlations between certain factors and a greater or lesser degree of consonant weakening. In addition to regional variety, the study explores the relationship between consonant production and gender and age to determine the effects, if any, they have on stop consonant production. The larger study also includes a comparison of consonant weakening phenomena both in word initial position as well as word internal position; effects of point of articulation and lexical stress will remain part of the investigation; however, as previously discussed in section 2.1.6 the inconsistent results of the flanking vowel analysis of the pilot study motivates the exclusion of this variable from the dissertation study. The pilot study used only the acoustic variable of RI to measure the degree of consonant weakening; however, to gain a more complete picture of consonant production, my dissertation study will include an analysis of %V in addition to RI to draw comparison between both /bdg/ and /ptk/ on the same scale. Previous work on consonant lenition of voiceless consonants includes an analysis of %V, showing that phonetic voicing of /ptk/ "is best described as gradient in nature, with implementations ranging from entirely voiceless occlusives to productions which are characterized by phonetic voicing throughout the entire closure phase of the stop, often including upper level formant structure associated with the realization of an approximant" (Lewis 2001:46). Other previous work also shows that many intervocalic realizations of /ptk/ are at least partially voiced (Hualde, Simonet & Nadeu 2011; Machuca Ayuso 1997; Martínez Celdrán 2009; Torreira & Ernestus 2011). Therefore, the inclusion of %V in addition to RI analysis for the dissertation study is relevant in that both acoustic variables can be used to compare both /bdg/ and /ptk/. Although VOT and closure duration could prove useful in a study of this type, it does not make sense to include them here given the lack of comparability between both /bdg/ and /ptk/. VOT and closure duration cannot be measured for the productions of /bdg/ due to the fact that when in intervocalic position, the productions of these phoneme segments have approximant realizations instead of occlusive realizations. In this case, the buccal organs approach but do not come into complete contact and are therefore deemed *approximants*. Since for /bdg/ we do not find a complete closure of the organs to measure closure duration or a release burst to measure VOT, these two correlates will not be used in the comparison of /bdg/ and /ptk/ here, rather left for future investigation of their effects on voiceless stop consonant weakening.

The data used for this analysis is taken from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) and uses semi-spontaneous speech to better understand weakening phenomena in Spanish. The use of semi-spontaneous data is advantageous compared to the more controlled analysis of tokens set in carrier phrases used in the pilot study. Analysis of stop consonants in unscripted, semi-spontaneous speech used for this corpus shows a clearer picture of the current state and extent of consonant weakening across different varieties of Spanish in actual speech, instead of scripted phrases read in a laboratory. The following sections will detail the methodology of the analysis of the linguistic and extralinguistic factors mentioned in this section.

2.3 Spanish varieties

The corpus data analyzed for my dissertation was collected from fifteen locales from varying regions in the Spanish-speaking world; these fifteen locales have been divided into seven primary varieties: Andean, Argentinian, Canarian, Caribbean, Chilean, Mexican, and Peninsular. Table 2.8 outlines the number of participants from each locale and the regional divisions of the locales.

Variety	Locales	Participants per locale	Total
Andean	Merida, Venezuela Bogota, Colombia Quito, Ecuador Lima, Peru	1 1 1 2	5
Argentinian	Buenos Aires Neuquen	3 1	4
Canarian	Las Palmas de Gran Canaria	2	2
Caribbean	San Juan, Puerto Rico	2	2
Chilean	Santiago de Chile	2	2
Mexican	Guadalajara Mexico DF	1 2	3
Peninsular	Vigo Madrid Jaen Jerez de la Frontera	2 2 2 2	8

Table 2.8. Spanish varieties and locales.

Based on previous literature on consonant lenition phenomena in Spanish discussed in the previous chapter in section 1.4 as well as the results of the pilot study, the varieties analyzed here and included in Table 2.8 have been selected based on the wide geographical range of the locales and because the Spanish of each of these regions is characteristically distinct from the others according to various facets such as phonetics, prosody and intonation, syntax and semantics (Hualde 2005; Lipski 1994). Therefore, it is expected that the Spanish of these different regions shows variation with respect to stop consonant production, with more conservative varieties being the Andean and Mexican varieties and more innovative weakening varieties to be Canarian and Caribbean. Although these regional divisions could prove problematic based on work in the field of dialectology, I elected to maintain them as intended by Prieto & Roseano (2009-2013) for the sake of consistency between my study and the work of the corpus' contributors. I will return to a more detailed explanation of this issue and the limitations that arise as a result in the discussion and conclusions in Chapter 4. By investigating the speech of all of these regions, my study expects to place the Spanish varieties on a lenition continuum from more conservative varieties to more innovative weakening varieties to show the gradient nature of lenition as a whole and the state of change of stop consonants in Spanish.

2.4 Participants

Speakers from different age groups are included in this study to account for consonant weakening that may manifest differently for younger and older speakers. As discussed in Chapter 1, section 1.3.6, older speakers have a tendency to favor more conservative phonetic variants while younger speakers employ innovative or new phonetic variants (Long 2014; Oftedal 1985). The data analyzed from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) hopes to reach this same conclusion, aligning with previous research that younger speakers tend to exhibit higher degrees of consonant weakening than older speakers. Data is analyzed from a total of 26 speakers for this study, ranging in age from 19-53 years old with an average age of 31.6 years and a median age of 27.5 years. Many of the younger participants are students; those participants that completed the Map Task—to be discussed in the next section—completed university or higher level education. In order to best account for consonant weakening phenomena according to age, I divided the participants into two age groups: 1) speakers younger than 30-years-old and 2) speakers older than 35-years-old. Of the 26 total participants, 14 belong to the younger age group with a mean age of 22.9 years and a standard deviation (σ) of 2.55. In the older age group, there are 12 participants with a mean age of 41.75 years and a standard deviation (σ) of 5.48. In order to divide the age groups, I noticed a clear break in participant ages as well as their life status. Members of the younger age group are mostly university students whereas members of the older age group have established careers; therefore, it seemed logical to divide the speakers in this manner while keeping in mind the mean and median participant ages and including a similar number of participants in each of the two groups.

In addition to age as an extralinguistic factor that could possibly affect the degree of consonant lenition, this study also codes for speaker gender, given that previous research has shown that gender may affect speaker selection of some allophones over others, as mentioned in Chapter 1, section 1.3.6 (Cepeda 1991; Clopper & Smiljanic 2011). Therefore, the corpus analysis includes data from 6 men and 20 women, all of whom are native to the locale in which they were recorded (Prieto & Roseano 2009-2013).

2.5 Task

The task analyzed for this study is a map task dialogue taken from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013). While the coordinators of the Atlas did record other tasks for the purpose of the atlas, my dissertation will only analyze the map task dialogues since this tasks is designed to elicit semi-spontaneous data in a naturalistic setting. As mentioned in Chapter 1, section 1.3.6, previous research has shown that semi-spontaneous and unscripted speech yields higher degrees of consonant weakening as compared to scripted and read speech, where there is more resistance to consonant lenition (Hualde, Simonet & Nadeu 2011; Lewis 2001). Therefore, analyzing data from the map task dialogues showcases weakening tendencies in naturalistic, semi-spontaneous speech as opposed to the scripted, read speech analyzed for the pilot study.

The *Map Task* is a dialogue that includes two participants who communicate with each other to accomplish a specific task; for the *Atlas*, the participants—in groups of two—communicated to give instructions on a map. Prieto & Roseano (2009-2013) explain the task on the website (http://prosodia.upf.edu/atlasentonacion/):

> Each of the two subjects has a map of an imaginary town marked with buildings and other specific elements such as fountains and monuments. A route is marked on the map of one of the two participants, and that person has the role of the instruction-giver. The version of the same map held by the other participant differs from that of the *instruction-giver* in that it does not show the route to be followed. The second participant therefore has to ask the *instruction-giver* questions in order to be able to reproduce the same route on his or her own map.

In (21), I present a short selection taken from the Map Task exercise from two female speakers from Merida, Venezuela, both age 29.

(21) **Follower**: "OK. Tengo acá la salida justo donde se encuentra la gasolinería. La gasolinería se encuentra frente a Modas Nuria."
Giver: "Pero la salida la tengo yo…eh… frente de la estatua del rey Jaime."
Follower: "No, yo la tengo justo en la gasolinería. ¿OK? Si sigo el trayecto de la gasolinería, voy a encontrar al lado derecho el Jardín Mayor y el Jardín Menor."
Giver: "Al lado de la salida tengo yo la droguería y el Jardín Menor."
Follower: "El Jardín Mayor ¿en qué lugar lo tienes?"
Giver: "Abajo."[12]

[12] **Follower**: "OK. I have here the exit right where we find the gas station. The gas station is located in front of Modas Nuria."
Giver: "But the exit, I have it…umm…in front of the statue of King Jaime."
Follower: "No, I have it right in the gas station. OK? If I follow the route from the gas station, I am going to find on the right side the Jardín Mayor and the Jardín Menor."
Giver: "Next to the exit I have the drug store and the Jardón Menor."
Follower: "The Jardín Mayor ¿in which place do you have it?
Giver: "Below." (my translation)

Previous work on consonant lenition in Spanish along with the results of the pilot study do show consonant weakening in scripted, laboratory speech. Therefore, by analyzing data that is semi-spontaneous in nature, my study hopes to show increased weakening and greater variation in stop consonant productions, aligning with previous research on consonant weakening phenomena carried out by Hualde, Simonet & Nadeu (2011) and Lewis (2001) among others. It is expected that more informal, natural speech will be produced during conversational style, semi-spontaneous, unscripted Map Task dialogues since speakers are less likely to pay attention to the task at hand or the fact that they are being recorded and engage more fully in the conversation, limiting the effects of the Observer's Paradox (Labov 1972).

2.6 Linguistic variables

Data collected from the Map Task dialogues include content words containing /ptk/ and/or /bdg/ in intervocalic position. The stop consonants in these content words are then coded according to consonant (/ptkbdg/), point of articulation (labial, dental, velar), sonority (voiced vs. voiceless), lexical stress (tonic vs. atonic syllable), and prosodic position (word initial vs. word internal). These variables are included in the analysis given the results of the pilot study and previous work on consonant lenition outlined in the previous chapter.

2.7 Acoustic variables

The acoustic variables used to measure and analyze consonant lenition in the current study are RI and %V. While the pilot study only investigates consonant lenition as it pertains to RI, the current study expands this analysis to include %V as well as additional extralinguistic factors to be discussed in the next section. %V will be measured by dividing the duration of voicing present (in ms) by the closure duration (in ms) of the stop consonant. Let us consider the following example of %V analysis in Figure 2.9. The spectrogram in Figure 2.9 shows the production of voiceless stop consonant /p/ by a female speaker, age 29, from Gran Canaria of the Canary Islands. The closure duration of [p] is marked with two red lines totaling 77.5ms and decreased overall acoustic energy in the formant structure as compared to the flanking vowels on either side of [p]. The blue circle shows voicing found during the production of /p/ totaling 54.5ms. Therefore the %V of [p] in Figure 2.9 is 70.3% (voicing duration 54.5ms / closure duration 77.5ms = 0.703). Previous research on %V in Spanish has shown that there is ample variation in the degree of voicing for voiceless stop consonants, and therefore scholars have elected to divide these voiced realizations of underlyingly voiced stop consonants into two categories: non-voiced or partially/fully voiced. The threshold used by O'Neill (2010) and Torriera & Ernestus (2011) is 50%. For the purpose of their respective studies, if a stop consonant reaches 50%V, they consider that production partially/fully voiced. If, however, the production of the stop does not reach 50%V, it is considered non-voiced. Other scholars, such as Hualde, Simonet & Nadeu (2011) elect to use a 60% threshold, making the conclusions yielding partially/fully voiced realizations of voiceless stop consonants even stronger. For my dissertation, I will also use a 60% threshold to identify partially/fully voiced stops in the current data set. Therefore, the production of /p/ in Figure 2.9 with a %V of 70.3% for the purposes of my study will be considered partially/fully voiced.

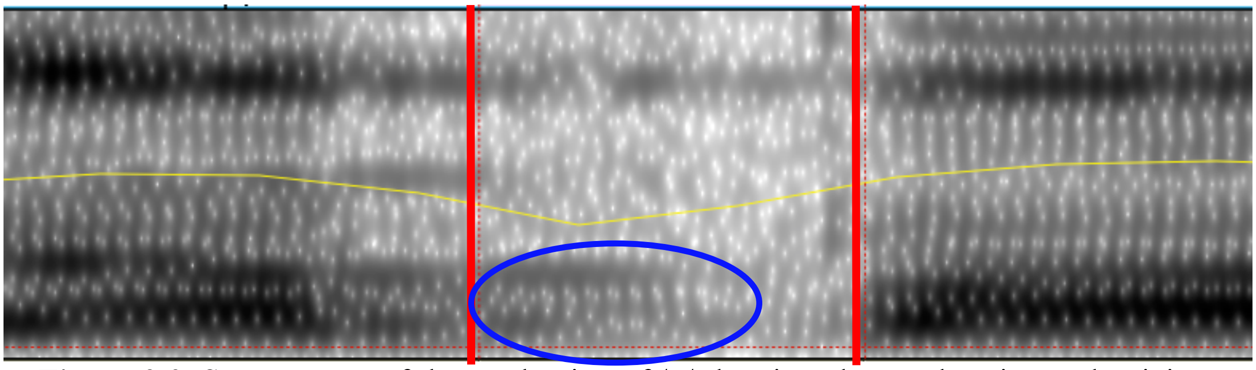

Figure 2.9. Spectrogram of the production of /p/ showing closure duration and voicing.

As previously mentioned, when comparing both voiceless and voiced phonemes /ptk/ and /bdg/, there are few acoustic correlates that can accommodate such a comparison, given the voiceless and voiced nature of the series. However, the additional acoustic correlate of %V adds another layer for comparison between voiceless productions of voiceless /ptk/ to those of voiced /bdg/.

2.8 Extralinguistic variables

The sociolinguistic variables investigated for this study include age, gender, and dialect. Previous work in sociolinguistics has shown that speakers belonging to different age groups tend to select certain phonetic variants; therefore, it is of interest to the current study to investigate participant age as a possible factor in the preference for the production of weaker consonants as opposed to more occluded ones. As discussed in Chapter 1, section 1.3.6, younger speakers have been shown to exhibit higher rates of innovative phonetic variants, such as palatalization of the velar phoneme /x/ as well as full voicing or partial voicing of /ptk/ (Flores 2016; Long 2014; Oftedal 1985). Previous work has shown mixed results on the effects of gender on specific phonetic patterns (Cepeda 1991; Clopper & Smiljanic 2011); therefore, the current study includes gender to see if there are effects on the degree of consonant weakening. Although previous work on consonant lenition has not focused on gender as a contributing factor to consonant weakening to my knowledge, my study includes gender as an extralinguistic variable to see if indeed it may play a role in the selection of weaker, more lenited consonants or stronger, more occluded consonants. The primary speech style investigated here will be semi-spontaneous; however, the results are compared with those of the strictly scripted laboratory speech of the pilot study. The final sociolinguistic factor to be analyzed for this study is dialect, or regional variety. By including a wide range of speech samples from all over the Spanish-speaking world and organizing them from lesser weakening, or more conservative varieties to higher weakening, or more innovative varieties, we can observe language variation and change at its current state. An analysis of this type with current semi-spontaneous data shows a snapshot of the variability of consonant weakening across the Spanish-speaking world today. We can use this data together with previous research on consonant weakening to show that it is a current and active phenomenon that occurs at different rates in different parts of the world by identifying more conservative and innovative varieties. Although this large-scale study gives an overview of stop consonant variability in Spanish today, the results would likely not have been the same 50 years ago nor will they be the same 50 years from now. This is indicative of a living language, its diverse group of speakers and their interactions through time that contribute to the evolution of language.

2.9 Statistical procedures

In order to determine the statistical significance of the results of my study, I employed R (R Core Team 2012) and lmerTest (Kuznetsova, Brockhoff & Christensen 2017) to perform a linear mixed effects analysis of the relationship between the two acoustic correlates used for the study, RI and %V, and the independent variables investigated: phoneme, sonority, point of articulation, lexical stress, prosodic position, as well as the gender, region and age of participant using a series of chi-square tests. With this design, we can identify statistically significant results in the data set, that is, results that do not occur purely by chance. For this study, my objective is to make generalizations about stop consonant production in seven regions, but since it is not possible to collect data from every Spanish speaker in all of these regions, I have analyzed a speech sample from each region. Simply calculating the mean averages of RI and %V, however, may lead to bias given the distribution of the participant pool and the individual tokens. Therefore, the differences that emerge from mean averages could be due only to chance, and this is where statistical tests can help determine if the results we see are actually meaningful in context.

To determine whether the observed differences are statistically significant, we consider the *p*-value, which is the primary output of statistical tests. The *p*-value indicates the probability of observing the difference if no difference exists. The null hypothesis used for this analysis is that there is no difference between groups, and the alternative hypothesis is that a difference does exist. To determine significance, the alpha value is set to $p < .05$, meaning that any p value less than .05 is deemed statistically significant. If $p > .05$, we say that the evidence against the null hypothesis is not strong enough, and we cannot reject the null hypothesis, i.e. there is no difference between the groups. If $p < .05$, however, we say that the evidence against the null hypothesis is strong enough, rejecting the null hypothesis and accepting the alternative hypothesis, i.e., the difference is truly present between groups. By using a Linear Mixed Effects Model, the design allows for multiple measures per participant, where multiple RI and %V values were calculated in different linguistic and extralinguistic contexts for each participant.

This would violate the independence assumption of ordinary linear regression where only fixed effects are considered. The way to account for this situation is to add a random effect for participant, which characterizes the idiosyncratic variation that is due to individual differences. Accompanying all *p*-values is a Chi-squared statistic, which tests the general significance of the data, as well as degrees of freedom (df), which represents "the number of independent units of information in a sample relevant to the estimation of a parameter or the calculation of a statistic" (Everett 2002:111).

In addition to the statistical significance of the data using the *p*-value, Chi-squared statistic and df, I have also included confidence interval data. A confidence interval is an interval estimate that allows us to make assumptions about the possible outcome of RI of an entire population while only using a sample data set. While the Chi-squared statistic reports on the statistical significance of the data set, the confidence interval indicates the magnitude of this difference and is useful for interpreting the model result. For example, if we consider the mean RI values in each region for stop consonants in tonic vs. atonic syllables, we will have two values. Consider the mean RI values for Chile in Table 2.9 for tonic and atonic syllables and the intensity difference (IntDiff) between consonants in tonic and atonic syllables in Chile. In this example, the RI difference in tonic syllables is larger than that of atonic syllables by 1.8dB. However, this is the conclusion based on the sample analyzed from the current data set, and if we were to analyze a difference sample set, the value may be different. Therefore, the goal of statistical analysis is to extrapolate the data and make inferences about the entire population using only the limited sample that we have available, and this is the contribution of the confidence interval. The confidence interval for the example in Table 2.9 tells us that we are 95% certain that the average

RI value in tonic syllables will be larger than in atonic syllables, and that the intensity difference between them will be between 0.93-2.84dB. This means that if we sample the population 100 times by inviting more participants and adding new Chilean data, etc., and each time we get an intensity difference between tonic and atonic syllables, 95 times out of 100, this intensity difference will be between 0.93-2.84. Thus, we are almost sure that tonic syllables have a higher RI value than atonic syllables in Chilean Spanish, and the result is significant.

	Relative intensity
tonic	5.4dB
atonic	3.6dB
IntDiff	1.8dB

Table 2.9. Mean RI values in tonic and atonic syllables and the intensity difference between them in Chilean Spanish.

The statistical data for this study will be presented in the following chapter using a variety of significance tables, confidence intervals, visuals and graphics to highlight the outcomes and significance of the data analysis.

2.10 Summary

This chapter has outlined the methodology of the current study as well as the results of a pilot study used to motivate the large-scale dissertation study. Linguistic variables explored for the pilot study include point of articulation, sonority, lexical stress, and following vowel. Results using the acoustic correlate of RI show that varieties in the Andean region of South America as well as Mexico exhibit lesser degrees of intervocalic consonant weakening than those found in Spain, the Canary Islands and Chile. However, none of the varieties show the same degree of weakening as another variety, and each variety maintains a definite distinction between the production of the voiceless phonemes /ptk/ and that of the voiced phonemes /bdg/. The preliminary results produced by the pilot study show that indeed there is a large degree of variability with respect to stop consonant production in intervocalic position across the Spanish-speaking world. The restricted nature of the pilot study, focusing on four primary regions and analyzing data using only RI measurements, was key in allowing me to gain a better understanding of the current state of consonant variability and in what ways I could expand the study to form a more complete picture regarding stop consonant production and variability across many varieties of Spanish. Therefore, the current study analyzes corpus data from the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) using the Map Task to investigate the degree of weakening across different varieties of Spanish in the following regions: Andean, Argentinian, Canarian, Caribbean, Chilean, Mexican and Peninsular. My study controls for the linguistic variables of phoneme, point of articulation, sonority, lexical stress, and prosodic position. The acoustic variables use to compare /ptk/ and /bdg/ include RI and %V. Extralinguistic factors investigated include dialect, gender, and age. The results of this more complete analysis will show the differing degrees of consonant variation across the Spanish-speaking world and to place each of these varieties on a lenition continuum from more conservative, non-leniting dialects to more innovative, high-leniting dialects, contributing to our knowledge about consonant weakening and language variation and change in Spanish. The following chapter will detail the results of the data analysis.

3. RESULTS

3. Results

This chapter presents a summary of the results of data analyses as well as interpretations of statistical tests run on the data set. This chapter is divided into two main sections according to the two dependent variables used to analyze the data: relative intensity (RI) and percent voicing (%V). Within each of these two sections I present the results according to the eight independent variables listed in Table 3.1, each of which includes an explanation for quick reference.

Independent variables	**Explanation**	
1. Sonority	/ptk/ voiceless /bdg/ voiced	
2. Phoneme	/p/ voiceless bilabial /t/ voiceless dental /k/ voiceless velar	/b/ voiced bilabial /d/ voiced dental /g/ voiced velar
3. Point of articulation	/p b/ bilabial /t d/ dental /k g/ velar	
4. Lexical stress	***p**aso* tonic syllable ***p**asó* atonic syllable	
5. Prosodic position	***p**aso* word-initial position *so**p**a* word-internal position	
6. Gender	male female	
7. Age	younger, <30 years old older, 35+ years old	
8. Region	Mexico Andean Region Chile Canary Islands	Spain Argentina Caribbean

Table 3.1. Independent variables analyzed.

Considering these eight independent variables, I include the token counts for each of the variables in Table 3.2. Token counts for each of the 26 individual speakers analyzed for this dissertation are included in Appendix II.

	Phoneme		Point of articulation		Sonority		Lexical stress		Prosodic Position		Gender		Age		Region
Mexico	/p/	12	bilabial	93	voiceless	100	tonic	126	word-initial	121	male	32	<30	103	264
	/t/	42	dental	84	voiced	164	atonic	138	word-internal	143	female	232	35+	161	
	/k/	46	velar	87											
	/b/	81													
	/d/	42													
	/g/	41													
Andean Region	/p/	34	bilabial	148	voiceless	258	tonic	235	word-initial	232	male	0	<30	437	589
	/t/	120	dental	247	voiced	331	atonic	354	word-internal	357	female	589	35+	152	
	/k/	104	velar	194											
	/b/	116													
	/d/	126													
	/g/	89													
Chile	/p/	23	bilabial	84	voiceless	137	tonic	144	word-initial	143	male	0	<30	0	296
	/t/	37	dental	63	voiced	159	atonic	152	word-internal	153	female	296	35+	296	
	/k/	77	velar	149											
	/b/	61													
	/d/	63													
	/g/	35													
Canary Islands	/p/	15	bilabial	48	voiceless	89	tonic	90	word-initial	76	male	92	<30	0	160
	/t/	44	dental	59	voiced	71	atonic	70	word-internal	84	female	68	35+	160	
	/k/	30	velar	53											
	/b/	33													
	/d/	15													
	/g/	23													
Spain	/p/	35	bilabial	164	voiceless	169	tonic	243	word-initial	264	male	134	<30	251	565
	/t/	63	dental	253	voiced	396	atonic	322	word-internal	301	female	431	35+	314	
	/k/	71	velar	148											
	/b/	129													
	/d/	190													
	/g/	77													
Argentina	/p/	22	bilabial	94	voiceless	124	tonic	147	word-initial	189	male	192	<30	288	378
	/t/	39	dental	165	voiced	254	atonic	231	word-internal	189	female	186	35+	90	
	/k/	63	velar	119											
	/b/	71													
	/d/	126													
	/g/	56													
Caribbean	/p/	44	bilabial	177	voiceless	191	tonic	178	word-initial	155	male	0	<30	464	464
	/t/	73	dental	188	voiced	273	atonic	286	word-internal	309	female	464	35+	0	
	/k/	74	velar	99											
	/b/	133													
	/d/	115													
	/g/	25													

Table 3.2. Token counts for all independent variables according to region.

For the dependent variable of RI, I use tables to present its mean values according to each of the independent variables. These tables are followed by explanations of the statistical outcomes of linear mixed effects analyses in R (R Core Team 2012) and lmerTest Package (Kuznetsova, Borckhoff & Christensen 2017) in terms of statistical significance of the independent variables as well as box plots that show the distribution of the data for each region based on the independent variables. The presentation of the data for %V of /ptk/ is slightly different from that of RI in that the %V values are binary and are classified as either voiced (partially/fully) or voiceless. It is important to note that the independent variable sonority will not be relevant in the discussion of %V because I am only interested in %V for voiceless stops /ptk/. Given the voiced nature of stops /bdg/, they inherently have 100%V and thus will not be included in the section on %V. I include tables presenting the percentage of /ptk/ tokens that are realized with more than 60%V according to region and each of the independent variables. Following the tables, I present the statistical significance of these results followed by bar graphs which show the proportion of voiced to voiceless realizations for each region based on all of the independent variables listed in Table 3.1. Following presentation of all of the results for RI and %V, I offer a summary before moving on to the discussion of the results in the next chapter.

3.1 Relative intensity

<u>3.1.1 Relative intensity according to sonority and region</u>[13]

[13] While there is a subsection later in the chapter (Section 3.2.1) that discusses %V and region specifically, the independent variable of region is inherently a part of the discussion on RI and sonority. Given the fact that the current study aims to investigate /ptk/ and /bdg/ separately for comparison, it would not make sense to conflate these two consonant series for the purposes of looking at RI and region. With %V, however, this is not an issue since voiced segments are not a part of the discussion given the fact that they are, by nature, produced with 100%V. Therefore, the %V and region section only investigates the consonants /ptk/, whereas the current section will look at RI according to sonority and region.

RI measurements were made for 2826 total tokens of intervocalic /ptk/ and /bdg/ in seven Spanish varieties: Mexico, the Andes, Chile, the Canary Islands, Spain, Argentina and the Caribbean. Table 3.3 summarizes the mean RI measurements according to sonority for all varieties, where /ptk/ represent the voiceless consonant series and /bdg/ represent the voiced consonant series. The consonants are divided in this manner to give a quick overview of the RI measurements in all varieties and the decibel (dB) distinction between the two stop consonant series, which can be seen in the third row of Table 3.3, IntDiff (= Intensity Difference). Following the presentation of the raw data, I will delve into the outcomes of all independent variables investigated for this study, offering detailed information about the statistical significance of this data set. All conclusions yielded by the results of this study are based on the current data set only and extrapolation to the general population of the seven Spanish varieties would require an expansion to this study. Upon looking at the information in Table 3.3, we can see that the distinction between the voiceless stop consonants /ptk/ and the voiced stop consonants /bdg/ is maintained in all varieties, despite the great variability that exists between each of the varieties themselves. Just as for the pilot study results in Chapter 2, Table 3.3. is color coded, with red cells indicating a more occluded production and green cells indicating a more open, vowel-like production. This scheme will be used throughout the chapter for fast reference of more/less occluded segments. It is noteworthy that some varieties, namely the Mexican and Andean varieties, show a greater distinction between the two series, 8.5dB and 8.1dB respectively, whereas the remaining varieties show a distinction of less than 5dB. The Caribbean variety shows very little distinction between /ptk/ and /bdg/, with the voiceless /ptk/ still exhibiting slightly higher RI values. The following section regarding the statistical significance of the data will show that the dB distinction for *all* of the varieties presented here is indeed statistically significant.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
/ptk/	12.1	9.7	6.9	6.4	5.9	5.4	2.8
/bdg/	3.6	1.6	2.4	2.0	1.5	1.5	1.5
IntDiff	8.5	8.1	4.5	4.4	4.4	3.9	1.3

Table 3.3. Decibel distinction between /ptk/ and /bdg/.

The two PRAAT spectrograms in Figures 3.1 and 3.2, displaying yellow intensity curves, clearly illustrate the contrast presented in Table 3.3 by showing the RI differences between two speakers' productions of word-internal [t̪] in an atonic syllable with the same flanking vowels, /i/ and /o/. The first of these, Figure 3.1, shows the RI of the word *caballito* 'little horse' as produced by a female Mexican speaker from the older age group, and the second, Figure 3.2, shows the RI of the word *derechito* 'little right' as produced by a female Caribbean speaker from the younger age group. The valleys and peaks surrounding the production of the segment /t/ are marked with black circles in both figures. In Figure 3.1, the RI of [t̪] is 13dB (equal to the difference between the valley and the peak: 68.8 – 55.8 = 13dB), a value indicative of a more consonant-like production and higher degree of occlusion. In Figure 3.2, however, the RI of [t̪] produced by the Caribbean speaker has a value of only 4.7dB (equal to the difference between the valley and the peak: 82.6 – 77.9 = 4.7dB), indicative of a more vowel-like and less occluded consonant production. These articulatory claims are further evidenced by the lack of activity in the waveform of Figure 3.1, showing complete closure of buccal organs and stoppage of airflow, whereas in Figure 3.2, the waveform is uninterrupted and formant structure appears, showing vibration of the vocal cords for the production of an underlyingly voiceless /t/. Figures 3.1 and 3.2 clearly represent the information presented in Table 3.3, where Mexican Spanish stop consonants /ptk/ are much more highly occluded than the same segments in the Caribbean Spanish variety.

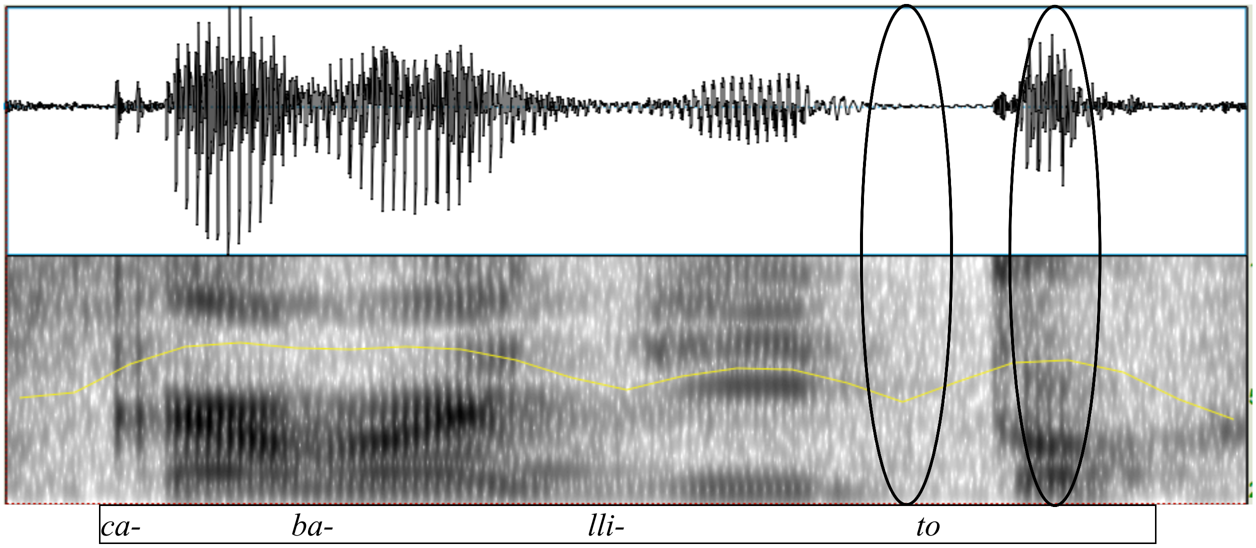

Figure 3.1. Measurement of the RI of the consonant [t̪] in the word *caballito* 'little horse' produced by a female Mexican speaker from the 35+ age group.

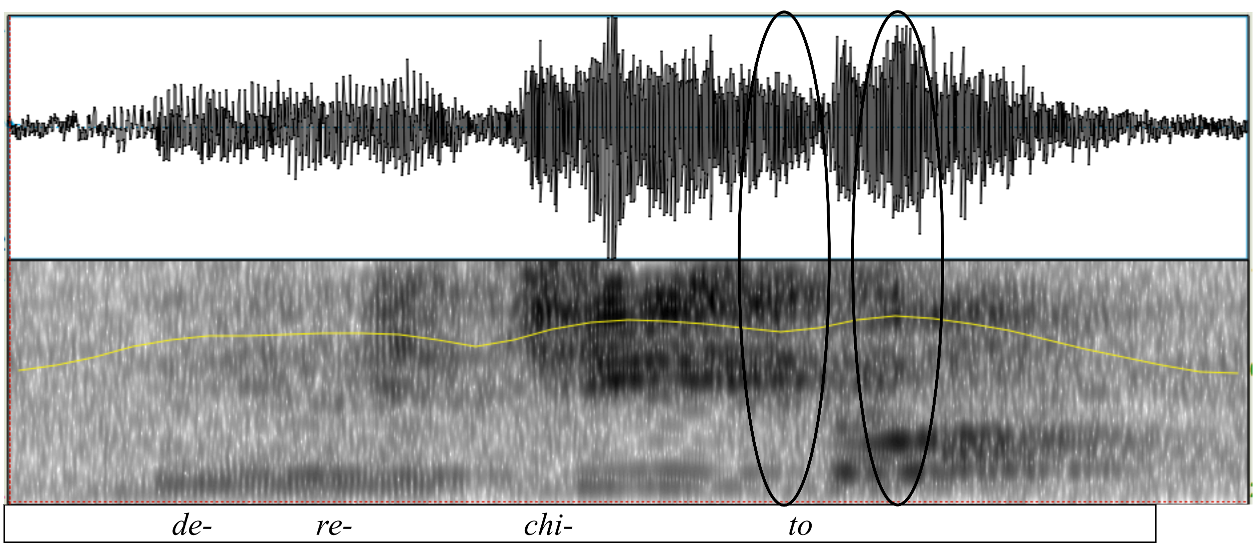

Figure 3.2. Measurement of the RI of the consonant [t̪] in the word *derechito* 'little right' produced by a female Caribbean speaker from the <30 age group.

The graphic in Figure 3.3 illustrates the information from Table 3.3 in a more visual way, similar to what we have previously seen for the pilot study data in Chapter 2. The graphic shows a RI scale ranging from 0-20dB, where 0dB represents more vowel-like, less occluded consonant productions and 20dB is indicative of a more stop-like, highly occluded production. The seven Spanish varieties included here are labeled and color coordinated: Mexican (MEX = blue), Andean (AND = red), Chilean (CHI = yellow), Canarian (CAN = orange), Peninsular (ESP = teal), Argentinian (ARG = pink), and Caribbean (CAR = green). We can see from the graphic that within each variety, there is a definite distinction between the production of the voiced and voiceless segments, that is, /bdg/ consistently show lower RI values and are thus on the left side of the RI scale, closer to 0dB, and /ptk/ show higher RI values and align more to the right. This graphic provides a clear picture of the overlap between Mexican Spanish /bdg/ (3.6dB) and Caribbean Spanish /ptk/ (2.8dB). It is also important to note that in the Caribbean variety, although the speakers do maintain the distinction between /bdg/ and /ptk/, the voiceless series phonemes are not much more occluded than their voiced counterparts, with an intensity difference between the two series of only 1.3dB. Overall, as we saw in the results of the pilot study, speakers of all varieties investigated in the present study are not conflating phoneme groups and make an effort to maintain a phonemic distinction between voiced /bdg/ and voiceless /ptk/.

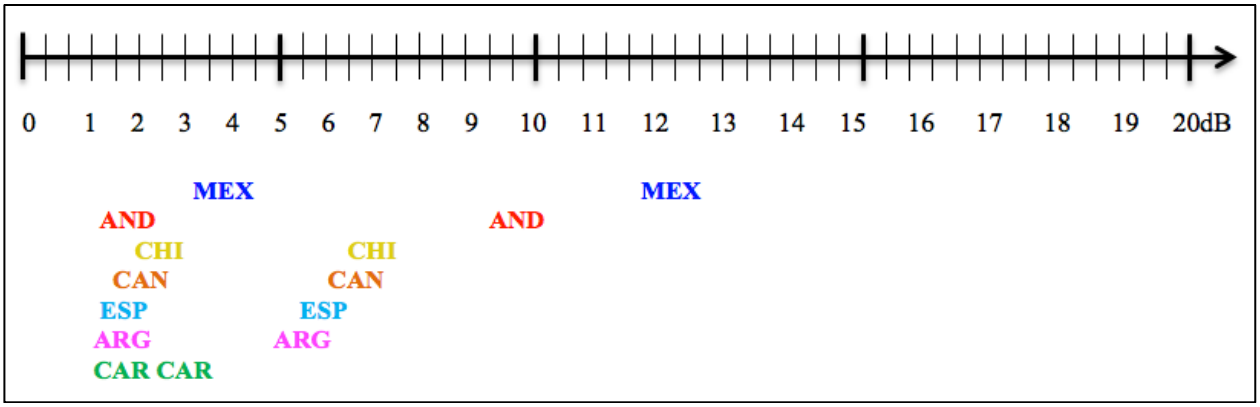

Figure 3.3. Visual representation of average RI values (dB) according to variety. Labels to the left represent /bdg/ and those to the right represent /ptk/.

While the visual representation in Figure 3.3 is helpful to conceptualize the differences between voiceless and voiced stop consonants in the different varieties of Spanish analyzed, it is noteworthy to mention that the differences between voiceless and voiced consonants in each variety are statistically significant. In order to determine the statistical significance of the results, meaning that the results are not occurring purely by chance, recall that a Linear Mixed Effects Model using *R* (R Core Team 2012) and lmerTest Package (Kuznetsova, Brockhoff & Christensen 2017) was performed on the data set. To determine the statistical significance of the data, we must consider the *p*-value, which is the primary output of these statistical tests. The *p*-value demonstrates the probability of observing the difference if no difference exists at a threshold of $p < .05$; in other words, any *p*-value less than .05 is deemed statistically significant. The statistical analysis of sonority shows that the difference between voiceless consonants /ptk/ and voiced consonants /bdg/ in each region is significant, as shown in Table 3.4, where statistical significance is marked with (*) following the Chi-square values. The Chi-squared statistic is used to determine the general significance of the data. The degree of freedom (df) represents “the number of independent units of information in a sample relevant to the estimation of a parameter or the calculation of a statistic" (Everett 2002:111). The df for the sonority difference between /ptk/ and /bdg/ in the current data set is 1. To determine significance, we use a threshold, or critical value, which is determined by the df and the desired significance level. If the Chi-squared value exceeds the threshold, it is statistically significant. However, if the variables, i.e. the df and the desired significance level, are held constant, then larger Chi-square values tend to be more significant than smaller ones. For example, in Table 3.4, the higher Chi-square value for the Andes is considered more significant than the lower values exhibited by the Canaries and the Caribbean. This data is further exemplified by the box plots in Figure 3.4. The box plots show the distribution of the data for voiceless and voiced stop consonants in each region (MEX = Mexico, AND = Andes, CHI = Chile, CAN = Canaries, ESP = Peninsular Spanish, ARG = Argentina, CAR = Caribbean) based on the minimum and maximum values, the first quartile represented by the left-hand side of the box, the median represented by the line in the middle of the box, and the third quartile represented by the right-hand side of the box. The individual dots represent various outliers in the data set. The box plots in Figure 3.4 clearly show that for all of the Spanish varieties studied, voiceless stop consonants /ptk/, represented by N and green box plots, have larger RI values than the voiced stop consonants /bdg/, represented by V and purple box plots, even though the magnitude of the difference varies from region to region, which I previously noted in the explanation of the raw data in Table 3.3. In addition, we can see from the green boxes that the RI range for voiceless stops within each region appears to be larger than the range of the voiced stops in the purple boxes, which are smaller in size. The range of values for voiceless and voiceless stops show overlap in Argentinian, Caribbean, and Chilean Spanish, whereas /ptk/ and /bdg/ do not show any overlap between the boxes in Andean, Peninsular or

Canarian or Mexican Spanish. In the latter varieties, stops /ptk/ and /bdg/ are realized as completely separate classes of segments.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Chi-squared	222.12*	909.75*	110.68*	60.05*	285.63*	125.63*	50.11*

Table 3.4. Statistical significance of the sonority difference between /ptk/ and /bdg/ according to region.

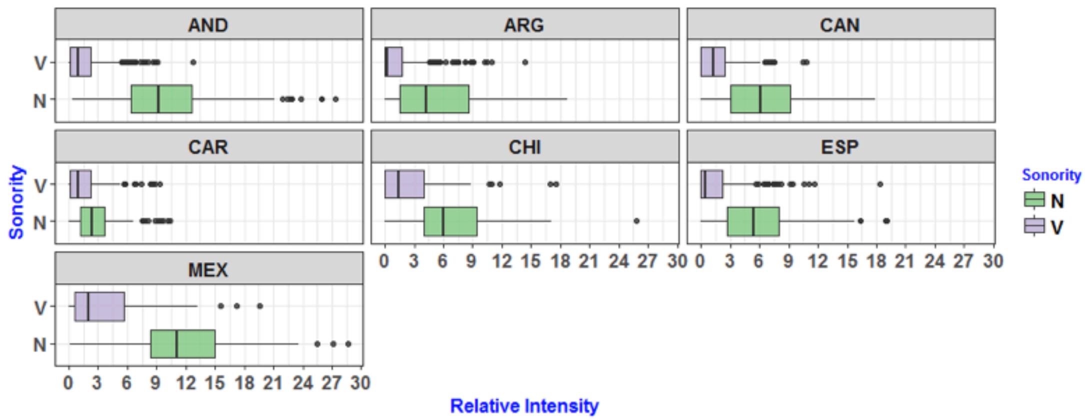

Figure 3.4. Box plots showing the RI differences between voiced (V) and voiceless (N) stop consonants in each region.

Further analysis of the independent variable of sonority yields a confidence interval of 95%. The confidence interval tells us how certain we can be that voiceless consonants will have a higher RI value than voiced consonants in any data sample, and by how much. The difference between mean RI values of voiceless and voiced stops when we analyze any new data set will fall within the dB ranges listed in Table 3.5 ninety-five percent of the time for each of the seven Spanish regions investigated. As an example, let us consider the confidence interval for sonority differences in Mexican Spanish. We are almost certain that the average RI value of voiceless consonants /ptk/ is larger than that of voiced consonants /bdg/, and that the intensity difference between them will be between 7.3 and 9.5dB in at least 95% of cases. This is true for the current data set if we go back to the mean RI averages presented previously in Table 3.3, which tells us that in Mexican Spanish the mean RI value for /ptk/ is 12.1dB and for /bdg/ is 3.6dB, with a difference of 8.5dB. The RI difference between /ptk/ and /bdg/ in Mexican Spanish is 8.5dB, which, as predicted, falls between the confidence interval range of 7.3-9.5dB. Therefore, if we were to add more participants and analyze more data for Mexican Spanish, the confidence interval tells us that we can be almost certain that /ptk/ will have higher RI values than /bdg/ and that the difference in dB between the two groups will be between 7.3 and 9.5 ninety-five percent of the time. We have previously seen that /ptk/ have higher RI values and are therefore more occluded than /bdg/ in all regions and that this result is significant. The decibel difference between these two groups will fall within the confidence intervals of each specific region listed in Table 3.5 at least 95% of the time.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Lower	7.3	7.8	3.6	3.3	3.9	3.2	0.9
Upper	9.5	8.9	5.2	5.5	5.0	4.6	1.7

Table 3.5. Confidence intervals of the difference between voiceless and voiced consonants.

3.1 2 Relative intensity and phoneme

Table 3.6 shows the mean RI measurements according to phoneme for the seven Spanish varieties analyzed for this study. I must note that the measurements in Table 3.6 are only descriptive in nature. Following presentation of the mean measurements, I will detail the statistical analysis of the data. Just as in the previous section, the color scheme of the table is as follows: cells shaded in green represent the lowest RI measurements within the voiceless /ptk/ or voiced /bdg/ series, and red represents the highest RI measurements. Given that there are now three levels of comparison for the three points of articulation, I have highlighted the middle RI measurements in yellow. At first glance, it is evident from Table 3.6 that higher or lower RI measurements according to point of articulation are not consistent across all of the varieties analyzed here. Each variety treats point of articulation separately. We notice in the sixth row of Table 3.6 that /d/ is the stop consonant with the lowest RI measurement in all varieties except the Canary Islands and Argentina. In the seventh row of Table 3.6, we see that /g/ exhibits the highest RI measurements of the voiced stop consonants /bdg/ in all varieties except the Caribbean and Argentina. The treatment of the voiceless consonants with respect to point of articulation is more varied. In the Canary Islands, Spain and Argentina, the velar stop /k/ exhibits the lowest RI values, whereas the bilabial stop /p/ exhibits the lowest RI values in Mexico, Chile and the Caribbean. The dental stop /t/ is the least occluded stop for the Andean region only.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
/p/	10.3	9.6	4.7	10.3	5.9	6.0	2.6
/t/	10.6	9.1	7.7	5.8	6.6	5.6	2.9
/k/	13.9	10.5	7.2	5.5	5.4	5.0	2.8
/b/	3.8	2.0	2.8	1.8	2.0	1.7	1.7
/d/	2.4	0.8	1.7	2.1	0.9	1.6	1.2
/g/	4.4	2.3	3	2.2	2.0	1.0	1.6

Table 3.6. Relative intensity measurements (dB) according to Spanish variety and phoneme.

Statistical analysis of the six phonemes (df = 5) show that the RI differences between all six consonants are significant, as shown in Table 3.7, with *p*-values of less than .05 for all regions. However, as previously discussed, the RI measurements do not show consistency across all Spanish varieties for each of the six phonemes. We can consider this information presented visually using the box plots in Figure 3.5. It remains evident that although the differences between the six phonemes within each variety are statistically significant, they do not pattern the same way inter-dialectally.[14] Looking at the box plots, we see great variability in the ranges associated with each of the stop consonants according to region. In almost all regions, the range of RI values for /ptk/ is greater than that of /bdg/, as evidenced by the larger size of the boxes, that is the pink, blue and yellow boxes. The mean RI values for voiceless stops range from 2.8dB for Caribbean Spanish to 13.9dB for Mexican Spanish. The orange, purple and green boxes are much smaller in size and represent a smaller RI range for the voiced stops. The mean RI values for voiced stops range only from 1.0 to 4.4dB. It is noteworthy that Mexican Spanish shows a really extended range for both voiceless and voiced consonants whereas Caribbean Spanish exhibits a highly reduced range for all stop consonants as compared to the other regions analyzed. As previously mentioned, the small dots to the right of the boxes represent the outliers in the data set. We can see that some varieties have many more outliers, such as the Caribbean variety, and nearly all of the varieties show more outliers for /bdg/ than for /ptk/.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Chi-squared	134.68*	951.67*	54.46*	93.85*	321.75*	131.72*	18.89*

Table 3.7. Statistical significance of the difference between phonemes /ptkbdg/ according to region.

[14] Given the complexity of the confidence interval function in statistical testing with variables that have more than two categories, I will not include a confidence interval table for region and point of articulation. The former is comprised of seven categories for the seven Spanish varieties studied and the latter is comprised of three: bilabial, dental and velar. A confidence interval for variables that have more than two categories is too difficult to explore since there would be 21 two-two comparisons, thus making a simple 2-way confidence interval impossible for these two independent variables. The other independent variables of this study—lexical stress, prosodic position, gender, and age—however, do include a confidence interval since they are binary and only have two categories; for example, atonic vs. tonic for lexical stress, word-initial vs. word-internal for prosodic position, etc.

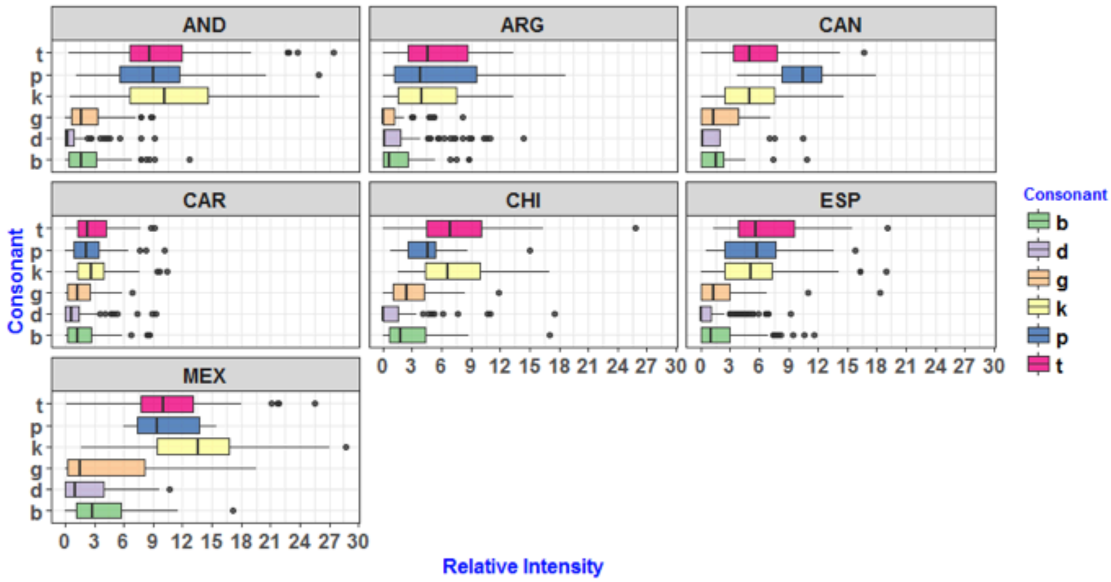

Figure 3.5. Box plots showing the differences among the six phonemes /ptkbdg/ in each region.

3.1.3 Relative intensity and point of articulation

If we conflate the phonemes according to point of articulation into three categories: bilabial, dental and velar, the results do show more of a pattern, although still not consistent between varieties. Consider Table 3.8. Once again, the cells with the highest RI values are highlighted in red, the middle RI values are in yellow, and the lowest RI values are in green, indicating a more open, vowel-like production. The consonants of Mexico, the Andean region and Chile pattern the same, with bilabial being the point of articulation with less occlusion and velar being the most occluded of the three. The consonants of Spain, Argentina and the Caribbean pattern the same in that the dental segments are the weakest, but the velar are still the most highly occluded. With the exception of Canarian Spanish, all varieties show that the velar point of articulation shows the highest degree of occlusion. Even though Canarian Spanish is an exception, the difference between the three points of articulation (bilabial = 4.5dB; dental = 4.8dB; velar = 4.1dB) is minimal, and therefore, we could easily generalize that velar segments are the least occluded overall.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
bilabial	4.6	3.8	3.3	4.5	2.8	2.7	1.9
dental	6.5	4.9	3.9	4.8	2.3	2.5	1.8
velar	9.4	6.7	5.9	4.1	3.6	3.1	2.5

Table 3.8. Relative intensity measurements in dB according to Spanish variety and point of articulation.

Statistical analysis of the results indeed shows that RI according to point of articulation is statistically significant in all regions except the Canary Islands and Argentina. Chi-squared statistic values and significance (*) are presented in Table 3.9, and the box plots in Figure 3.6 illustrate the trends for each region. The df for relative intensity and point of articulation is 2. Although the RI differences between bilabial, dental and velar points of articulation in Mexico, the Andean region, Chile, Spain and the Caribbean are significant, statistical results show that there is not consistency of the relative order of the points of articulation. This is precisely what I previously discussed regarding the raw data in Table 3.8. The velar segments are more highly occluded for all varieties except the Canarian whereas the least highly occluded segments are bilabial for Mexican, Andean and Chilean Spanish and dental for Peninsular and Caribbean Spanish. These patterns are clearly shown by the box plots, where B (green boxes) represents bilabial segments, D (purple boxes) represents dental segments, and R (orange boxes) represents velar segments. To more easily identify the regions where point of articulation results are significant, I have outlined them with red rectangles. The box plots once again show a lot of variability in the overall range of RI values. Andean and Mexican Spanish show the greatest range, where mean values range from 3.8-9.4dB. Canarian Spanish shows a reduced range for point of articulation, from 1.8-2.5dB, as well as for the differences between the three points of articulation in this variety as a whole. In addition, Andean, Argentinian, Canarian, and Peninsular Spanish include many outlier tokens that do not fall within the average range of RI values. This is indicative of a lot of RI variability within these regions.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Chi-squared	36.38*	37.09*	20.70*	0.89	12.96*	1.36	6.63*

Table 3.9. Statistical significance of the difference between bilabial, dental and velar points of articulation according to region.

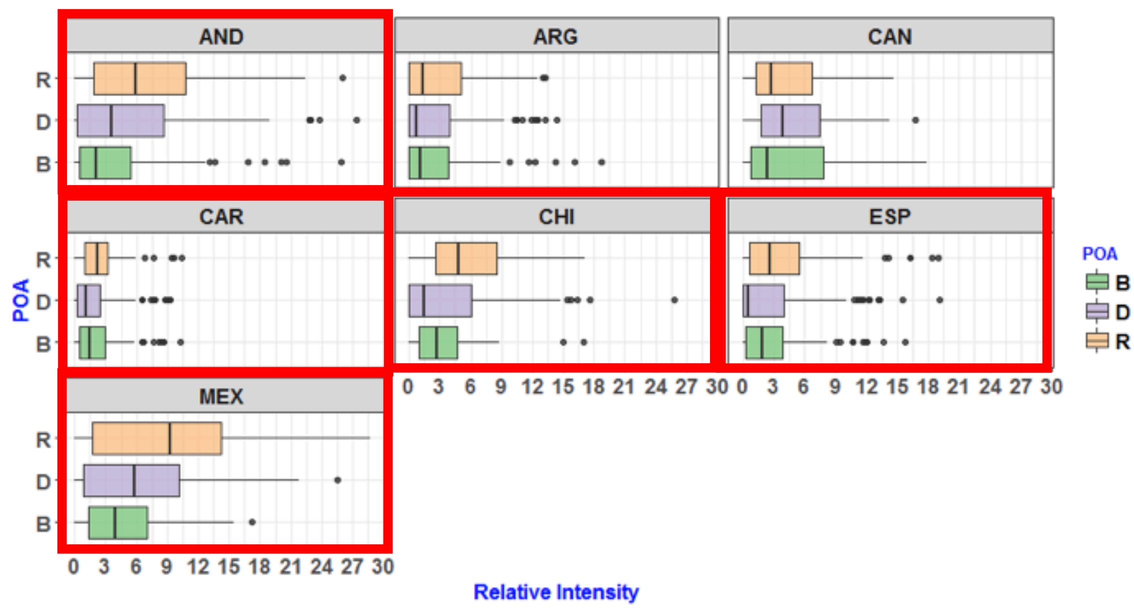

Figure 3.6. Box plots showing the differences among the three points of articulation: bilabial (B), dental (D) and velar (R) in each region.

3.1.4 Relative intensity and lexical stress

Recall that previous research on laboratory speech shows that stop consonants in lexically prominent syllables exhibit higher degrees of occlusion. This phenomenon is illustrated by the two PRAAT images in Figure 3.7 and 3.8, taken from a young, female Andean speaker from the current data set. The speaker produces the words *ubi<u>c</u>ada* 'located,' where the production of [k] is in a tonic syllable and *ubi<u>c</u>a* 'locate,' where the production of [k] is in an atonic syllable. The images in Figure 3.7 and 3.8 show the RI contrast of these two productions of [k], with the yellow intensity curve and the corresponding peaks and valleys of [k] marked with black circles. The production of [k] in Figure 3.7 shows a RI measurement of 24.9dB in lexically tonic position (maximum intensity 78.0 – minimum intensity 53.1 = 24.9dB), whereas the production of /k/ in Figure 3.8 shows a RI measurement of 17.6dB (maximum intensity 77.2 – minimum intensity 59.6 = 17.6) in lexically atonic position, which is 7.6dB less than in tonic position. In addition, we notice a higher amplitude waveform and longer duration of segments and syllables in the tonic context in Figure 3.7, which is to be expected, given previous research on lexical stress and consonant lenition.

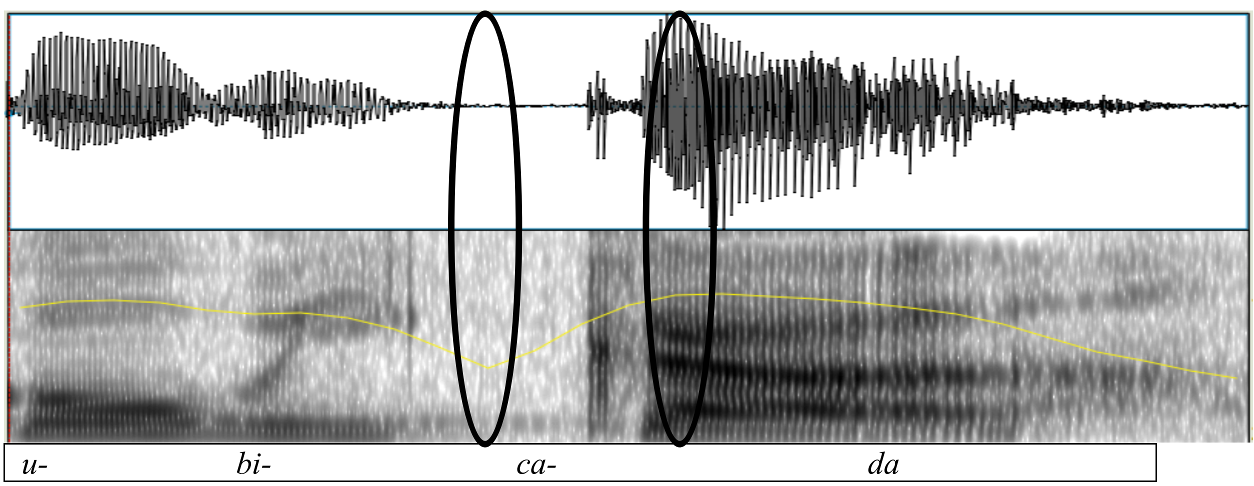

Figure 3.7. Measurement of the RI of [k] in the word *ubicada* 'located,' as produced by a young, female Andean speaker.

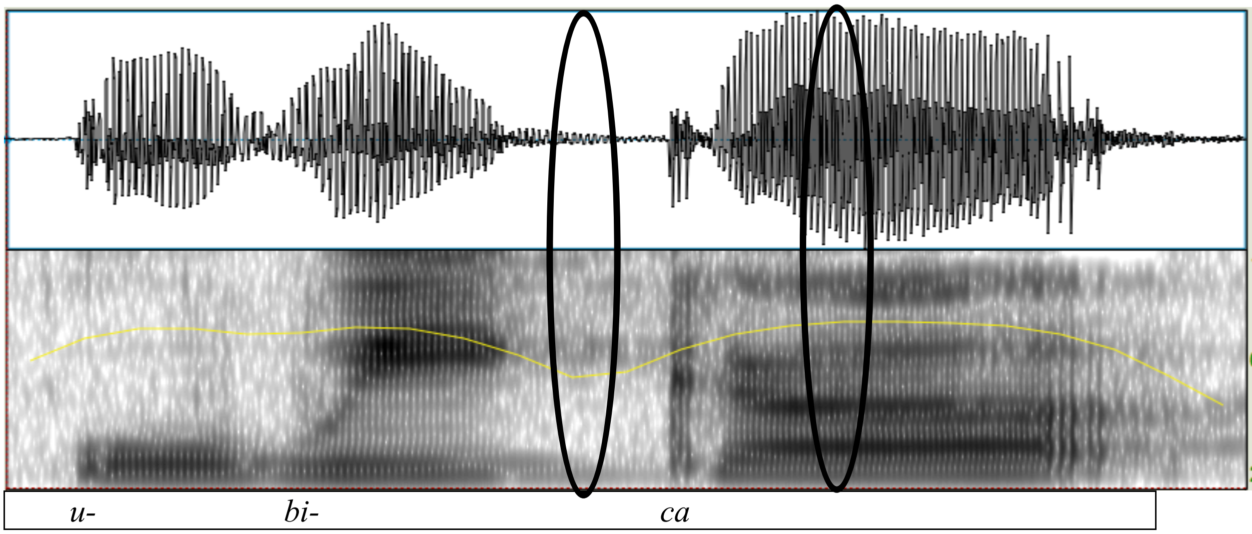

Figure 3.8. Measurement of the RI of [k] in the word *ubica* 'locate,' as produced by a young, female Andean speaker.

The current data set supports the conclusion that stop consonants are more occluded in tonic syllables than in atonic syllables in all varieties except in Caribbean Spanish, where stop consonants in tonic syllables are very slightly less occluded (1.9dB in tonic versus 2.1dB in atonic). We can see this in Table 3.10, where all varieties other than the Caribbean variety show higher RI values in tonic position when compared to consonants in atonic position. Higher RI values are highlighted in red, indicative of a more occluded consonant production, and lower RI values are highlighted in green for a more open, vowel-like production of the stop consonant.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
tonic	7.1	6.1	5.4	5.2	3.2	3.2	1.9
atonic	6.5	4.6	3.6	3.5	2.6	2.5	2.1

Table 3.10. Decibel distinction between consonants in tonic and atonic syllables.

Despite the promising trends, however, statistical tests show that these results are only significant in four of the seven Spanish varieties analyzed. In this data set, stop consonants in tonic position exhibit significantly higher RI values in the Andean region, Chile, the Canary

Islands, and Spain. RI according to lexical stress is not statistically significant for Mexican, Caribbean or Argentinian Spanish which have *p*-values greater than .05. Statistical significance (*) and Chi-squared statistic values are presented in Table 3.11. The df for relative intensity and lexical stress is 1. RI values according to lexical stress are displayed visually in Figure 3.9, and regions where the differences are significant are outlined with red rectangles. The purple boxes in Figure 3.9 show the tonic syllables, and we can see that in all cases, except the Caribbean variety, the mean RI values are slightly higher. In the regions where the difference between stop consonant production in tonic and atonic syllables is statistically significant (Canarian, Chilean, Peninsular and Andean), we see greater separation in the position of the boxes within their respective plots. It is also noteworthy that some of the regions have much larger value ranges, such as Andean, Mexican and Canarian Spanish. In addition, many of the regions exhibit a high number of outliers in this data set, which could have ultimately affected the overall results. Previous research shows that, in general, prominence affects weakening phenomena; therefore, the trends that we see in Figure 3.9, where prominence is not always statistically significant, is an interesting finding.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Chi-squared	0.24	28.68*	15.67*	6.69*	4.45*	3.03	1.19

Table 3.11. Statistical significance of lexical stress according to region.

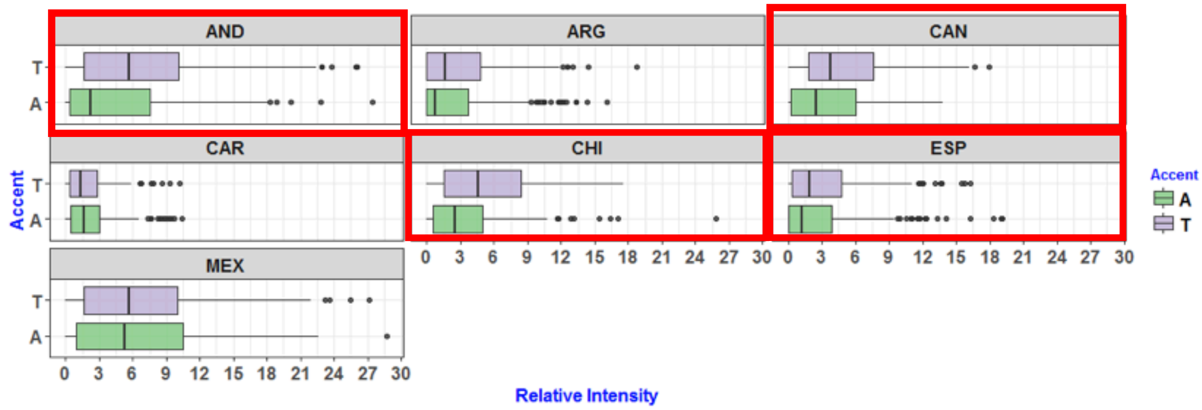

Figure 3.9. Box plots showing the RI differences between tonic (T) and atonic (A) position in each region.

Further analysis of lexical stress in the regions where this variable is statistically significant indicates that we can be 95% sure that the RI of stop consonants /ptkbdg/ in tonic position are larger than the RI of stop consonants in atonic position by a range of the lower limit to upper limit, as indicated in Table 3.12. Let us consider the confidence interval for lexical stress differences in Andean Spanish, for example. We are 95% sure that the average RI value of stop consonants in tonic position is larger than that of stop consonants in atonic position with a range of 1.4 to 3.0dB.

	Andes	**Chile**	**Canaries**	**Spain**
Lower	1.4	1.0	0.4	0.04
Upper	3.0	2.8	3.0	1.2

Table 3.12. Confidence intervals of the difference between tonic and atonic position.

3.1.5 Relative intensity and prosodic position

Like lexical stress, previous research has shown that prosodic position also plays a role in consonant lenition, where prosodically strong positions, such as word-initial position, show lower degrees of consonant weakening than prosodically weak positions, such as word-internal position. I illustrate this using the two PRAAT images in Figures 3.10 and 3.11, taken from a 38 year-old male speaker from the Canary Islands from the current data set. The images once again show the yellow intensity curve with the minimum and maximum intensity valleys and peaks marked with black circles. In Figure 3.10, the speaker produces the word *pasa* 'pass,' where intervocalic, word-initial [p] has a RI measurement of 18dB (maximum intensity 75.2 – minimum intensity 57.2 = 18dB) in word-initial position. In Figure 3.11, the speaker produces the word *supone* 'supposes,' where intervocalic, word-internal [p] has a RI of only 9.9dB (maximum intensity 68.2 – minimum intensity 58.3 = 9.9dB), or considerably less than the [p] in Figure 3.10, which is consistent with previous research on the topic.

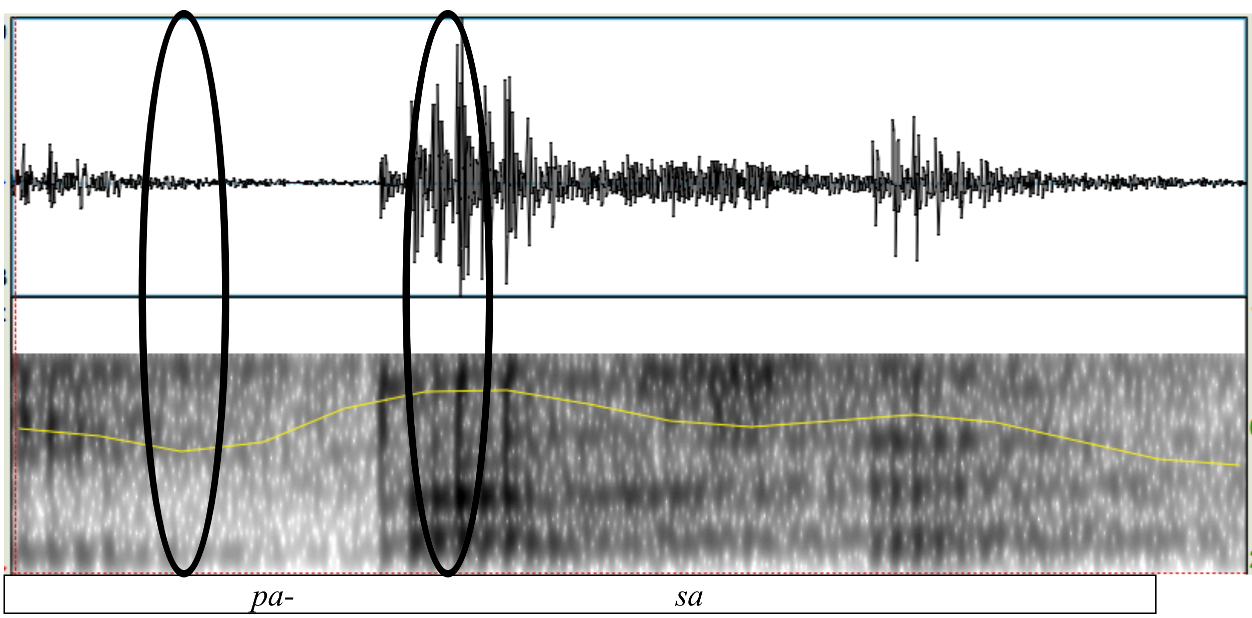

Figure 3.10. Measurement of the RI of [p] in the word *pasa* 'pass,' as produced by an older, male Canarian speaker.

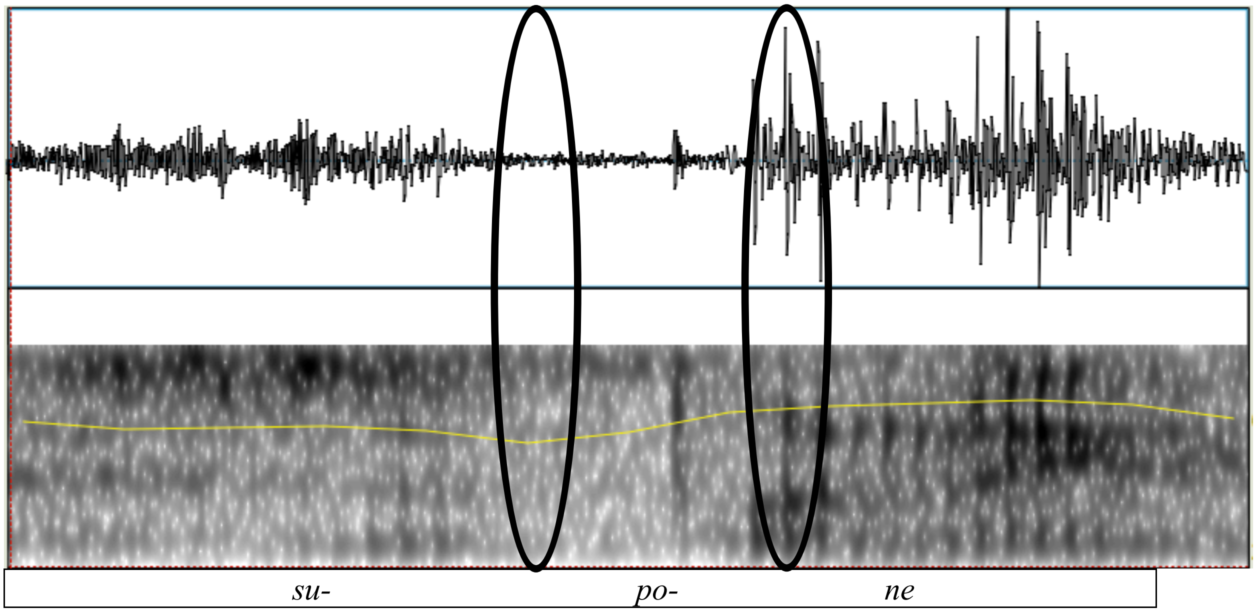

Figure 3.11. Measurement of the RI of [p] in the word *supone* ‘supposes,’ as produced by an older, male Canarian speaker.

This conclusion is supported in the current data set in all regions, except for Mexican Spanish, where stop consonants in initial position show lower RI values than stop consonants in internal position, as seen in the first column of Table 3.13, which highlights the mean RI averages in initial and internal positions for all Spanish varieties studied.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
initial	6.3	5.6	5.2	5.4	3.0	3.0	2.3
internal	7.2	4.9	3.8	3.6	2.7	2.5	1.9

Table 3.13. Decibel distinction between consonants in initial and internal position.

Even though this trend seems quite consistent, these differences are only statistically significant in four of the seven varieties: the Andean region, the Canary Islands, the Caribbean and Chile. The differences presented in Table 3.13 are not significant for Mexico, Spain or Argentina. This is of particular interest for Mexican Spanish, given that the current data set did not produce results consistent with previous research on consonant lenition according to prosodic position. Table 3.14 highlights the Chi-squared statistic values and statistical significance (*) by region. The df for relative intensity and prosodic position is 1. Following this information are the box plots in Figure 3.12, where regions that show word-initial position (S) with significantly higher RI values than in word-internal position (I) are outlined with red rectangles. Once again, the box plots show a high degree of range variability, with a high number of outliers in many of the regions. Andean and Mexican varieties show a much larger range of RI values than that of Caribbean Spanish. The former two varieties have a RI range from less than 3dB to 9-10dB, whereas in Caribbean Spanish, mean RI values are less than 3dB for both word-initial and word-internal positions. It is noteworthy that three of the four regions where this difference is significant are the same as we have seen previously for RI as it relates to lexical stress: the Andes, Chile and the Canary Islands. This data shows that the stop consonants of the Andean region, Chile and the Canary Islands are produced with more occlusion in tonic syllables and word-initial position, and the results are significant and align with previous research on consonant weakening in Spanish.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Chi-squared	2.88	14.25*	8.30*	7.33*	1.08	1.44	4.38*

Table 3.14. Statistical significance of prosodic position according to region.

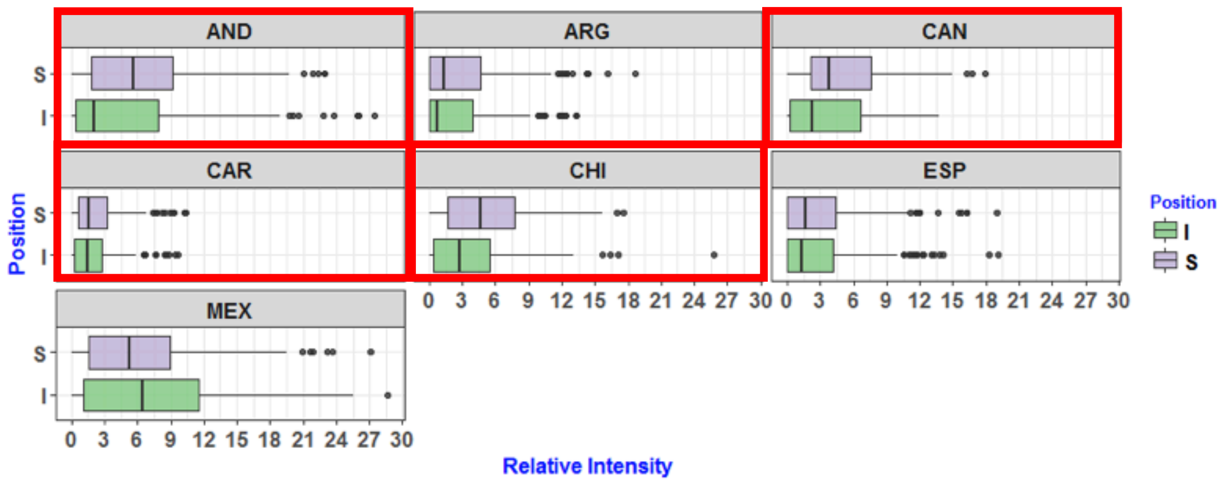

Figure 3.12. Box plots showing the RI differences between word-initial (S) and word-internal (I) position in each region.

Confidence interval analyses of prosodic position in the regions where this difference is statistically significant tell us that we can be 95% certain that stop consonants in word-initial position will be produced with higher RI than stop consonants in word-internal position within the ranges in Table 3.15. For example, in the data for Canarian Spanish, we are almost sure that /ptkbdg/ will be more highly occluded in word-initial position than in word-internal position, and the range of the difference between the two positions will be between 0.4 and 3.0dB.

	Andes	Chile	Canaries	Spain
Lower	1.4	1.0	0.4	0.04
Upper	3.0	2.8	3.0	1.2

Table 3.15. Confidence intervals of the difference between tonic and atonic position.

3.1.6 Relative intensity and gender

Sociolinguistic factors such as age and gender of speaker have been shown to play a role in language variation and change. This section details the results of RI values according to gender for the current data set, which comprises data from twenty female speakers and six male speakers. Given the unbalanced nature of the data set with respect to gender and the fact that not every Spanish variety analyzed included data from both female and male speakers, I present the data together instead of dividing it according to region. The mean RI averages for all female and male speakers are presented in Table 3.16. Overall, we notice that male speakers in this data set produce stop consonants with lower RI values, that is, consonants that are more open and less occluded.

	Female	**Male**
Relative intensity	4.0	3.2

Table 3.16. Mean RI differences according to gender.

Despite this promising trend, the results are not significant. The data is further illustrated with the box plots in Figure 3.13 for males (M) and females (F). Overall, the mean RI values of all six stops are quite low considering these include combined averages of /ptk/ and /bdg/. The range of values for both male and female speakers is 0-6dB; however, there are many outliers for both speaker groups, which contribute to the amount of variability in the gender data overall. We do notice that on the whole, male speakers tend to have slightly lower RI values, as evidenced by the purple box, which has a smaller overall range and is positioned toward the left-hand side, indicative of lower RI values than the green box representing female speakers.

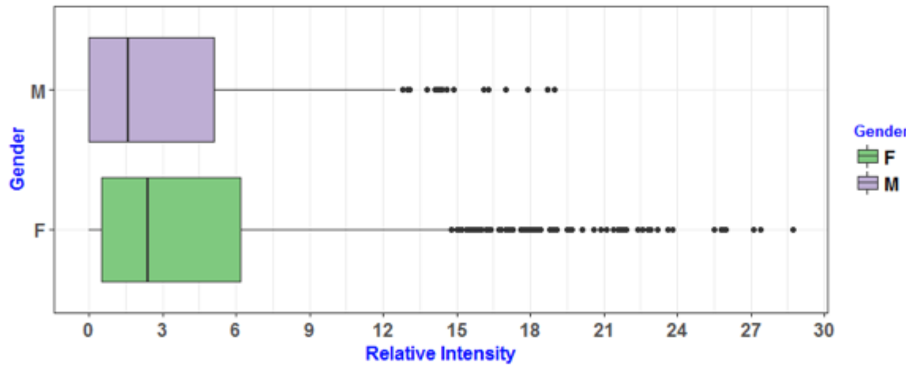

Figure 3.13. Box plots showing the RI differences according to gender.

Although not statistically significant, this trend holds true if we break down the RI differences for males and females according to sonority, as seen in Table 3.17. Males in the current data set show lower RI values both for voiceless and voiced consonants, meaning that their consonant production is less occluded in general. This data is represented visually in Figure 3.14.

	Female	**Male**
/ptk/	7.1	6.4
/bdg/	1.9	1.4

Table 3.17. Mean RI differences according to gender and sonority.

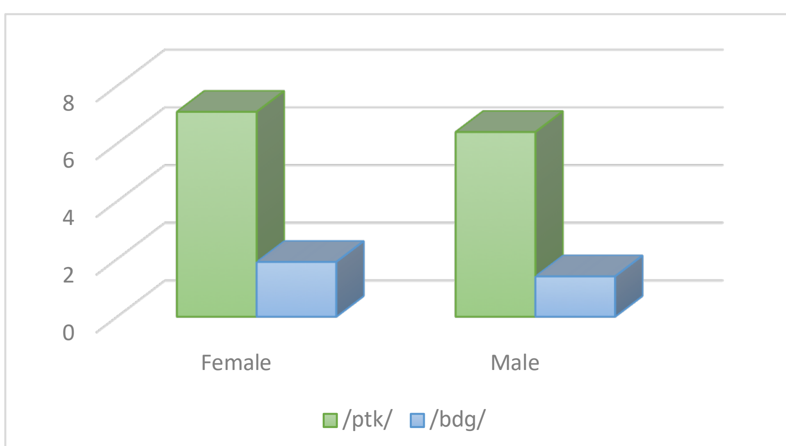

Figure 3.14. Relative intensity differences according to gender and sonority.

Within the current data set, four of the seven varieties studied included RI data from both males and females. The information in Table 3.18 shows the mean RI differences for males and females according to these four regions. As we can see from the data in Table 3.18, the overall trends previously discussed only hold true for two of the four regions that have data for both female and male speakers: Mexico and Spain. The other two regions, the Canary Islands and Argentina show the inverse, with females exhibiting higher RI values than males. It is important to remember that these results are not statistically significant. This information is presented visually in Figure 3.15, showing inconsistent results for gender in Mexico, Canary Islands, Spain, and Argentina. The imbalance in the distribution of speaker demographics, including 6 male speakers and 20 female speakers, could contribute to the inconsistency for gender results that we see in Table 3.18 and Figure 3.15. Further discussion of this imbalance will be detailed in the following chapter, part of which discusses the results and limitations of the study.

	Mexico	**Canaries**	**Spain**	**Argentina**
Female	7.2	4.2	3.0	2.3
Male	3.6	4.8	2.2	3.2

Table 3.18. Relative intensity according to gender for four Spanish varieties.

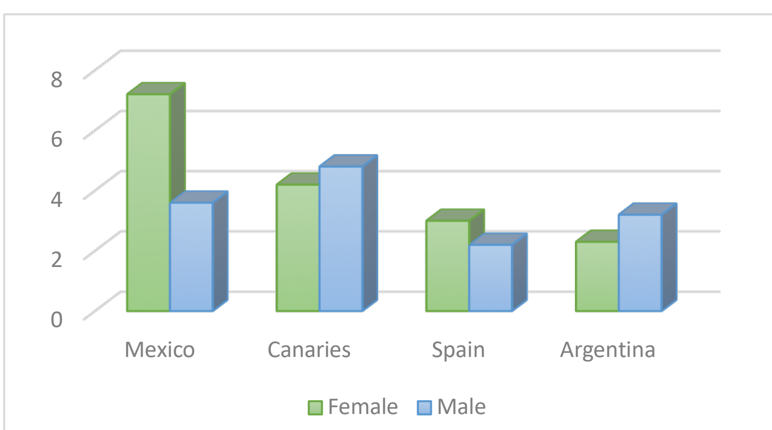

Figure 3.15. Relative intensity according to gender for four Spanish varieties.

3.1.7 Relative intensity and age

Age is the second sociolinguistic factor investigated for this study, and like gender, the data presents some interesting trends, but here, some are statistically significant. The current data set includes RI values from 14 speakers that are under the age of 30 and 12 speakers that are over the age of 35. Four of the seven Spanish varieties analyzed have speakers from both age groups. The following tables and figures will outline the details of this analysis and present the statistically significant results. Overall, the mean RI values in Table 3.19 show that older speakers have more highly occluded consonants than younger speakers.

	35+	**< 30**
RI values	4.6	3.3

Table 3.19. Mean RI differences according to age.

This trend holds true if we break down the data according to sonority and age to show the RI differences between younger and older speakers for both age groups. The data presented in Table 3.20 and the box plots in Figure 3.16 illustrate these differences between younger (0) and older (1) speakers. The box plots show results for voiced (V) consonants /bdg/ and voiceless consonants /ptk/ (N). The size differential between boxes is due to variability based on sonority; voiceless consonants /ptk/ (N) have larger boxes because the RI values for /ptk/ have a much larger range than that of voiced consonants /bdg/ (V). We also see here again a high number of outlier cases, contributing to a pattern of high variability in stop consonant production for speaker age. For both stop consonant series, however, we do notice that older speakers in this data set tend to have higher RI values than younger speakers.

	35+	< 30
/ptk/	7.7	6.3
/bdg/	2.3	1.5

Table 3.20. Mean RI differences according to age and sonority.

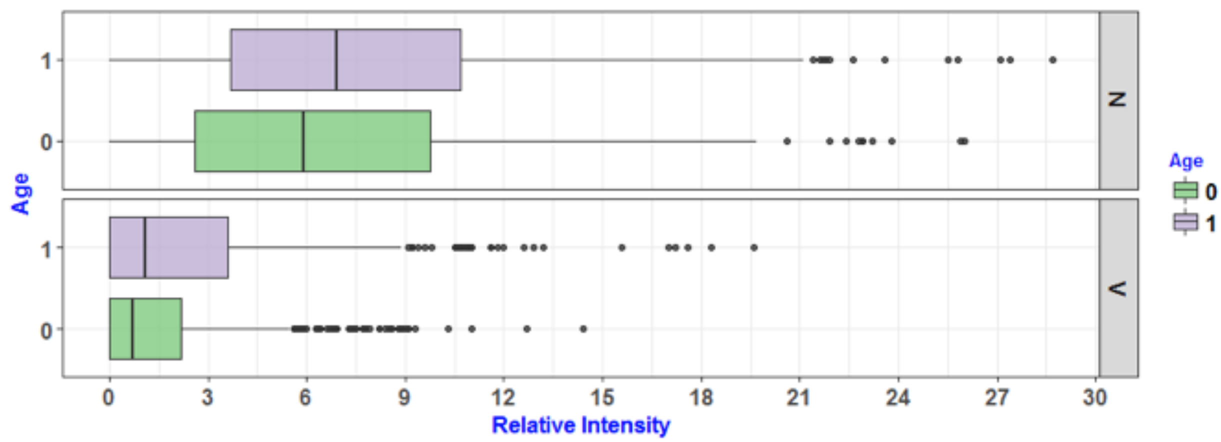

Figure 3.16. Relative intensity differences according to age and sonority (voiceless = N, and voiced = V) where younger speakers = 0 and older speakers = 1.

The results presented here, however, are only statistically significant for voiced consonants /bdg/, with a *p*-value that is less than .05 marked with (*) in Table 3.21. The df for relative intensity and age according to sonority is 1. The younger speakers have lower RI values than older speakers for both voiceless and voiced stop consonants, but that the difference is only statistically significant for /bdg/.

	/ptk/	/bdg/
Chi-squared	0.13	7.74*

Table 3.21. Statistical significance of age according to sonority.

Looking at the overall significance of RI based on age is useful, however, if we break down the data and look at only regions with both younger and older speakers, more interesting patterns emerge. Consider the information presented in Table 3.22, which shows the mean RI values for younger and older speakers in Mexico, the Andes, Spain, and Argentina. In all regions except the Andes, older speakers tend to produce stop consonants with higher RI values, meaning that their consonant production is overall more occluded, whereas younger speakers produce stop consonants with less occlusion. In the Andean region, however, the mean RI values for both older and younger speakers is the same, 5.2dB.

	Mexico	**Andes**	**Spain**	**Argentina**
35+	8.2	5.2	3.0	3.0
< 30	4.6	5.2	2.6	2.7

Table 3.22. Relative intensity according to age for four Spanish varieties.

Despite these trends, these differences between younger and older speakers are only statistically significant in Mexican Spanish, as evidenced by the Chi-squared statistic values in Table 3.23. The df for relative intensity and age according to region is 1.

	Mexico	**Andes**	**Spain**	**Argentina**
Chi-squared	21.44*	0.09	1.25	0.03

Table 3.23. Statistical significance of age according to region.

We can visualize this data using the box plots in Figure 3.17, where graphs with only one bar (Canary Islands, the Caribbean and Chile) indicate that each of those regions did not offer data from both age groups. The only region where this difference is statistically significant is Mexico, which is outlined with a red rectangle. Once again, we note the larger RI range for Mexican and

Andean varieties as compared with Argentinian and Peninsular Spanish, where the ranges are smaller. The confidence interval for the significant results from Mexico tells us that we can be 95% certain that younger speakers will produce lower RI values than older speakers with a range of 2.0-5.0dB.

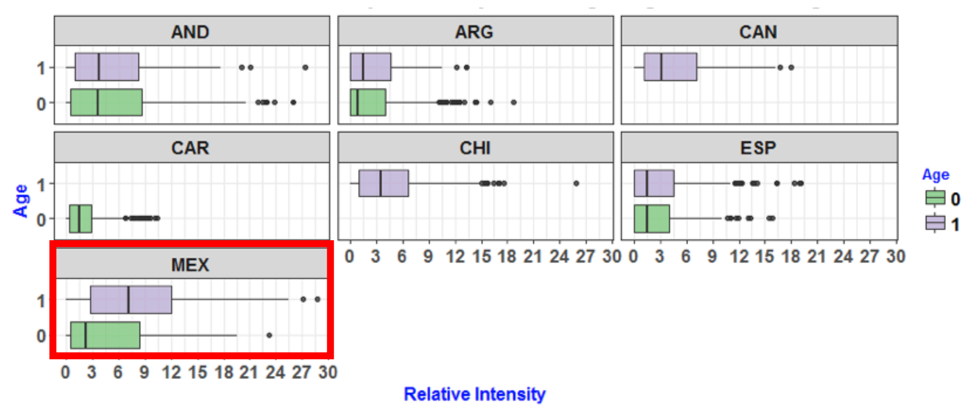

Figure 3.17. Relative intensity differences according to age and region where younger speakers = 0 and older speakers = 1.

Combining gender and age data from the previous results shows us that younger speakers, both male and female, produce consonants with lower RI values than older male and female speakers in this data set. Although these trends are not statistically significant, we can still visualize the differences in Table 3.24 and Figure 3.18. I will review these trends again in the following chapter by discussing how future work can address the variables of gender and age to better contribute to the discussion of consonant lenition in Spanish according to sociolinguistic factors.

	< 30	35+
Female	3.3	4.8
Male	3.2	3.3

Table 3.24. Mean RI differences according to age and gender.

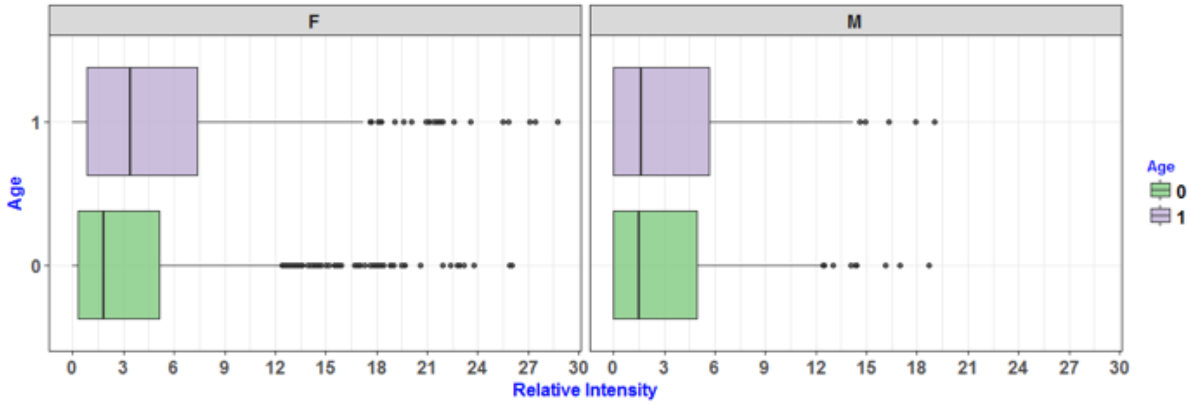

Figure 3.18. Relative intensity differences according to age and gender where younger speakers = 0 and older speakers = 1.

3.1.8 Summary of relative intensity

The previous sections outlined the results for RI and the various independent linguistic variables explored for this study: sonority (voiced vs. voiceless), phoneme (/ptkbdg/), point of articulation (bilabial, dental, velar), lexical stress (tonic vs. atonic syllables), and prosodic position (word-initial vs. word-internal). Results were also presented for the three independent extralinguistic variables of region (Mexico, Andes, Chile, Canary Islands, Spain, Argentina, vs. Caribbean), gender (male vs. female) and age (<30 vs. 35+ years old).[15] Overall results show that the RI distinction between voiceless and voiced stop consonants in the current data set is statistically significant in all regions, as is the difference between each of the individual phonemes. With respect to point of articulation, velar segments tend to show higher degrees of occlusion except in Canarian Spanish, and this result is statistically significant for five of the seven varieties

[15] As part of the statistical analysis run on the current data set, I explored the possibility of interactions between the independent variables investigated for this study; however, factors such as overall data structure, total token counts and the distribution of tokens complicated this process. In order to consider these interactions, there would be 28 two-two interactions and 58 combinations of three level interactions, and for many of these groups, there is simply not enough data to yield statistically significant results. The way my study is designed is not conducive to investigating independent variable interactions, which is thus an important area for future work on consonant lenition. Any such effort would likely need to employ a more controlled data elicitation task that would yield more appropriate data structure and distribution.

studied here: the Andes, the Caribbean, Chile, Mexico, and Spain. Consonants in the onset of tonic syllables tend to have higher degrees of occlusion than consonants in the onset of atonic syllables, and this result is significant for Andean, Canarian, Chilean and Peninsular Spanish. Regarding prosodic position, results show that stop consonants in word-initial position have higher RI values than those in word-internal position, and the results are statistically significant in four of the seven Spanish varieties studied: the Andes, the Canary Islands, the Caribbean and Chile. Results for the sociolinguistic variables of gender and age are not as clear. Although trends show that females and older speakers produce consonants with higher RI values, these results are not statistically significant except for Mexican Spanish, where younger speakers below the age of thirty have significantly lower RI values than older speakers.

The following section will consider these same independent variables (other than sonority, which is not relevant) with respect to the acoustic correlate of %V. I will present raw data as well as statistical significance of all variables analyzed for this study.

3.2 Percent voicing

3.2.1 Percent voicing and region

%V data was analyzed for 1028 tokens of intervocalic /ptk/ in seven varieties of Spanish: Mexican, Andean, Chilean, Canarian, Peninsular, Argentinian and Caribbean. Of the 1028 %V tokens, only 174 exhibited voicing percentages that were *not* either 0% or 100% voiced. Therefore, in order to better balance the data, these 174 tokens were divided in two at a threshold of 60%. If a consonant shows %V of less than 60%, it is considered voiceless, and if it shows %V higher than 60%, it is considered partially/fully voiced. Previous research has used a similar method to account for voiced and voiceless productions of the underlyingly voiceless stop consonants /ptk/ (Hualde, Simonet & Nadeu 2011). Consider the partially voiced production of /p/ in the PRAAT image in Figure 3.19. The total closure duration for [p] is 66.1ms, but the voiced portion of this closure, which can be seen through the darkened color of formants one and two as well as the glottal pulses indicating vibration of the vocal folds, is 34.6ms. Therefore, the %V of [p] in Figure 3.18 is 52.3% (34.6 / 66.1 = 52.3% voiced), but since the %V does not reach a 60% majority voicing, it is considered a non-voiced production of /p/ for the purposes of the current study.

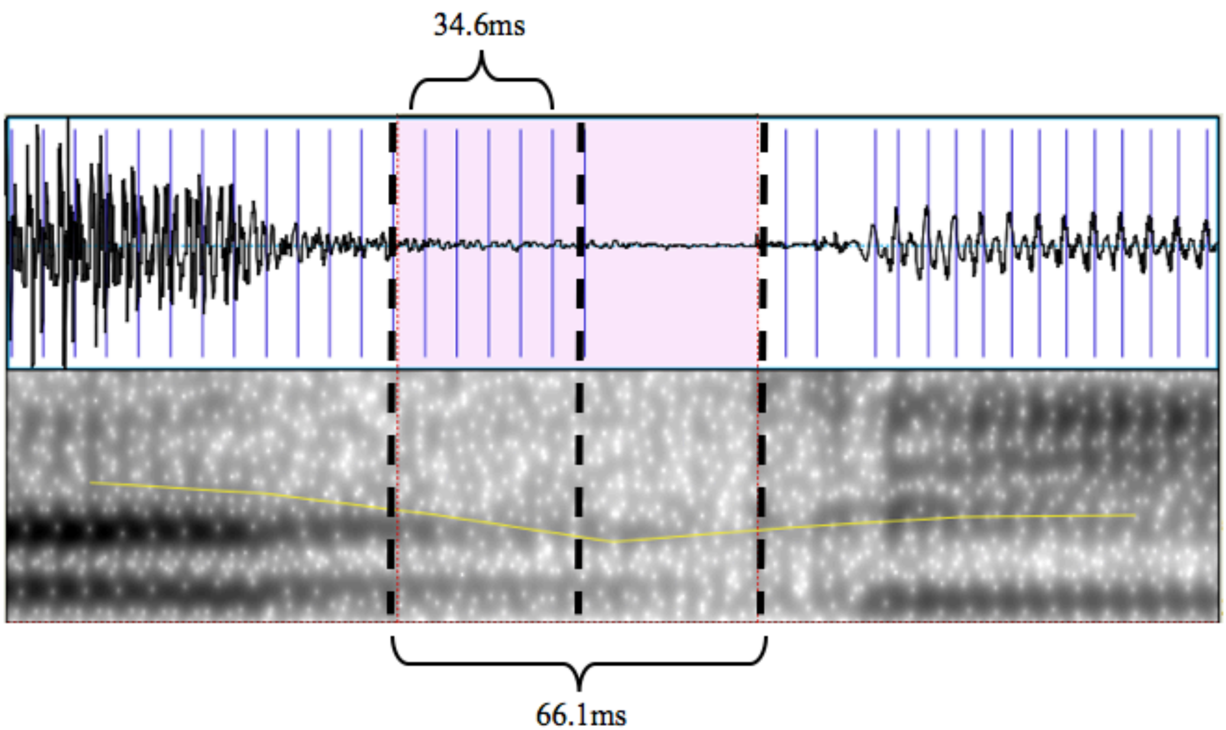

Figure 3.19. Measurement of %V of the production of [p].

Taking this information into consideration, notice the raw data presented in Table 3.25, which shows the percentage of underlying /ptk/ tokens that have voiced surface productions according to region. Included here for ease of reference, the total token counts for /ptk/ listed in Table 3.25

are the same as those previously outlined in the voiceless category under ‘sonority’ in Table 3.2 at the beginning of the chapter. The graph in Figure 3.20 illustrates the information in Table 3.25, showing that the productions of /ptk/ in Argentina, the Caribbean, Spain and Chile are voiced on the surface more than 65% of the time. While Mexican, Andean and Canarian Spanish do show some surface voicing of /ptk/, frequencies do not reach even 40% in any of these varieties.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Voiced /ptk/	39.6%	12.0%	86.0%	31.0%	78.9%	69.4%	74.4%
Total /ptk/	100	258	137	89	169	124	191

Table 3.25. Percentage of /ptk/ tokens that are realized as voiced stops according to region.

Statistical tests (df = 6) show that the %V differences between each of these regions is statistically significant, with a *p*-value of < .05 for all regions. The stacked bar graphs in Figure 3.20 show the same information from the raw frequencies in Table 3.25 presented using the proportion of %V of voiceless productions (= 0) to the proportion of partially/fully voiced productions (= 1). The %V frequencies from Table 3.25 for partially/fully voiceless productions are shown by the red portions of each bar, and the blue portions of each bar represent the partially/fully voiced realizations of /ptk/ in each region. For example, in the Andean region (AND), the majority of productions of are realized as voiceless (88%), while in Chilean Spanish (CHI), the majority of productions of are realized as partially/fully voiced (86%).

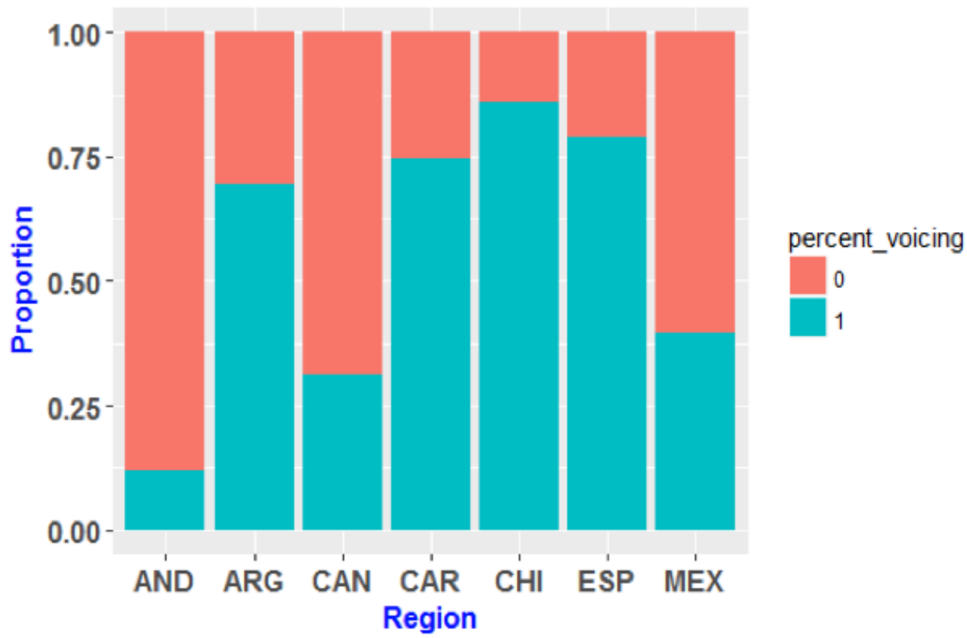

Figure 3.20. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ in each region.

To illustrate regional differences between partially/fully voiced and voiceless productions of /ptk/, I have extracted two examples from the current data set, one from an older, female Mexican speaker and the other from an older, female Chilean speaker. The following two PRAAT images in Figures 3.21 and 3.22 show a voiceless and voiced realization of /t/ by the Mexican and Chilean speaker, respectively. In Figure 3.21, the closure duration of [t̪] is identified between the two dotted lines by lack of movement in the waveform in addition to lack of formant structure and glottal pulses, which indicate vibration of the vocal folds. The closure duration of [t̪] here is 73.8ms. In Figure 3.22, on the other hand, there is no clear closure of [t̪], but rather we notice periodicity of the waveform and darker formant structure along the bottom, indicative of a voiced realization of underlying /t/. In Figure 3.22, contrary to Figure 3.21, we also notice that the glottal pulse lines showing vocal fold vibration persist throughout the segment's duration, indicative of a voiced realization. The characteristics of the image in Figure

3.22 are much more typical of an intervocalic voiced stop rather than a voiceless stop. These two figures are indicative of the previously discussed results showing that Mexican Spanish has much fewer cases of voicing of voiceless stops, while surface voicing of underlying /ptk/ in Chilean Spanish is much more frequent.

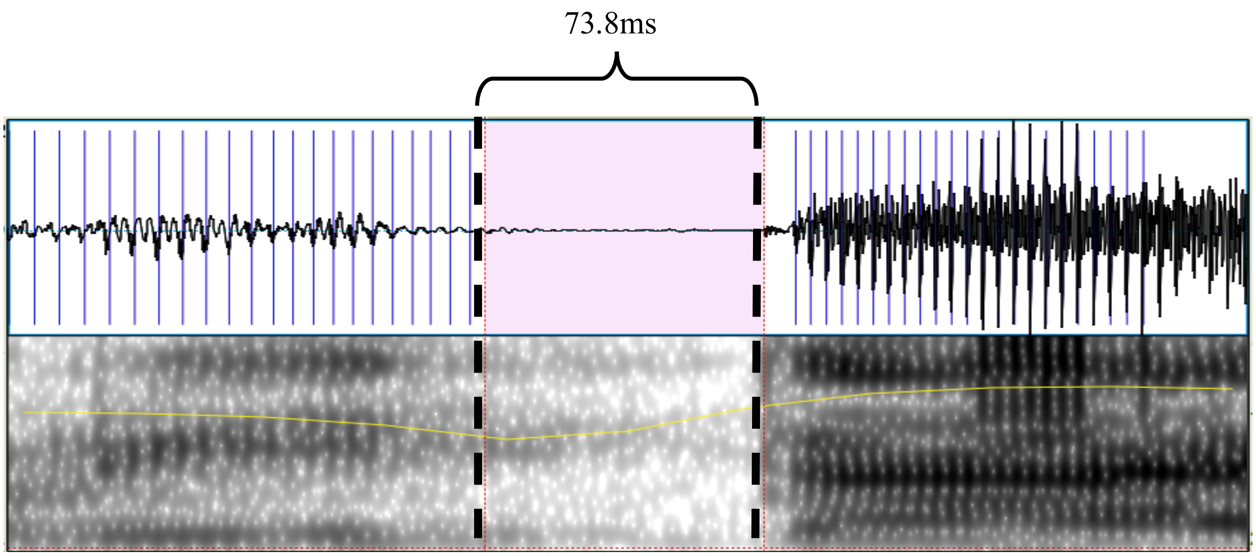

Figure 3.21. Voiceless realization of intervocalic /t/ by an older, female Mexican speaker.

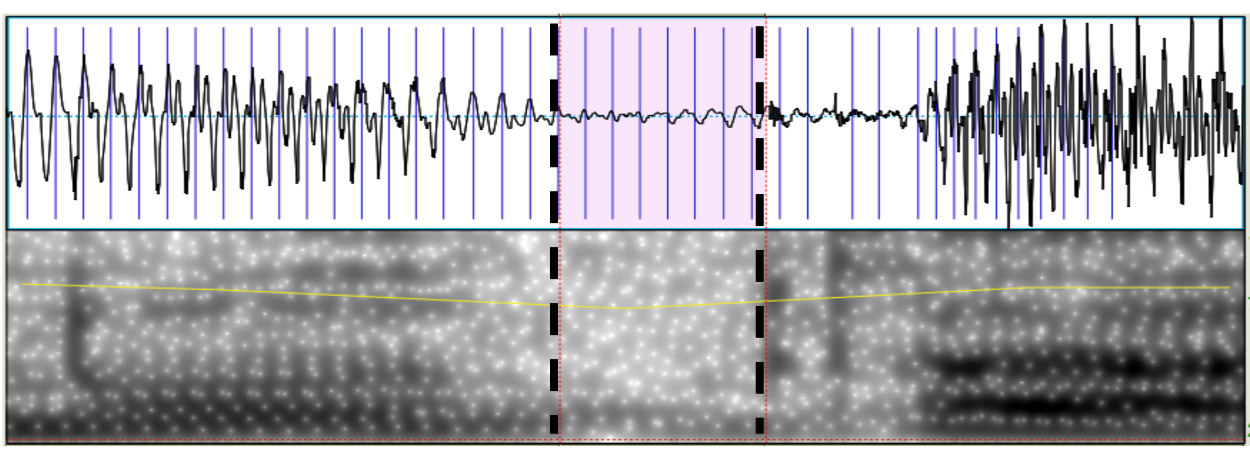

Figure 3.22. Voiced realization of intervocalic /t/ by an older, female Chilean speaker.

3.2.2 Percent voicing and point of articulation

Previous research shows that consonants may be either lesser or more highly occluded according to their point of articulation Looking at the percentage of /ptk/ tokens that exhibit surface voicing according to point of articulation—bilabial /p/, dental /t/ and velar /k/ in the current data set—we notice that this is not consistent across the different Spanish varieties investigated. Table 3.26 shows the breakdown of the percentage of voiced tokens of /ptk/ in each region according to point of articulation. For Andean and Canarian Spanish data from the current set, all three points of articulation produced surface voicings in less than 50% of cases, whereas in Argentinian, Caribbean, Chilean and Peninsular Spanish, all three points of articulation produce surface voicing more than 50% percent of the time. For Mexican Spanish, however, the majorities are not consistent. The bilabial segment /p/ is the segment which is most often realized with voicing in Mexico, Chile, Spain and the Caribbean, meaning that the majority of the varieties studied yielded a voiced realization of underlying /p/ more than /t/ or /k/. This is not the case for Andean Spanish, where the dental segment is most often voiced, or for the Canary Islands and Argentina, where the velar segment is most often produced with voicing.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
/p/ frequency	66.7%	12.1%	95.7%	6.7%	82.9%	52.6%	87.8%
/p/ tokens	93	148	84	48	164	94	177
/t/ frequency	27.9%	13.8%	77.8%	34.9%	78.3%	71.4%	79.4
/t/ tokens	84	247	63	63	253	165	188
/k/ frequency	43.5%	9.8%	87.0%	37.9%	77.3%	73.7%	62.0%
/k/ tokens	87	194	149	149	148	119	99

Table 3.26. Percentage of tokens that are realized as voiced stops according to point of articulation and region as well as total token counts for each subgroup.

The differences between the three points of articulation are only significant in three of the seven varieties: Mexico, Argentina and the Caribbean, although the relative order of these is not consistent. Chi-squared statistic values and statistical significance (*) are listed in Table 3.27. The df for %V according to point of articulation and region is 2. The stacked bar graphs in Figure 3.23 show the raw frequencies from Table 3.26 presented using the proportion of voiceless productions (= 0) to the proportion of partially/fully voiced productions (= 1) of /ptk/ in each region. For example, in the Mexican region (MEX), the blue bars show that bilabial tokens are realized as partially/fully voiced in 66.7% of cases, whereas the dental and velar tokens are realized as partially/fully voiced in 27.9% and 43.5% of cases, respectively. The regions where the differences between the three points of articulation are statistically significant are outlined with red rectangles.

	Mexico	**Andes**	**Chile**	**Canaries**	**Spain**	**Argentina**	**Caribbean**
Chi-squared	7.80*	1.84	4.21	2.91	0.13	8.54*	9.90*

Table 3.27. Statistical significance of %V according to point of articulation and region.

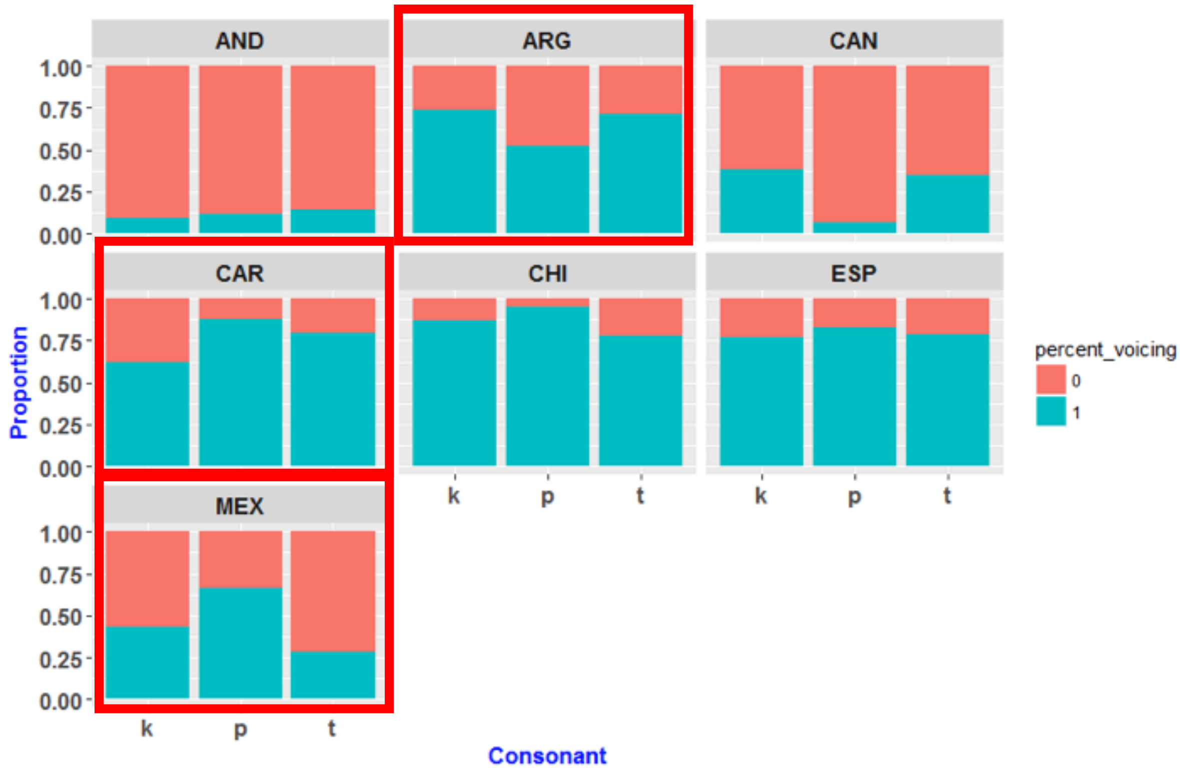

Figure 3.23. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to point of articulation where p = bilabial, t = dental and k = velar.

3.2.3 Percent voicing and lexical stress

Given previous research on consonant weakening in Spanish, we would expect stop consonants in atonic position to show higher %V values because atonic position is prosodically weaker than tonic position and is therefore more susceptible to weakening and voicing. However, the data from the current set does not show consistent results with respect to lexical stress. Consider the mean averages in Table 3.28 for each region. The data analyzed for Mexico, the Andes and Chile show that /ptk/ in tonic position are indeed less likely to be produced with surface voicing, in agreement with previous research on the topic. However, /ptk/ of the Canary Islands, Spain, Argentina and the Caribbean are actually more likely to be voiced in tonic position rather than atonic position, contrary to what we would expect.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Tonic frequency	34.4%	8.9%	85.5%	34.0%	79.7%	72.1%	75.5%
Total tokens	126	235	144	90	243	147	178
Atonic frequency	42.0%	14.4%	86.5%	26.5%	78.0%	67.6%	74.0%
Total tokens	138	354	152	70	322	231	286

Table 3.28. Percentage of tokens that are realized as voiced stops according to lexical stress and region as well as total token counts for each subgroup.

While these trends are very interesting, they are not statistically significant. The Chi-squared statistic values and statistical significance (*) in Table 3.29 tell us that contrary to previous research, which primarily focuses on laboratory speech, /ptk/ in the current data set for all varieties investigated does not show higher percentages of surface voicings either in tonic position or atonic position. The df for %V according to lexical stress and region is 1. The slight differences between tonic position and atonic position and %V revealed in Table 3.28 are represented visually in Figure 3.24 by the stacked bar graphs showing the proportional difference between %V frequencies of stop consonants in tonic syllables and atonic syllables. In the Andean region (AND), the blue bars show that only 8.9% of consonants in tonic syllables and 14.4% of those in atonic syllables are realized as partially/fully voiced. In Chilean Spanish (CHI), however, 85.5% of consonants in tonic syllables and 86.5% of those in atonic syllables are realized as partially/fully voiced. As we can see, even though certain varieties exhibit higher or lower %V values, the difference between the productions of /ptk/ in atonic (A) and tonic (T) position are relatively similar.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Chi-squared	0.11	0.18	0.04	2.71	0.006	0.28	0.04

Table 3.29. Statistical significance of %V according to lexical stress and region.

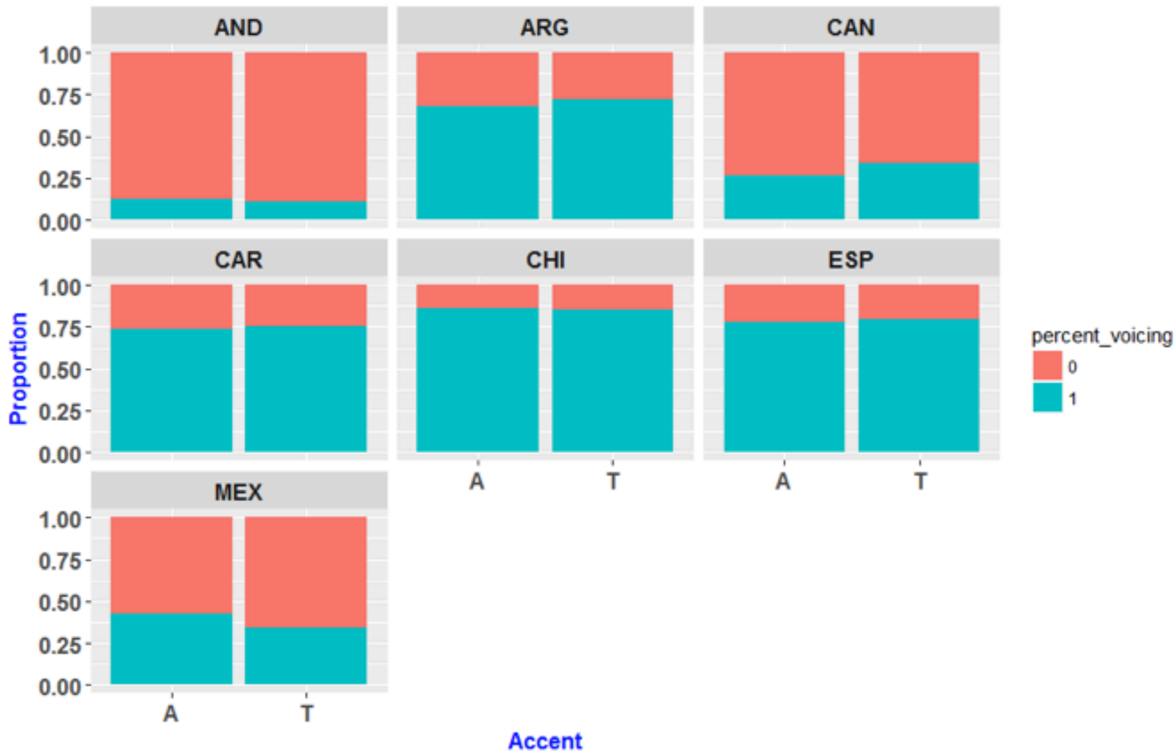

Figure 3.24. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to lexical stress in each region where T = tonic position and A = atonic position.

3.2.4 Percent voicing and prosodic position

Regarding prosodic position, we would expect a similar situation as with lexical stress. Previous research has shown that consonants in prosodically strong positions, such as word-initial position, are less susceptible to weakening than consonants in word-internal position. However, just as with lexical stress, the semi-spontaneous data of the current set does not show strong differences between the percentage of voicing for these two positions; however, there is consistency among all seven varieties analyzed, as shown by the raw data in Table 3.30. In each region, the percentage of /ptk/ tokens realized with voicing is higher in initial position than in internal position, which is contrary to what we would expect, given the fact that initial position is prosodically stronger.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Initial	46.2%	12.1%	89.2%	33.9%	86.0%	72.1%	75%
Total tokens	121	232	143	76	264	189	155
Internal	35.5%	11.8%	82.3%	25%	70.7%	66.0%	74.2%
Total tokens	143	357	153	84	301	189	309

Table 3.30. Percentage of tokens that are realized as voiced stops according to prosodic position and region as well as total token counts for each subgroup.

As noted previously for lexical stress, prosodic position is also not a statistically significant variable for surface voicing of /ptk/, meaning these consonants are not significantly more likely to be produced with voicing in word-initial position or word-internal position. Although the results are not statistically significant, this is useful knowledge in that we now have evidence that position is not a variable that contributes to voicing of intervocalic /ptk/. Chi-squared statistic values and the lack of significance are presented in Table 3.31. The df for %V according to prosodic position and region is 1. We can visualize the slight difference by looking at the stacked bar graphs in Figure 3.25, showing proportions of %V according to prosodic position, internal (I) or initial (S). As in previous graphs in this section, the blue bars correspond to the percentage frequencies listed in Table 3.30. For example, in Peninsular Spanish, the percentage of /ptk/ realized as partially/fully voiced in word-initial position is 86.0%, while only 70.7% are realized as partially/fully voiced in word-internal position. We can see from the graphs, as before, that the Andean and Mexican regions have much lower proportions of /ptk/ tokens realized with either partial or full voicing. For each of the regions, the percentage of /ptk/ tokens realized as voiced in initial position is slightly higher, as evidenced by the blue bar on the right of each region's graph.

	Mexico	Andes	Chile	Canaries	Spain	Argentina	Caribbean
Chi-squared	2.98	0.06	1.49	0.42	2.84	0.11	0.01

Table 3.31. Statistical significance of %V according to prosodic position and region.

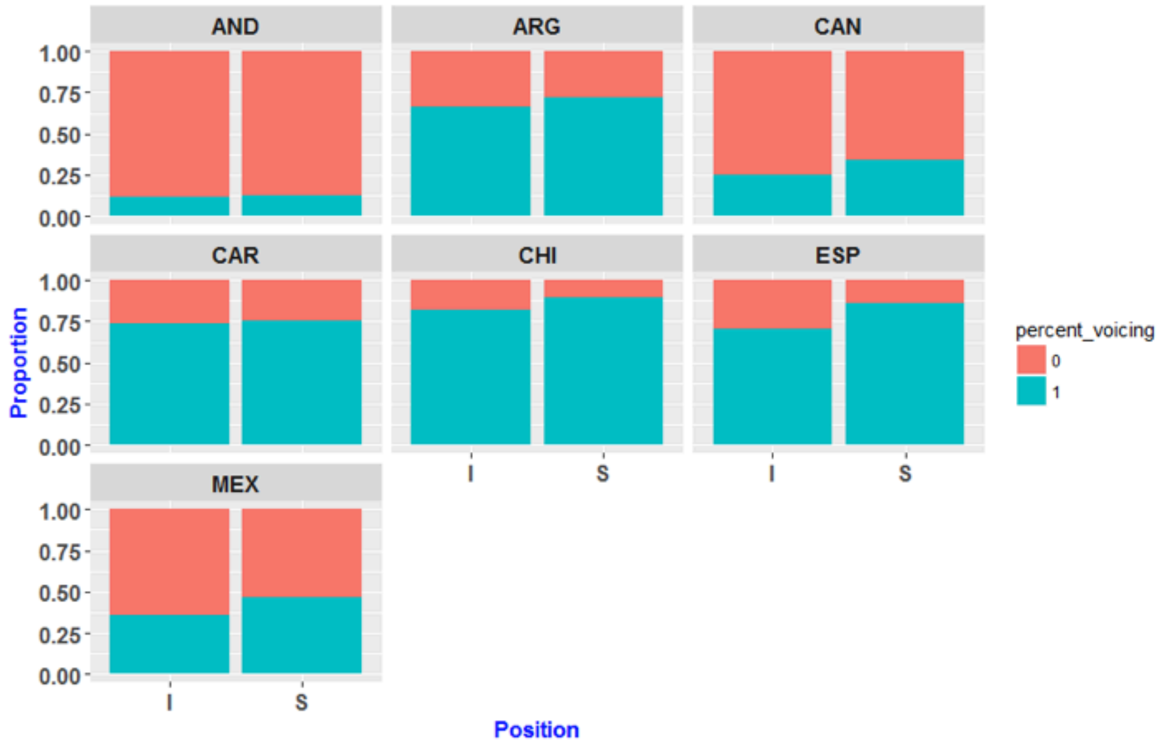

Figure 3.25. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to prosodic position in each region, where S = initial position and I = internal position.

3.2.5 Percent voicing and gender

Just as we have seen with RI, sociolinguistic factors such as gender and age, which will be discussed in this section and the next, have been shown to play a role in language variation. Because the current data set has an unequal number of men and women and not all varieties in the corpus had available data for both genders, this section will outline the overall differences between male and female speakers as well as the differences in regions where data from both genders was available. Overall, the data shows that female speakers in this data set produce

56.5% of /ptk/ tokens with partial/full voicing, whereas male speakers produce only 37.2% of /ptk/ tokens with partial/full voicing. This is not what we would expect given that in Section 3.1.6 on RI and gender, female speakers exhibited higher RI values for /ptk/ than male speakers, that is, more occluded consonant productions. If a RI value closer to zero is more open, and thus more vowel-like, we would expect males to also have a higher percentage of voicing of /ptk/ given their lower RI values. A discussion of these results will be outlined in the following chapter on discussion and conclusions.

If we consider the four regions where data from both genders was available, as shown in Table 3.32, we notice that female speakers are more likely to produce /ptk/ with voicing in the Canary Islands, Spain, and Argentina. This is not the case for the Mexican Spanish data, where male speakers are more likely to produce voiced realizations of /ptk/ than female speakers.

	Mexico	**Canaries**	**Spain**	**Argentina**
Female	37.1%	60.0%	84.1%	91.1%
Total tokens	232	68	431	186
Male	58.3%	11.5%	55.2%	47.3%
Total tokens	32	92	134	192

Table 3.32. Percentage of tokens that are realized as voiced stops according to gender and region as well as total token counts for each subgroup.

Statistical tests (df = 1) show that of these four regions, the differences between male and female speakers are only significant in two regions: Argentina and the Canary Islands. Chi-squared statistic values and statistical significance (*) are shown in Table 3.33, followed by a visual representation of these proportions in Figure 3.26, where the blue bars show the raw frequencies previously listed in Table 3.32. For example, in Argentinian Spanish, female speakers produce /ptk/ with partial/full voicing in 91.1% of cases and male speakers produce /ptk/ with partial/full voicing in only 47.3% of cases. The regions with only one bar did not have data available for both genders, and the regions where gender is a significant variable in the realization of /ptk/ with voicing are outlined with a red rectangle. We can clearly see the gender differences in all four of these regions, where female speakers of the current data set from Argentina, the Canary Islands and Spain have higher proportions of voiced realizations (=1) than voiceless realizations (=0). In Mexico, however, male speakers have higher proportions of voiced realizations than females.

	Mexico	**Canaries**	**Spain**	**Argentina**
Chi-squared	0.01	19.40*	3.26	20.21*

Table 3.33. Statistical significance of %V according to gender and region.

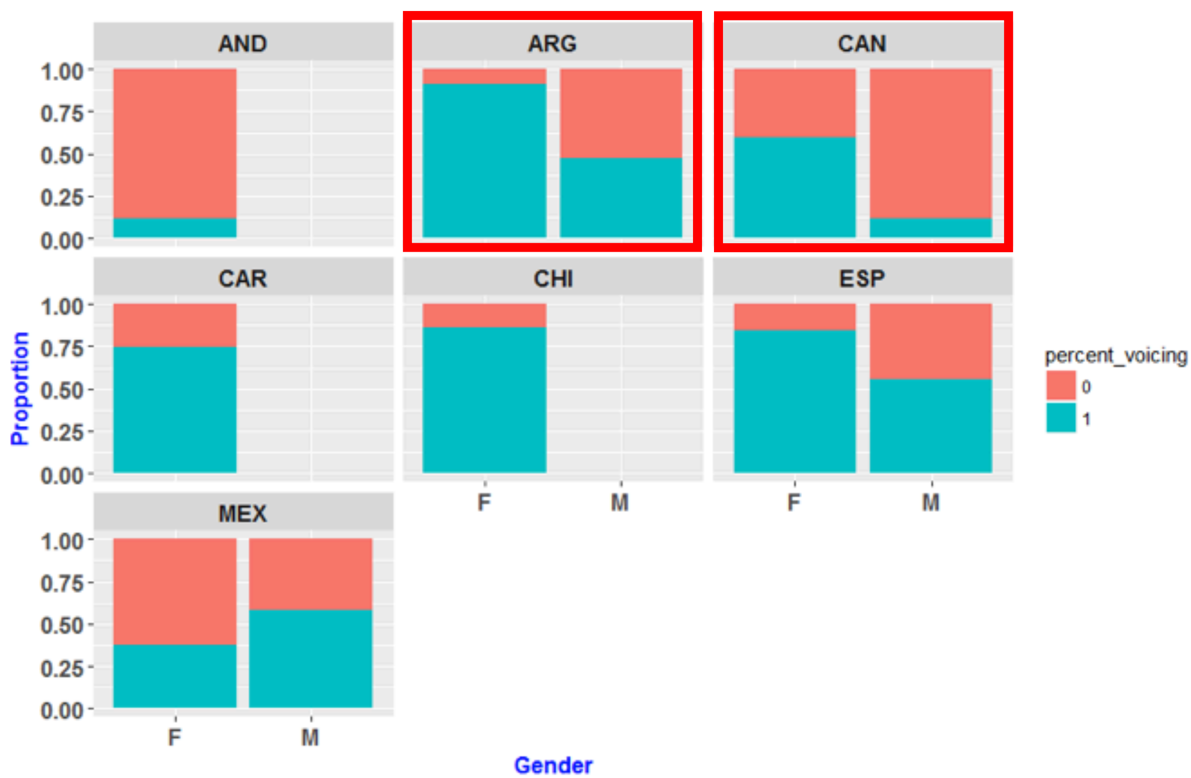

Figure 3.26. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to gender in each region where F = female and M = male.

<u>3.2.6 Percent voicing and age</u>

Age is the second sociolinguistic factor used as an independent variable in this analysis and has been shown to play a significant role in previous research on language variation in Spanish. Although only four of the seven varieties studied had data available for both age groups, younger (< 30 years old) and older (35+ years old), overall trends show that younger speakers in this data set produce /ptk/ with surface voicing 50.4% of the time while older speakers produce voiced realizations of /ptk/ in 57.7% of cases. As with the gender variable, this result is not what we would expect given the presentation of RI results in Section 3.1.7, where younger speakers show lower RI values, and therefore more open, vowel-like productions of stop consonants. We would then expect them to have higher %V as well, since voiced segments have lower RI values. Possible conclusions about these unexpected results and those of gender will be discussed in the following chapter on discussion and conclusions.

If we break down this data into the four regions where data from both younger and older speakers was available, which is presented in Table 3.34, we can see that younger speakers have higher %V than older speakers in Spain, which is consistent with the raw data results from Section 3.1.7, where younger speakers in Mexico and Spain also exhibited lower RI values. In the Andean region as well as in Argentina, older speakers have higher %V. It is noteworthy, however, that the percentage of partially/fully voiced tokens produced in Peninsular Spanish are almost equal, where the other regions (Mexico, the Andes, and Argentina) show a greater difference between the two age groups.

	Mexico	Andes	Spain	Argentina
35+	18.5%	22.4%	78.4%	92%
Total tokens	161	152	314	90
< 30	77.8%	8.3%	79.7%	62.8%
Total tokens	103	437	251	288

Table 3.34. Percentage of /ptk/ tokens realized as voiced stops according to age and region as well as total token counts for each subgroup.

Statistical tests (df = 1) show that in the four regions with data from both age groups, the difference between younger and older speakers is statistically significant for speakers of Andean and Mexican Spanish, as evidenced by the Chi-squared statistic values and statistical significance (*) in Table 3.35. The pattern, however, is not consistent between these two varieties, which we can clearly see in the visual representation of this data in the stack bar graphs of Figure 3.27. As in the previous graphs, the blue bars show a visual representation of the raw frequencies from Table 3.34, showing the percentage of partially/fully voiced realizations by younger and older speakers. In Andean Spanish, older speakers tend to have higher %V (22.4%), whereas in Mexican Spanish, older speakers tend to have lower %V (18.5%). The two regions where the data is statistically significant are outlined with a red rectangle; the other regions either are not significant or only have data from one age group.

	Mexico	Andes	Spain	Argentina
Chi-squared	28.52*	9.22*	0.02	2.31

Table 3.35. Statistical significance of %V according to age and region.

Figure 3.27. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to age and gender in each region where 0 = <30 and 1 = 35+.

If we consider both age and gender data together, we notice differences between the two age groups with respect to gender. The percentage of voiced realizations of /ptk/ are shown in Table 3.36 and visually with the stacked bar graphs in Figure 3.28, where the younger age group is identified on the left by zero and the older age group is identified on the right by one. The raw frequency percentages from Table 3.36 are represented by the blue bars in Figure 3.28, which show the percentage of tokens realized as partially/fully voiced. Overall, older female speakers of this data set have the highest %V, while older male speakers have the lowest %V of the four categories. These results are not statistically significant.

	< 30	35+
Female	50.5%	64.0%
Total tokens	1307	959
Male	49.3%	26.6%
Total tokens	236	214

Table 3.36. Percentage of tokens that are realized as voiced stops according to age and gender as well as total token counts for each subgroup.

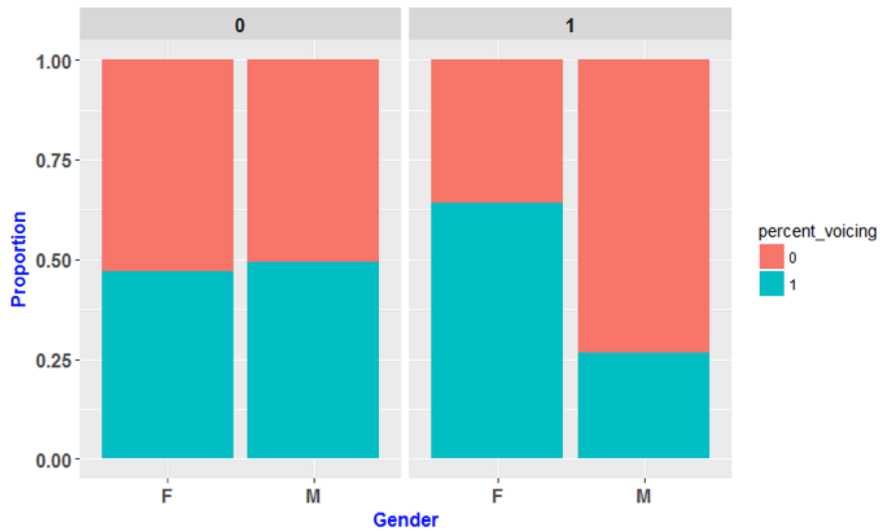

Figure 3.28. Proportions of %V of voiceless productions (= 0) and voiced productions (= 1) of /ptk/ according to age and gender where 0 = <30 and 1 = 35+.

<u>3.2.7 Summary of percent voicing</u>

This section detailed the results of the %V data for the seven Spanish varieties analyzed for this study and whether the various independent linguistic variables explored were statistically significant: point of articulation (bilabial, dental, velar), lexical stress (tonic vs. atonic syllables), and prosodic position (word-initial vs. word-internal). Results were also presented for the three sociolinguistic variables of region (Mexico, Andes, Chile, Canary Islands, Spain, Argentina, vs. Caribbean), gender (male vs. female) and age (<30 vs. 35+ years old). Overall, the results show that the %V differences between all seven regions are statistically significant, with Mexican, Andean and Canarian Spanish showing lower %V and Chilean, Argentinian, Peninsular and

Caribbean Spanish showing higher %V. With respect to point of articulation, the distinction between bilabial, dental and velar segments was significant for three of the seven regions: Mexico, Argentina and the Caribbean; however, the relative order of the three points of articulation was not consistent across the different varieties. Consonants in the onset of tonic syllables tend to have higher %V in the Canary Islands, Spain, Argentina and the Caribbean despite the results not being statistically significant. Regarding prosodic position, results show that stop consonants in word-initial position are more likely to have higher %V than those in word-internal position in all seven varieties, contrary to what we would expect; however, the results are not statistically significant. Results for the sociolinguistic variables of gender and age are mixed. Female speakers tend to have higher %V, and this difference is significant in Argentinian and Canarian Spanish. Age data shows that younger speakers tend to produce higher %V in Mexican Spanish, but lower %V in Andean Spanish, and these results are significant.

3.3 Summary

This chapter has presented the results of my data analysis on the stop consonants /ptk/ and /bdg/ in seven regions of the Spanish-speaking world: Mexico, the Andes, Chile, the Canary Islands, Spain, Argentina and the Caribbean. The dependent variables of RI and %V were used to determine the effects of sonority, phoneme, point of articulation, lexical stress, prosodic position, gender, and age on the degree of intervocalic consonant weakening. I have presented mean averages of raw data as well as statistical significance of the independent variables from tests run in R (R Core Team 2012) and lmerTest Package (Kuznetsova, Borckhoff & Christensen 2017). Results show that region is a statistically significant variable for RI and %V, indicating that the realization of stop consonants in this data set is varied across the seven Spanish varieties investigated and that this variation does not occur by chance. The other independent variables investigated are also significant for RI but not always for %V, as illustrated in Table 3.37, which summarizes the statistically significant results for the remaining independent variables according to region. Statistical significance is indicated with (*). We can see from the table that the variables of sonority, phoneme and point of articulation are statistically significant with respect to RI for all regions analyzed, whereas lexical stress and prosodic position are only significant for some regions. Significant results for %V are not as prevalent since phoneme and point of articulation—which is essentially the same variable for /ptk/—are only significant in Mexico, Argentina and Chile. Lexical stress and prosodic position were not significant for %V in any of the seven regions. Gender and age, two sociolinguistic variables used for this study, did not yield many statistically significant results either for RI or %V.

Region	**Sonority**	**Phoneme**		**Point of Articulation**		**Lexical Stress**		**Prosodic Position**		**Gender**		**Age**	
	RI	RI	%V	RI	%V	RI	%V	RI	%V	RI	%V	RI	%V
Mexico	*	*	*	*	*							*	*
Andean Region	*	*		*		*		*					*
Chile	*	*		*		*		*					
Canary Islands	*	*		*		*		*			*		
Spain	*	*		*		*							
Argentina	*	*	*	*	*						*		
Caribbean	*	*	*	*	*			*					

Table 3.37. Summary of statistically significant results for all variables analyzed.

The following chapter will discuss the implications of these results as they pertain to the research questions set out in Chapter 2, various limitations of the study, and directions for future research.

4. DISCUSSION, CONCLUSIONS AND FUTURE RESEARCH

4. Discussion, conclusions and future research.

4.1 Overview

This chapter offers a discussion of the results of the acoustic analysis of the stop consonants /bdg/ and /ptk/ presented in the previous chapter by discussing both acoustic correlates used in the study—relative intensity (RI) and percent voicing (%V)—as they pertain to the eight independent variables investigated: sonority, phoneme, point of articulation, lexical stress, prosodic position, gender, age and region. Taking into consideration the three research questions proposed for this study—repeated for convenience in (22)—I provide a discussion of my results as they relate to previous work on stop consonant lenition outlined in Chapter 1 and detail their implications for the study of consonant lenition in Spanish. In the concluding remarks section of this chapter, I will discuss the overall contributions and limitations of my dissertation, followed by directions for future research on stop consonant lenition in Spanish and Romance.

(22)
a. How do linguistic factors such as sonority, phoneme, point of articulation, lexical stress, and prosodic position affect consonant lenition across different varieties of Spanish?
b. How do the sociolinguistic factors of gender, age and dialect affect consonant lenition across different varieties of Spanish?
c. Is there a correlation of consonant lenition of /ptk/ and /bdg/ between more radical and more conservative Spanish varieties with respect to the acoustic correlates of RI and %V?

4.2 Research Question #1

4.2.1 Summary of findings

4.2.1.1 Relative intensity

The acoustic correlate of RI proved to be very useful to compare both sets of stop consonants, /bdg/ and /ptk/, in the same manner. Overall, RI according to sonority and region shows that the decibel (dB) difference between voiced consonants /bdg/ and voiceless consonants /ptk/ is significant according to region. The visual representation of these results is repeated in Figure 4.1 for reference. The data shows that Mexican as well as Andean speakers tend to exhibit a larger dB distinction between /bdg/ and /ptk/, which is not the case for Caribbean speakers, where /ptk/ RI values are only slightly higher than those of /bdg/. What we notice, therefore, is that there is indeed a significant difference in the production of /bdg/ and /ptk/ for all varieties analyzed, but that this difference is not consistent across varieties. Two varieties have an average distinction over 8dB (Mexican and Andean), and one variety has an average distinction of less than 1.5dB (Caribbean), while the other four varieties have an average distinction between 3.9 and 4.5dB (Chilean, Canarian, Peninsular and Argentinian).

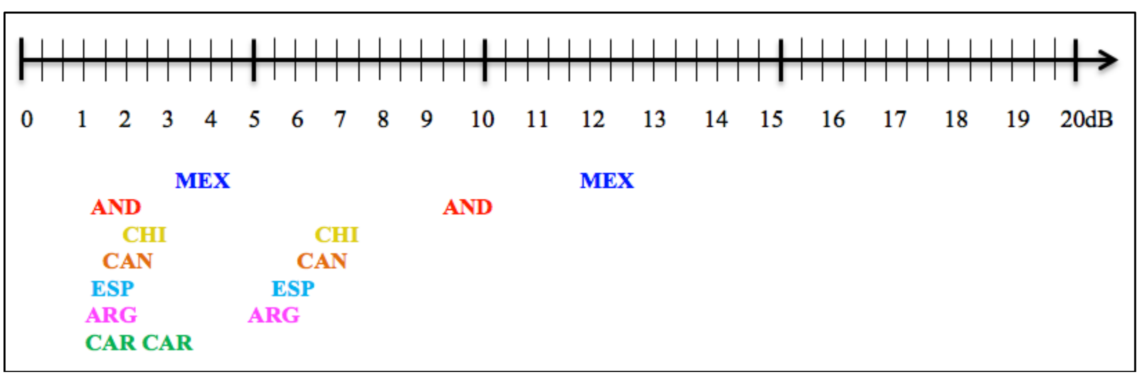

Figure 4.1. Visual representation of average RI values in dB according to variety. Labels to the left represent /bdg/ and those to the right represent /ptk/.

It is noteworthy that not all varieties analyzed for this study pattern the same way, and that there is a significant degree of variation between each of the varieties. Four of the seven varieties use a similar decibel range to distinguish voiced and voiceless consonants, while other varieties either make a larger distinction (Mexican and Andean) or a smaller one (Caribbean). An important factor to consider, however, is the range of RI values obtained during data analysis. The /bdg/ values for Mexican and Andean Spanish do not overlap with those of /ptk/, indicating a complete phonological separation of the two stop consonant series. In addition, these two varieties present the largest range of RI values out of all of the regions analyzed. Of the remaining five varieties, all show slight overlap between the production of /bdg/ and /ptk/, and /bdg/ and /ptk/ in the Caribbean variety almost completely overlap in their stop consonant productions. In all seven varieties, however, the overall range of RI values for /ptk/ is greater than that of /bdg/, which is indicative of greater variability in the production of the voiceless stop consonants /ptk/ than that of voiced the stop consonants /bdg/. The increased range and greater variability in the production of /ptk/ tells us that among all of the varieties, and especially within each variety, the realization of /ptk/ is much more varied given the potential range of phonetic realizations available in different prosodic contexts: voiceless occlusive, voiced occlusive, voiced approximant and, in some extreme cases, deletion. These varied realizations can yield a much larger range of RI values than the phonetic outcomes of /bdg/ in intervocalic position, which can surface as voiced approximants or be elided.

For all varieties, the difference between the six phonemes in question, /ptkbdg/, is significant even though each variety does not treat them the same way. The most occluded segment overall varies: /k/ in Mexican and Andean Spanish, /t/ for Chilean, Peninsular and Caribbean Spanish, and /p/ for Canarian and Argentinian Spanish. The least occluded segment is the dental segment /d/ in all varieties except Canarian and Argentinian Spanish. Given the mixed results yielded when each phoneme is considered individually across the seven varieties, the data becomes a bit clearer if we conflate the phoneme groups to consider point of articulation as an independent variable: bilabial segments /pb/, dental segments /td/ and velar segments /kg/. As mentioned in the previous chapter, in section 3.1.3, point of articulation is a statistically significant variable for RI in all regions except the Canary Islands and Argentina. In all varieties except the Canary Islands, which is excluded by a very negligible margin, the velar segment exhibits the highest degree of occlusion, as evidenced by its higher RI values when compared with bilabial and dental segments. With respect to the point of articulation that experiences the greatest degree of weakening, the results are mixed: Mexican, Andean and Chilean Spanish show that the bilabial segments have the lowest mean RI values, whereas in Peninsular, Argentinian and Caribbean Spanish, the dental segments have the lowest mean RI values. What we notice again here concerning the point of articulation, just as I have commented previously regarding differences of sonority and phoneme according to region, is that different regions appear to treat point of articulation differently with respect to RI. This regional differentiation tells us that the linguistic and extralinguistic factors that are shown to play a role in consonant lenition do not necessarily affect consonant lenition the same way in different regions. More about these implications and possible effects of word frequency will be discussed in an upcoming section on the implications of the first research question. It is important to mention that the claims made here apply to the current data set, and in order to extrapolate this to the general population, more data would be needed.

Concerning lexical stress, mean RI values for stop consonants in tonic syllables are higher than those in atonic syllables, except in the Caribbean variety, where RI values for voiced and voiceless stops exhibit extreme overlap. This finding is only significant, however, for four of the seven varieties investigated using this data set: Andes, Chile, Canary Islands and Spain. In addition to lexical stress, prosodically strong positions, such as word-initial, tend to experience lower rates of consonant weakening than prosodically weaker positions, such as word-internal. Although mean RI values for all varieties except Mexican Spanish show that stop consonants in word-initial position are more occluded than those in word-internal position, the current data set reveals that this result is only statistically significant in four of the seven varieties investigated: Andes, Chile, Canary Islands and the Caribbean. It is noteworthy that the first three of these four varieties also show statistically significant results for lexical stress, indicating similarities among their treatment of stop consonants according to both independent variables of lexical stress and prosodic position.

4.2.1.2 Percent voicing

Given the inherent nature of the voiced and voiceless stop consonant series, the second acoustic correlate used for analysis in this study only pertains to the voiceless /ptk/. Since /bdɡ/ are by nature voiced segments, their %V values are all 100% voiced; therefore, the purpose of including %V for this analysis is to determine what percentage of tokens of /ptk/ also show surface voicing despite being underlyingly voiceless. As mentioned in Chapter 2, section 2.7, on acoustic variables, the process for determining %V of /ptk/ for the purposes of this study uses a 60%V threshold, in agreement with previous work that uses a similar approach (Hualde, Simonet & Nadeu 2011; O’Neill 2010; Torreira & Ernestus 2011). %V values at or above this threshold are considered partially/fully voiced, whereas %V values below the 60%V threshold are considered non-voiced. As part of the data analysis process, I originally coded the data for the exact %V of the duration of each voiceless segment without the use of the threshold. However, during the analysis, it became evident that more than 83% of the /ptk/ tokens showed either 0%V or 100%V, ultimately affecting the overall %V results. Therefore, in an effort to avoid using skewed and poorly distributed data, I decided that employing a threshold to divide the tokens into two groups: non-voiced vs. partially/fully voiced would allow for a clearer picture of the %V data overall. Therefore, all %V data for /ptk/ is binary, and the analysis used to investigate the effects of the independent variables are proportional in nature, showing the proportion of partially/fully voiced tokens of /ptk/ to those that are non-voiced.

The %V differences collected during data analysis are statistically significant between all regions investigated for this study. It is noteworthy, however, that the productions of /ptk/ in Argentina, the Caribbean, Spain and Chile are partially/fully voiced in more than 65% of cases, whereas the voiced realizations of /ptk/ in Mexican, Andean and Canarian Spanish do not even reach 40%. The highest degree of %V of /ptk/ is found for Chilean Spanish, at 86%V, which is a new finding presented by this study, given that, to my knowledge, previous work has not explored surface voicing of /ptk/ in Chilean Spanish. When analyzing the data, it became evident very quickly that /ptk/ are realized as voiced approximants in intervocalic position without any closure duration and that voiced consonants /bdg/ are, for the most part, elided. While the presence of intervocalic voicing of /ptk/ is of particular interest to the current study, in order to determine those varieties that are inciting change, it is also important to identify those varieties that have appeared to guard the more traditional distribution of stop consonants in Spanish, namely the Andean and

Mexican varieties. While the analysis of Andean and Mexican Spanish show some voicing of intervocalic /ptk/, these varieties are at a much earlier state of change than the varieties mentioned in the previous paragraph, where %V is well over 50%. This is supported by previous work on Colombian highland Spanish (Lewis 2001) and Mexican Spanish (Lavoie 2001). In addition to having low proportions of voiced productions of /ptk/, these two varieties also show a greater RI difference, as discussed in the previous section.

Point of articulation does have a significant effect on %V for three of the seven varieties investigated in this data set: Mexico, Argentina and the Caribbean. This is surprising given the fact that point of articulation is a significant variable for RI in five of the seven varieties, only one of which—Mexico—shows significance for both RI and %V. We would hope that the relative order for point of articulation, then, would be consistent for RI and %V; however, this is not the case. %V values in Argentina show that the bilabial segment /p/ is the least often voiced, while the velar is most often produced with partial/full voicing. For the Caribbean Spanish data analyzed, the bilabial segment /p/ is the one most often realized with voicing, whereas the velar /k/ is least often produced with surface voicing. The velar segment also has the highest RI values. The Argentinian and Caribbean varieties show the exact opposite pattern, and the results for these two respective varieties are statistically significant. Mexico is similar to the Caribbean variety in the sense that bilabial /p/ is the segment most likely to experience surface voicing; however, the dental /t/ is the one least likely to experience surface voicing, at only 27.9%. This result is statistically significant. The point of articulation results yielded by the current data set for RI in Mexican Spanish do not align with the %V data in this region, just as we have seen with Argentinian and Caribbean Spanish. Therefore, it appears that there is not a correlation between RI values and %V proportions since we would have expected that lower RI values would predict more open, vowel-like consonant productions and, as a result, see a higher percentage of /ptk/ tokens realized with partial/full voicing.

The linguistic variables of lexical stress and prosodic position were also expected to play a role in the proportion of /ptk/ tokens with partial/full voicing. Results of the data analysis show that lexical stress is not a significant predictor of whether a voiceless stop will be realized with surface voicing. In fact, this variable is not statistically significant for any of the regions analyzed for this study given that the raw data shows mixed results. Mexican, Andean and Chilean Spanish show a tendency for stops in atonic position to have higher proportions of voiced realizations, whereas the Spanish of the Canary Islands, Spain, Argentina and the Caribbean show the opposite: stops in tonic position tend to produce more voiced realizations. Prosodic position also does not yield statistically significant results in any of the seven regions, even though all regions trend toward the same pattern: stops in initial position are more likely to be produced with surface voicing. It is important to note that the conclusions discussed here are based on the data extracted from this particular corpus, and in order to make broader generalizations about these Spanish populations as a whole, an expansion of this study would be necessary.

The previous two sections review the main findings for the two acoustic correlates used in this study to investigate consonant lenition: RI and %V and, how they are affected by the independent variables of sonority, phoneme, point of articulation, lexical stress, and prosodic position. Overall, my results show that /ptk/ and /bdg/ remain distinct phonological categories in all of the varieties studied here, with a high degree of overlap between these two stop consonant series in Caribbean Spanish. Point of articulation is a significant variable that affects the degree of consonant lenition as well as the proportion of %V of /ptk/ differently in different Spanish regions. The linguistic variables of lexical stress and prosodic position do not have a significant effect on %V for any of the regions; however, they do significantly affect the RI for some regions where stop consonants in prosodically strong positions, such as the onset of tonic syllables or word-initial position, have higher RI values than those in the onset of atonic syllables or in word-internal position.

4.2.2 Implications of findings

The linguistic factors investigated show significant effects on consonant lenition in multiple varieties of Spanish; however, not all of the variables were significant for each of the Spanish varieties investigated. Overall, the voiceless segments /ptk/ are more occluded than voiced segments /bdg/ in all seven varieties, which is consistent with results from Colantoni & Marinescu (2010) for Argentine Spanish. Region is a statistically significant independent variable that contributes to the degree of separation between /ptk/ and /bdg/ in different Spanish varieties that few to no studies have investigated. Carrasco, Hualde & Simonet (2012) compare consonant lenition of /bdg/ in Costa Rican Spanish with Madrid Spanish, and Lewis (2001) contrasts /ptk/ in Colombian Spanish and a Peninsular dialect (Bilbao) to comment on consonant lenition phenomena in different varieties of Spanish. Lewis (2001) finds that Peninsular Spanish produces more lenited forms than Colombian Spanish, and Carrasco, Hualde & Simonet (2012) find differing treatment in consonant weakening of /bdg/ in Costa Rican and Madrid Spanish, depending on the preceding segment. Therefore, my study expands on previous work on regional differences of consonant lenition phenomena by comparing both voiceless /ptk/ and voiced /bdg/ across multiple varieties of Spanish. My results show that Mexico and the Andean region exhibit a much greater degree of separation between the voiceless and voiced consonants, clearly maintaining the voiceless vs. voiced phonological distinction, which is characteristic of the traditional distribution of Spanish stop consonants (Harris 1969; Hualde 1989; Lozano 1978; Mascaró 1984). However, while the other varieties—Canarian, Peninsular, Chilean, Argentinian and Caribbean—still show two distinct phonemic categories, the degree of separation between /pkt/ and /bdg/ is smaller, and there are more instances of overlap and surface voicing of underlying /ptk/. As discussed in Chapter 1, Martinet (1952) and Penny (1991) refer to historical changes in the consonantal system of Spanish as chain reactions used to maintain previous distinctions of the Latin consonant system, where voiceless geminate stops simplified to intervocalic voiceless stops (/ppttkk/ > /ptk/), which, in turn, encouraged the previously voiceless stops to become voiced (/ptk/ > /bdg/). In order to avoid merger, the originally voiced segments became fricatives (/bdg/ > /βðɣ/). In Old Spanish, voiced stops /bdg/ remained phonemically distinct from voiced fricatives /βðɣ/ in many positions. However, neutralization of the phonetic realizations of /bdg/ and /βðɣ/ began to occur first at the beginning of a word, where voiced stops and voiced fricatives were indistinguishable when preceded by a pause or a nasal and were completely neutralized in all contexts by the fifteenth century (Penny 1991; Walsh 1991). If we consider phonetic overlap of the realizations of /ptk/ and /bdg/ to be an innovative phenomenon, which could potentially lead to consonant recategorization of specific lexical items (Hualde, Simonet & Nadeu 2011), it becomes evident that the variation shown by the varieties analyzed for this study are either more conservative or more innovative since certain varieties have higher degrees of overlap between /ptk/ and /bdg/. The high degree of voiced-voiceless overlap that is shown to occur within Caribbean Spanish in the current data set as well as the overlap between Caribbean /ptk/ and Mexican /bdg/ has important implications for stop consonant perception and communication, both within varieties as well as across different varieties. More about a perceptual approach to analyzing stop consonant lenition will be revisited in this chapter's section on directions for future research.

The treatment of the six phonemes investigated is different for each variety, which is further evidence that speakers of different regions do not show the same patterns according to phoneme. Point of articulation is also a statistically significant variable; however, the treatment of bilabial, dental and velar segments is not consistent across varieties. This result is especially noteworthy given that previous research on the effects of point of articulation on stop consonant weakening does not show significant results for RI (Lewis 2001). However, Colantoni & Marinescu (2010) find the highest degree of lenition for dental stops and Carrasco, Hualde & Simonet (2012) find that, in Costa Rican Spanish, /g/ is weaker than /b/ and /d/ in postconsonantal position, but not in postvocalic position, where /g/ is stronger. One contributing factor to the increased lenition of /d/ is its susceptibility to weakening in words ending with *-a**d**o*, for example, which has been investigated by Eddington (2011). He finds that when /ð/[16] appears in past participle suffixes, such as *-ado*, *-ada, -ados, -adas*, it is more highly lenited and often deleted, in agreement with Bybee (2001, 2002), who investigates lenition in high frequency words. Along these lines, it is noteworthy that the Map Task dialogue performed by the participants as part of the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013) lends itself to numerous occurrences of /d/ between vowels in internal, atonic position, e.g. *la**d**o* 'side', *to**d**o* 'all' or *Santa*

[16] Eddington (2011) identifies /βðɣ/ as the underlying segment as opposed to /bdg/ used by other scholars.

*Cándi**d**a* ‘Saint Innocent’. In many of these cases, /d/ is completely weakened to the point of elision.

Lexical stress and prosodic position only exhibit statistically significant results in some of the varieties investigated. In the current data set, lexical stress is significant for the Andean region, Chile, the Canary Islands and Spain, where stop consonants in atonic position experience higher degrees of consonant weakening as evidenced by their lower RI values. Prosodic position is significant for the Andean region, Chile, the Canary Islands and the Caribbean, where stop consonants in word-internal position experience higher degrees of consonant weakening given their lower RI values as well. As discussed in Chapter 1, previous research based primarily on scripted speech shows that stop consonants in lexically stressed syllables exhibit greater prominence and higher degrees of consonant occlusion (Browman & Goldstein 1992; Cho, McQueen & Cox 2006; Gili Fivela et al. 2008; Keating et al. 2003). This is also true of Spanish in both scripted and unscripted speech (Carrasco, Hualde & Simonet 2012; Colantoni & Marinescu 2010; Cole et al. 1999; Hualde, Simonet & Nadeu 2011; Ortega Llebaria 2004). However, Lewis (2001) finds less contrast between prosodically strong positions and those that are prosodically weak in less formal, unscripted speech. Lewis (2001:162) comments on the RI differences of V1-C (preceding vowel + consonant) and V2-C (consonant + following vowel) environments:

> In unusually careful speech, in which syllabic boundaries are clearly marked, the difference between the V1-C and V2-C values would always be strongly significant. In less formal speech, however, values associated with V1-C and V2-C begin to resemble one another, indicating that a consonant has lost its syllabic affiliation, which is taken to be evidence of lenition or weakening. By maintaining a larger disparity between the intensity values associated with a consonant and the following vowel, as opposed to a preceding vowel, a consonant is incorporated into syllable

> structure as an onset and is consequently strengthened in the sense that it is protected by its incorporation into CV structure (Lewis 2001:162).

Speech style (e.g., scripted vs. unscripted speech) is not a direct predictor of speech rate; however, scholars often use different speech styles in order to indirectly elicit different rates of speech. For example, speakers completing a reading task would be expected to speak slower and pay more attention to their speech than those who complete a more informal interview (Kirchner 2004; Lewis 2001). Soler & Romero (1999:483) control for two different speech rates, asking their participants to produce words within a carrier phrase using “Harris’s (1992) ‘alegretto’, that is, a moderately fast, colloquial way of speaking, while the other rate is very slow and extremely precise”. They find a clear effect of rate of speech on both the duration as well as the degree of constriction of stop closures. The fact that the current data set is comprised of tokens extracted from a task where speakers interact with each other could be a contributing factor to the neutralization of RI values according to lexical stress and prosodic position. Given the increased speech rate and comfortability of the participants, this task allowed for elicitation of more natural, semi-spontaneous speech. My data shows that neither lexical stress nor prosodic position has a significant effect on the degree of weakening experienced by stop consonants in Mexican and Argentinian Spanish. The lack of statistically significant results for these two varieties, however, is still an important outcome since it reveals that these two factors do not contribute to voicing of an underlyingly voiceless stop. In this case, a negative result is a result nonetheless. The fact that this study investigates consonant lenition of semi-spontaneous, interaction-based data, as opposed to scripted, laboratory speech, suggests that perhaps lexical stress and prosodic position experience neutralization in natural, semi-spontaneous speech in some varieties.

The varieties that show high degrees of voicing of the consonants /ptk/ in the current data set are Chile, Argentina, the Caribbean and Spain. This result is not surprising for Peninsular Spanish, since other scholars have found similar results with high degrees of surface voicing of /ptk/ (Hualde, Simonet & Nadeu 2011; Lewis 2001; Martínez Celdrán 2009; Torreblanca 1976). In addition, we might have expected that the Caribbean variety analyzed here, from San Juan, Puerto Rico, also would show a high degree of lenition given Guitart's (1978) analysis of Havana Spanish, where voicing of /ptk/ is particularly frequent. However, the high %V that the current analysis finds for Argentinian Spanish is contradictory to Colantoni & Marinescu (2010), which does not find any evidence for intervocalic voicing of /ptk/ in their data set. The speakers in Colantoni & Marinescu (2010), however, were all male. The data from the current set incorporates tokens for both males and females, and interestingly enough, the female Argentinian speakers produce 91.1% of their /ptk/ stops as partially/fully voiced, while the male speakers in my study do not quite reach half; only 47.3% of male /ptk/ tokens are partially/fully voiced. Canarian Spanish, on the other hand, does not show a high proportion of %V in the current data set, which is very peculiar considering that multiple scholars have found much higher rates of surface voicing for /ptk/ in this variety (Oftedal 1985; Trujillo 1980).

What we can conclude from the current data set, therefore, is that the Mexican and Andean speakers analyzed here are more conservative in their overall production of intervocalic stop consonants when compared with speakers of other varieties analyzed such as Caribbean, Chilean, and Peninsular Spanish. The Caribbean Spanish speakers in this data set produce the highest degree of lenition of /ptk/, where productions of /ptk/ greatly overlap with those of /bdg/.

4.2.3 Further Implications: Comparison to Pilot Study

As mentioned in the previous paragraphs, several studies show that higher degrees of consonant lenition occur in semi-spontaneous speech than in scripted speech (Hualde, Simonet & Nadeu 2011; Kirchner 2004; Lewis 2001; Soler & Romero 1999), which is more controlled and increases speakers' awareness of their productions. Despite my methodological choice to focus solely on semi-spontaneous speech, a quick comparison with the scripted, more controlled data collected from the pilot study outlined in Chapter 2 provides support for higher degrees of weakening in semi-spontaneous speech. Consider the following two figures, which compare the overall RI results from the pilot study (Figure 4.2) and those from the larger dissertation study (Figure 4.3). This comparison demonstrates that even though the patterns among the varieties are similar between the two speech styles (i.e., read speech vs. semi-spontaneous speech), the RI values for the pilot study are higher for all varieties investigated (Colombian, Mexican, Peruvian, North-Central Peninsular, Southern Peninsular/Insular and Chilean) than those for the dissertation (Mexican, Andean, Chilean, Canarian, Peninsular, Argentinian and Caribbean). For the pilot study, /bdg/ ranges from about 2-8dB and /ptk/ ranges from about 9-16dB, while for the dissertation, /bdg/ ranges from 1-4dB and /ptk/ ranges from 3-12dB. It is for this reason that I have included only an analysis of semi-spontaneous speech for the dissertation, since my ultimate goal is to determine how widespread consonant lenition is in the Spanish-speaking world in more *naturalistic, semi-spontaneous* speech.

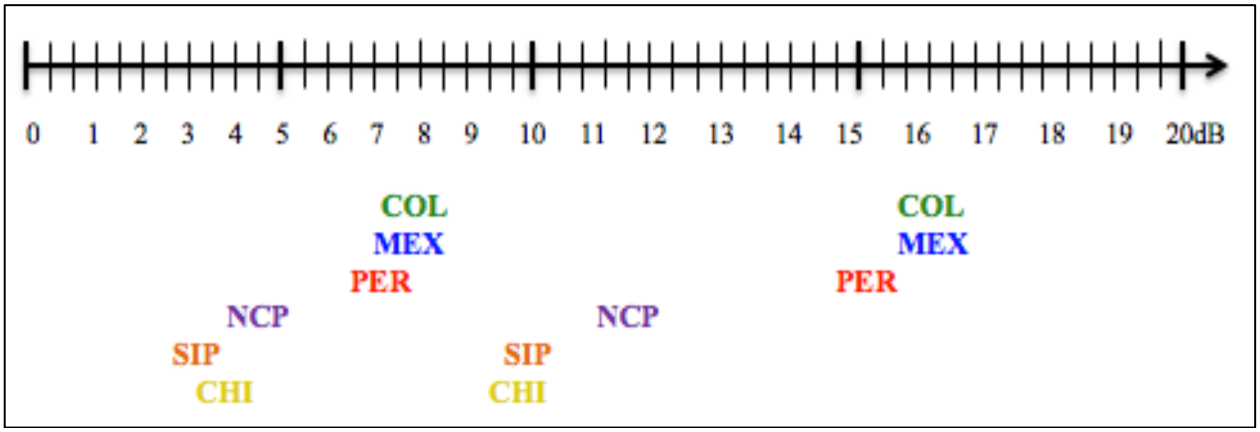

Figure 4.2. Visual representation of pilot study results of RI values for read speech.

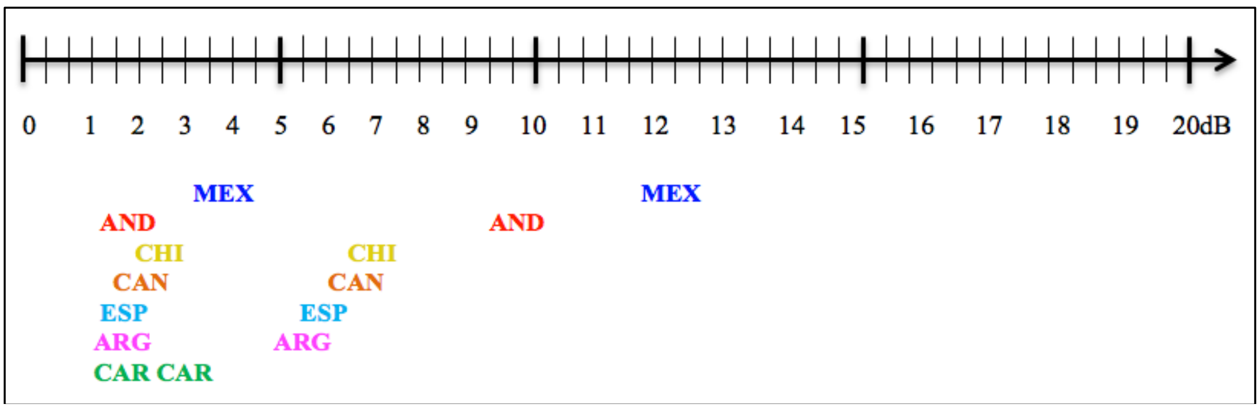

Figure 4.3. Visual representation of dissertation results of RI values for semi-spontaneous speech.

4.3 Research Question #2

4.3.1 Summary of findings

4.3.1.1 Relative intensity

The results of the RI analysis indicate that male speakers in this data set tend to produce stop consonants with lower RI values, which are indicative of more open, vowel-like stop productions; however, this tendency is not statistically significant. This trend holds true if we consider the stop consonant series separately: /ptk/ vs. /bdg/. Male speakers tend to produce both sets of stop consonants with lower RI values than female speakers. If, however, we consider separately each of the four regions where data for both genders is available, this trend is only true in two of the four varieties. In the Mexican and Peninsular Spanish analyzed for this study, male speakers tend to produce stop consonants with lower RI values, which are indicative of more open, vowel-like consonant productions, whereas in the data of the Canary Islands and Argentina, the opposite is true.

Only four of the seven regions analyzed for the current study have data available for members of both age groups: Mexico, Andes, Spain and Argentina, three of which are the same as the data for both genders (Mexico, Andes and Argentina). The data overall for these four regions shows that younger speakers produce lower RI values, or more open, vowel-like stop consonants, than older speakers. This trend still stands if we break down the consonants according to sonority, where RI values for both /ptk/ and /bdg/ show the same pattern: younger speakers produce lower RI values for both sets of stop consonants. This data, contrary to the age data, does yield some statistically significant results, but only for the voiced stop consonants /bdg/: younger speakers exhibit higher degrees of consonant weakening for /bdg/ than older speakers. Considering the data according to region, we notice that in the data from Mexico, Spain and Argentina, younger speakers tend to produce less occluded stop consonants than older speakers. In the Andean data, however, there appears to be no difference in the RI values for younger and older speakers. The results are only statistically significant for the Mexican Spanish data, where younger speakers exhibit less occluded stop consonants than older speakers. It is noteworthy that the token counts here are quite well distributed, with 103 tokens for younger speakers and 161 tokens for older speakers in the Mexican Spanish data. Combining the data from the two sociolinguistic variables of gender and age yields an interesting trend, although not statistically significant. Younger, male speakers are most likely to produce stop consonants with low RI values than older, female speakers, who are most likely to produce stop consonants with the highest RI values.

4.3.1.2 Percent voicing

With respect to the two sociolinguistic variables of gender and age, %V data does reveal some significant results. Here we notice that in three of the four regions where data for both genders is available —Argentina, the Canary Islands and Spain, female speakers tend to exhibit higher %V than male speakers. This is very peculiar since male speakers tend to have lower RI values overall. Given the fact that vowels are naturally voiced segments, we would expect lower RI values to correlate with higher %V proportions; that is, we would expect that male speakers would produce more voiced tokens of underlying /ptk/ if there were indeed an inverse correlation between RI and %V. However, this is only the case in the Mexican Spanish data, where male speakers tend to produce more voiced realizations of /ptk/ than female speakers, but these results are not significant. Of the three regions where females tend to have higher %V than males, only two of these are statistically significant: Argentina and the Canary Islands. The token counts for these two regions are relatively well distributed between male and female speakers.

Regarding the independent variable of age, statistical testing of the current data set shows that speakers at least 35-years-old tend to produce more voiced realizations of underlying /ptk/ than younger speakers below 30 years of age. Just as with the gender data, this is not what we would expect given that younger speakers exhibited lower RI values overall. In the four regions where data from both age groups is available for analysis—Mexico, the Andes, Spain and Argentina, the trends are split. Youngers speakers in Mexico and Spain have higher %V than older speakers; however, in Spain, this difference is only marginal (79.7% to 78.4%, respectively), and in Mexico, the difference is significant. In the Andean region and Argentina, the trends are inverted, where older speakers have higher %V than younger speakers; however, this result is only significant for the Andean region. Compared with the other independent variables analyzed for this study, it is noteworthy that this is the first time in the analysis where Mexico and the Andes seem to diverge since in nearly all of the other categories, these two regions seem to have very similar characteristics with respect to RI and %V. Taking into account age and gender for these four regions does not yield significant results. Overall, older female speakers exhibit the highest %V, whereas younger male speakers have the lowest %V, contrary to what we have noticed for RI, where the inverse is true. Of course, we must reiterate that these conclusions are based on the current data set only, and in order to apply this information to the general population, an expansion of the current study with more data would be necessary.

4.3.2 Implications of findings

The incorporation of the sociolinguistic variables of gender and age is a relatively new area of investigation regarding stop consonant lenition, and the results produced by the current analysis have proven to be merely a starting point of what will hopefully become a fruitful area of future investigation. Bayley & Tarone (2011), Cepeda (1991), Flores (2016), Labov (2001), Long (2014), and Oftedal (1985) have concluded that factors such as age and/or gender may play a role in consonant weakening and that weakening is not limited to members of only one age group or gender]. However, to my knowledge, no one has completed an acoustic analysis of both stop consonant series, /ptk/ and /bdg/, while taking into account both speaker age and gender. The sociolinguistic factors of gender and age yield mixed results, but nevertheless, offer insightful information about directions for future research. Gender is only a significant factor in the data from the Canary Islands and Argentina, where female speakers produce significantly more voiced tokens of underlying /ptk/ than male speakers. Age is a significant variable in the Mexican Spanish data, where younger speakers produce more lenited stop consonants with lower RI values and more voiced tokens of underlying /ptk/. This conclusion seems to fit our expectation that lower RI values for /bdg/ and /ptk/ in younger speakers overall would correlate with increased instances of surface /ptk/ voicing. Although not a significant variable for all of the varieties investigated in this study, age does play a role in stop consonant lenition, in particular, surface voicing of /ptk/ in the Mexican Spanish data, which could be indicative of a change in progress. Since older speakers have higher RI values coupled with lower proportions of %V compared with the lower RI values and higher proportions of %V for younger speakers, more investigation is needed in this area to see if there is progress towards more lenited consonant productions among younger Mexican speakers. Age is also a significant variable in the Andean Spanish data for %V; however, in this variety older speakers produce more voiced realizations of underlying /ptk/, despite their relatively high RI values. Recall that in his study of Canary Island Spanish, Oftedal (1985) reports that both younger and older speakers produce high degrees voicing of underlyingly voiceless stops /ptk/, with higher rates occurring among younger speakers. Long (2014) finds that younger speakers ages 14-29 and male speakers show preference for the deleted variant of /g/ when compared to older, female speakers. The conclusions from my data expand on the sociolinguistic analyses of Long (2014) and Poblete (1995) of Caracas (Venezuela) and Valdivia (Chile) Spanish by offering gender and age data for four additional Spanish varieties: Mexico, Spain, Canary Islands, and Argentina, and the results confirm that male speakers and younger speakers tend to favor more weakened variants.

These sociolinguistic results are not only relevant for synchronic evidence of language variation, but also for diachronic language variation and change since we can observe consonant weakening through time by studying speakers of different ages in order to determine the direction of consonant change. If we think about stop consonants that are more open and vowel-like as being innovative, then young, male speakers in this study are the innovators of the change, whereas older, female speakers are the conservationists that guard a more highly occluded production of stop consonants. The results produced by the current data set can speak to innovation and change driven by certain social groups, i.e. younger speakers and male speakers. Silva-Corvalán (2001: 243) states: "[U]no de los principios básicos de la sociolingüística histórica es que no es posible comprender el desarrollo de un cambio lingüístico fuera de la estructura social de la comunidad en la que ocurre."[17] Silva-Corvalán (2001:250) comments on gender, age and social class as sociolinguistic factors that contribute to linguistic variation, more specifically, that women tend to use linguistic variants that are considered to be of higher prestige, more conservative or more "standard" variants than men. Women self-correct more frequently in formal styles, a conclusion that is confirmed by studies such as Valdivieso and Magaña (1991) on the aspiration of /s/ in Chilean Spanish. In addition, preference for certain variants by members of a specific age group, such as younger speakers of the Mexican Spanish data producing more voiced realizations of /ptk/, could be indicative of change occurring from

[17] One of the basic principles of historical sociolinguistics is that it is not possible to understand the development of a linguistic change outside of the social structure of the community in which it occurs (Silva-Corvalán 2001: 243) [my translation].

the top down. In other words, speakers have conscious awareness of linguistic variants and the social advantages that they might have based on their selection of more prestigious variants, which is common among speakers aged 25-50 years who are established in their professional life and in their community (Silva-Corvalán 2001). Change may also occur from the bottom up, where speakers are unaware of changes occurring that are initiated first in conversational style due to internal linguistic factors and are, at times, linked to socioeconomic status (Labov 1994; Silva-Corvalán 2001). The results of the sociolinguistic data in my analysis show the possibility of change toward less occluded stop consonants by younger speakers and male speakers, a result that merits further investigation with more speakers from more regions.

The sociolinguistic variable of region has proven to be a significant factor for consonant lenition. The different regions investigated as part of this analysis treat the two consonant series, voiced /bdg/ vs. voiceless /ptk/, differently. Some varieties, namely the Mexican and Andean data from the current set, show less consonant weakening when compared with the other five varieties. This conclusion is a considerable expansion on the work on consonant deletion in different varieties of Spanish by Lewis (2001) and Carrasco, Hualde & Simonet (2012). In addition, Caribbean Spanish shows a very high degree of consonant weakening, in agreement with Guitart (1978), almost to the point of neutralization between voiceless /ptk/ and voiced /bdg/. These results further support the lenition continuum hypothesis proposed by this study, where certain Spanish varieties experience high degrees of consonant weakening while others are quite conservative in their consonant production, clearly maintaining the two distinct phoneme series with minimal overlap. Given that the lenition continuum is strongly linked to the third research question of this dissertation, it will be discussed in greater detail in the next section of this chapter. In this final section, I will discuss how synchronic stop consonant lenition can shed light on diachronic stop consonant lenition through our understanding of the lenition continuum, and how different Spanish varieties are placed on this continuum, ranging from more conservative varieties with lower degrees of consonant weakening to more innovative varieties with high degrees of consonant weakening and overlap between voiced and voiceless stop consonants.

4.4 Research Question #3

4.4.1 Summary of findings

Using the results from the synchronic analysis, I am able to build an acoustically grounded continuum of synchronic consonant lenition, from conservative to innovative, on which I can place the different varieties of Spanish investigated, thus allowing me to respond to the third research question proposed by my dissertation. Those varieties that show lesser degrees of consonant weakening, that is, lower RI values and lower proportions of %V, such as Mexican and Andean Spanish, exhibit consonant productions that are closer to the traditional description of the allophonic distribution of the voiced and voiceless phoneme series in Spanish (Harris 1969; Hualde 1989; Lozano 1978; Mascaró 1984). In this traditional description, voiceless /ptk/ are realized as the voiceless allophones [pt̪k], and voiced consonants /bdg/ are realized as voiced approximants [βðɣ], most notably in intervocalic position. On the other hand, those varieties that show higher degrees of consonant weakening, that is, higher RI values, higher proportions of %V and more overlap between the productions of /ptk/ and /bdg/, such as Caribbean Spanish, exhibit consonant productions that are further from the aforementioned traditional description. The continuum that I propose in Figure 4.4 uses the results of the acoustic analysis to arrange the seven Spanish varieties investigated for this dissertation according to their relative degree of consonant weakening. The conservative varieties, which exhibit more occluded productions, are placed on the left side of the continuum, and the innovative or radical varieties, which exhibit more open, vowel-like productions—in some cases to the point of total loss, are placed on the right side of the continuum.

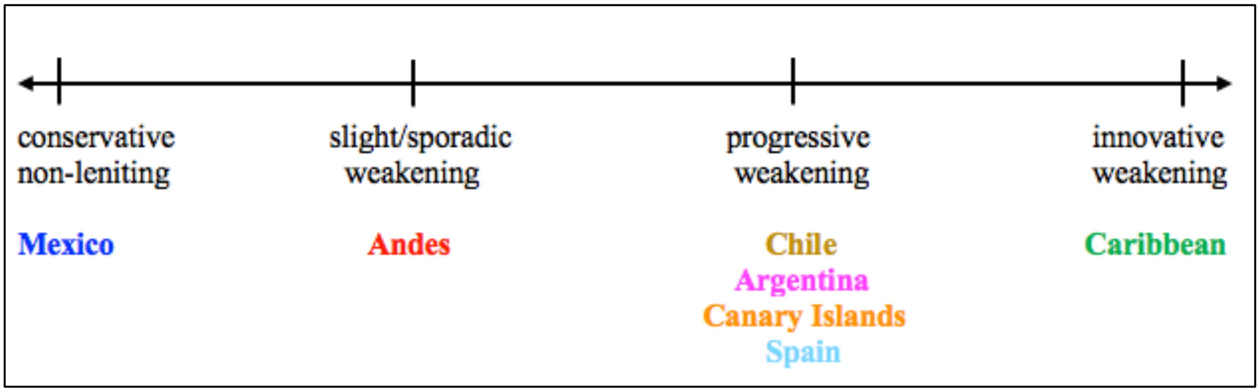

Figure 4.4. Proposed lenition continuum based on the results of this dissertation.

4.4.2 Implications

The continuum presented in Figure 4.4 cannot be completely applied to previous historical contexts given that the sociopolitical and economic situations in each of these regions were quite different centuries ago. Newer types of language contact and multiple levels of bilingualism at various stages have been introduced to communities of researchers in recent years, all of which cannot be addressed through use of synchronic data. However, presenting a synchronic continuum of language variation does have important implications for how we understand language change *processes* through time by looking at the various factors that intertwine to produce such extensive variation from one variety to the next. In other words, acoustically analyzed synchronic data sheds light on processes that could drive diachronic language change by helping us create a present-day model to show how linguistic and extralinguistic factors play a role in consonant lenition variation and to compare it to similar consonant lenition variation of centuries past. Synchronic analysis takes a snapshot of stop consonant variation at one point in time, and through a comparison of synchronic data with what we know about historical stop consonant variation across the Romance languages, we can begin to understand how both linguistic and extralinguistic factors, in addition to possible social, economic and political factors and situations of language contact and bilingualism could have contributed to the phonetic and phonological diversification of the Romance languages (Labov 1972, 1974). If we consider stop consonant lenition in Romance from a historical perspective, we notice that not only do stop consonants have different phonological outcomes in different Romance languages, but also that there are different outcomes with respect to point of articulation. That is, bilabials, dentals and velars do not have the same treatment across varieties or within the same variety, both diachronically and synchronically (Cravens 2002). Let us consider the information in Table 4.1, which incorporates examples from Boyd-Bowman (1954, 1980). Italian seems to have experienced minimal consonant change in its development from Latin, where intervocalic stop consonants such as /p/, /t/, and /d/ are preserved. French, on the other hand, has experienced high degrees of fricativization and loss, two processes involved in consonant lenition (Cravens 2002; Wireback 1997). It is important to mention that these changes, which phonologically fossilized centuries ago, are not likely to experience orthographic changes of the type *taco* > *tago* 'taco' or *vida* > *vía* 'life' in Chilean Spanish (Hualde, Simonet & Nadeu 2011). However, the lack of orthographic and phonological change in present-day Spanish does not mean that surface deletion is not occurring regularly at the phonetic level in some Spanish varieties (Colantoni & Marinescu 2010; Cole et al. 1999; Hualde, Simonet & Nadeu 2011; Lewis 2001; Long 2014;

Martínez Celdrán 1984; Oftedal 1985; O'Neill 2010; Torreira & Ernestus 2011; Trujillo 1980 among others).

Voiceless Stops /ptk/			**Voiced Stops / bdg/**		
RĪPA	*It.* ripa *Sp.* riba *Pt.* riba *Fr.* rive	p = p p > β p > b p > v	PROBĀRE	*It.* provare *Sp.* probar *Pt.* provar *Fr.* prouver	b > v b > β b > v b > v
VĪTA	*It.* vita *Sp.* vida *Pt.* vida *Fr.* vie	t = t t > ð t > d t > Ø	VEDERE	*It.* vedere *Sp.* ver *Pt.* ver *Fr.* voir	d = d d > Ø d > Ø d > Ø
PLACĒRE	*It.* piacere *Sp.* placer *Pt.* prazer *Fr.* plaisir	k > tʃ k > θ/s k > z k > z	RĒGĪNA	*It.* reina *Sp.* reina *Pt.* rainha *Fr.* reine	g > Ø g > Ø g > Ø g > Ø

Table 4.1. Romance outcomes of Latin stop consonants.

If we consider historical consonant lenition from Table 4.1 alongside the synchronic stop consonant variation present in Modern Spanish, we can see how language change becomes possible due to the way the independent variables interact with one another in each of the regions investigated, yielding either more occluded or more lenited stop consonant productions. Consonant lenition is not, however, the only process that has occurred in Romance languages; other phonological features have produced a wide range of variability across different varieties. Consider the development of the vowel systems of Portuguese and French, which include various nasal vowel phonemes that do not exist in Spanish or Italian, or perhaps the development of the affricate phonemes /ts/, /dz/, /tʃ/, /dʒ/ of Spanish, French, and Portuguese, which all became fricatives with the exception of the Spanish /tʃ/ and in some cases, the Portuguese /tʃ/. We can use the results of the synchronic data analysis from the present study to draw a parallel between the phonological and phonetic variation that exists today both interdialectally and cross-linguistically for Romance languages with the variation that existed in the past. The primary conclusion, therefore, is that consonant lenition variation depends greatly on interactions between linguistic and sociolinguistic factors both in a present as well as a historical context.

The allophonic variation experienced by a particular stop consonant at any one time ranges greatly depending on various linguistic and sociolinguistic factors, as I have shown in the previous sections of this chapter. Lewis (2001:11) presents the diagram in Figure 4.5, which illustrates the phonetic implementation of stop consonants in intervocalic position as a result of lenition processes. As we see from the diagram, the voiceless stops /ptk/, depending on the various independent variables that affect consonant lenition, may surface as voiceless stops [pt̪k], voiced stops [bd̪g], voiced fricatives [βðɣ] or voiced approximants [β̞ð̞ɣ̞]. Likewise, the voiced stops /bdg/ may surface as voiced stops [bd̪g], voiced fricatives [βðɣ], voiced approximants [β̞ð̞ɣ̞] or suffer complete elision [∅]. We see that due to this variation, the surface realizations of the two stop consonant series have potential for overlap, which has been shown through the acoustic analyses in the present study. In some varieties, this overlap is more extensive than in others.

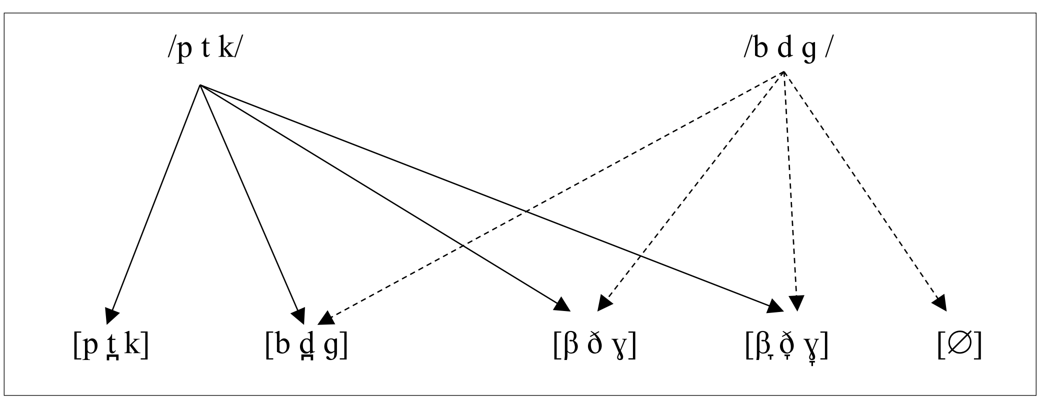

Figure 4.5. Phonetic implementation of intervocalic stops in Modern Spanish as a result of lenition processes (Lewis 2001:11).

What may seem like a very clear and organized pattern of systematic chain-shifts identified by Martinet (1952), are not, in fact, changes operating in a chain where consonant weakening works in tandem among the different members of the voiceless and voiced stop consonant series. Rather, what we can infer from the acoustic analysis of synchronic stop consonant variation is that stop consonant variation in present-day Spanish does not fit the mold, so to speak, of the traditional distribution of stop consonant realizations. The changes that do occur represent a series of more complex processes acting at different intensities and rates in different regions, even though they appear on the surface to be elaborately linked. We can conclude, therefore, from this study that traditional descriptions of allophonic distribution are not entirely complete, since the acoustic analysis of stop consonant production across multiple varieties of Spanish taking into account a variety of linguistic and extralinguistic factors shows a much larger range of variation, both within and among different Spanish varieties.

The synchronic variation of stop consonant production found in Spanish may also have important implications for the study of geminate consonant productions in Italian. Certain varieties of Italian have been reported to exhibit preaspiration before the consonant closure, such as *fatto* 'done' [fahto], and a shorter closure duration than geminates without preaspiration, which puts into question whether preaspiration could be indicative of consonant weakening of /ppttkk/ in Sienese Italian (Stevens & Hajek 2007). This potential lenition of geminate consonants is coupled with the phenomenon known as *la gorgia Toscana*, which is identified by Canalis (2013), Cravens (2002), and Giannelli (2000), among others, as the spirantization of voiceless stops in Tuscany, where /ptk/ surface as [hθɸ], respectively, in weak positions (Giannelli 2000:26). Just as voiceless singleton consonants in Tuscany have been affected by lenition processes, studies such as Payne (2005), Stevens (2011), and Stevens & Hajek (2007) show that the geminates of this same region are also being affected. This research on consonant lenition in another Romance language strengthens both the diachronic and variationist aspects of my study by highlighting synchronic stop consonant variation in what is traditionally viewed as a more conservative Romance variety as well as how phonetic variation (e.g., consonant lenition) of one level of the phonological system (e.g., voiceless singleton occlusives /ptk/) can potentially correlate—although not necessarily—with phonetic variation developments in other levels (e.g., voiceless geminate occlusives /ppttkk/).

As scholars such as Lewis (2001), Machuca-Ayuso (1997), Oftedal (1985), and Torreblanca (1976) have suggested, consonant weakening is not a binary phenomenon, but rather a gradient scale of more occluded to more lenited variants that depend on structural, linguistic and extralinguistic factors. When comparing the body of relevant previous research to the current study, we note that the latter expands upon the former not only through its wide range of data and independent variables, but also through its commentary on the past through the use of present-day Spanish data, or what William Labov (1974) refers to as “On the use of the present to explain the past.” It has become clear that despite the underlying phonological structure of Spanish, high degrees of variation of allophonic weakening in semi-spontaneous speech are present in many Spanish varieties today, and this variation depends on a variety of linguistic and extralinguistic factors.

4.5 Concluding Remarks

4.5.1 Contributions

This study represents a novel approach to the study of stop consonant lenition for a number of reasons. Through the use of acoustic and statistical analyses of Spanish stop consonants, I have identified the effects (or lack thereof) of several independent variables, both linguistic and extralinguistic, on stop consonant lenition in seven varieties of Spanish to determine the degree of consonant lenition using the acoustic correlates of RI and %V. Unlike previous research on consonant lenition, my study compares several varieties of Spanish within the same study using data extracted from a corpus that was carried out using the same methodological procedures for all participants. In addition, my study compares both stop series within the same study, which is a difficult task due to the voiced and voiceless nature of the stops and the lack of acoustic correlates available to look at both stop series at the same time. I have also expanded on previous research on stop consonant lenition in Spanish by looking at the sociolinguistic variables of gender and age in multiple varieties of Spanish. The culmination of the current analysis is the placement of different Spanish varieties on a synchronic lenition continuum that ranges from more conservative varieties with lower degrees of consonant lenition, to more innovative, radical varieties, which exhibit high degrees of consonant lenition and voicing of underlyingly voiced stops. This lenition continuum is evidence that the interactions of various linguistic and extralinguistic factors play a role in the degree of weakening found in a particular variety of Spanish. Finally, my dissertation makes suggestive points regarding the processes of diachronic consonant lenition by showing that synchronic consonant lenition variation can be used as evidence that similar consonant variation occurred historically across Romance languages. The following sections present some limitations of this study, which, in turn, hope to inspire directions for future research.

4.5.2 Limitations

As with many empirical linguistic studies, data analysis using semi-spontaneous speech extracted from a corpus does not come without limitations. I chose to use an already well-established corpus for data analysis, the *Atlas interactivo de la entonación del español* (Prieto & Roseano 2009-2013). As I mentioned previously in Section 2.3, the regional divisions of the corpus data (Mexico, Andes, Caribbean, Argentina, Chile, Spain, and Canary Islands) are problematic in that dialectological work shows that identifying dialects according to seemingly arbitrary borders corresponding with specific countries could be misleading when considering specific features of a given variety. For example, considering the speech of Mexico or the Andes to be one singular "dialect" is troublesome since these areas are so vast, encompassing multiple varieties with distinctive features within one so-called "dialect." This is also true of smaller regions that have differing characteristics within a smaller area, such as the Canary Islands or the Caribbean. With the present study, the only Map Task data available for the Caribbean region was that of San Juan, Puerto Rico. Due to the limited availability of data for this region and my choice to include Caribbean Spanish in my overall results, my generalizations for the production of occlusive consonants in the Caribbean region as identified by the corpus authors are under the umbrella of Caribbean Spanish, but they are not necessarily indicative of Caribbean Spanish as a whole. However, this is a limitation that I chose to accept in my decision to use a pre-prepared corpus. While carrying out this study, it became clear that regional differences within a certain "dialect" could have potentially contributed to the overall outcome of the results. Therefore, when scholars prepare corpora for regional/dialectal analysis, it is very important to carefully consider the selection of locales and the subsequent grouping into "dialects" and/or regions. Regarding the corpus I used, it would perhaps be helpful to rename this region 'Puerto Rican Spanish' until more data from various locales across the Caribbean could be added.

In addition to the regional divisions of this corpus, the data available for analysis for my study is limited. Due to the varying lengths of the recordings I used for the analysis of stop consonants, the number of tokens for each variety analyzed is not well balanced in terms of total tokens or voiced vs. voiceless tokens. One region has only 160 available tokens (Canary Islands), while others have 500 or more (the Andes and Spain). The fact that the Canarian Spanish data does not pattern like any of the other varieties in terms of point of articulation could be due to relatively low token counts (bilabial = 48, dental = 59, velar = 53). Most of the other varieties analyzed have token counts close to or greater than 100 for each point of articulation. In addition to point of articulation, the Canarian Spanish data exhibits an unusually low proportion of voiced tokens of underlying /ptk/, which could also be due to low token counts in general. There were only a total of 89 /ptk/ tokens available for analysis; therefore, while my analysis shows that Canarian Spanish speakers only produce partially/fully voiced tokens 31% of the time, this must be considered with caution due to the distribution and availability of tokens. The limited availability of the analyzable data coupled with the complexity of possible interactions between all of the variables investigated resulted in running a series of Chi-square tests to test statistical significance. Despite their inability to report on interactions between independent variables, the Chi-square tests used here have been fruitful by shedding light on the individual effects of the independent and extralinguistic variables, an important starting point for this strand of research on consonant lenition variation and the relevant linguistic and extralinguistic variables that play a role in the degree of weakening present in each variety. Using this research as a point of departure, more sophisticated modelling of a larger, more balanced data set is an important next step to further our knowledge regarding possible interactions between variables and draw more definitive conclusions.

The data for each of the seven regions included in the corpus is also not well balanced for speaker age and gender; therefore, some regions only include data for female speakers (the Andes, the Caribbean, and Chile) while others include either younger speakers (the Caribbean) or older speakers (the Canary Islands and Chile), but not both. The distribution of tokens, at times, is not well balanced across individual speakers either; some speakers have as few as 12 tokens available for analysis, while others have more than 400. The number of male and female speakers available for analysis is limited to 20 female speakers (2,266 total tokens) and six male speakers (450 total tokens) that are not evenly distributed throughout the seven regions. Only four regions (Mexico, Canary Islands, Spain, and Argentina) have available data for both male and female speakers, and the tokens are not always well distributed within each region. For example, the Mexican data provides 32 tokens for males and 232 tokens for females, whereas the Argentinian data produces a very even distribution of 192 tokens for males and 186 tokens for females. My data shows that in Mexican Spanish, male speakers tend to produce more voiced realizations of /ptk/ than female speakers; however, for Mexican /ptk/ gender data, as previously mentioned, the imbalance of token counts is substantial. All of these factors, therefore, make accounting for gender very difficult and could have contributed greatly to the outcome of the results. However, beginning an investigation of gender as an independent sociolinguistic variable in the study of stop consonant lenition is an important step in the right direction and opens doors for future research on the topic, which will require better distributions of tokens among male and female speakers as well as more even distributions across all regions analyzed.

Despite the limitations of a corpus-based data set, in my opinion, the benefits of using this approach, as opposed to using more controlled or scripted speech, allows for a more complete understanding of the actual state of stop consonant lenition in natural, semi-spontaneous speech. Allowing participants to speak freely with their interlocutor during the Map Task dialogues in order to accomplish a common goal ultimately reduces the Observer's Paradox (Labov 1972) by shifting the participants' focus away from their speech production and onto the task at hand, ultimately eliciting more natural speech. The more scripted, laboratory approach of the pilot study, where target words were produced in a carrier phrase, seemed to force speakers to read each phrase carefully, which obviously does not resemble their everyday speech.

In addition to the use of corpus data, it is important to take into account the actual data itself when considering the limitations of this study. As mentioned multiple times in Chapter 3, for RI, many of the Spanish varieties investigated have multiple outlier values, as evidenced by the whisker portions of the box plots in the figures of Chapter 3, section 1. While the range of RI values in general for all varieties is smaller overall for /bdg/ than /ptk/, voiced stops show more outliers than voiceless stops. The outliers for /bdg/ could have contributed to the mean averages of RI for the Spanish varieties investigated, but since the outliers are almost exclusively higher RI values, if they did have an effect on the mean averages, excluding the outliers would only make the mean averages for voiced stops /bdg/ lower, ultimately increasing the average overall dB difference between /bdg/ and /ptk/. In addition to the high number of outliers for /bdg/ in the Caribbean variety, the Caribbean data set also shows a high number of outliers for /ptk/. Voiced and voiceless stops in Caribbean Spanish have very low RI values as compared to the other Spanish varieties investigated here. Therefore, the high number of outliers for this variety could be indicative of language variation and change in progress, but clearly, more data on this variety is needed in order to shed further light on this issue. Another reason for the high level of variability and the number of outliers could be an artifact of the Map Task itself. Since the speakers are interacting with one another to figure out how to arrive to one point on the map, on occasion they employ emphatic, hyperarticulated speech, emotion and pauses. These factors could have contributed to variation within each variety and also within the speech of each participant; therefore, future work could shed light on the extent of this variation by using a wider variety of tasks, and perhaps multiple tasks within the same study to use for comparison.

The primary goal of this study was to compare both voiceless and voiced consonants using the same methodology and acoustic measurements. However, given the inherent nature of these two stop consonant series, voiced vs. voiceless, the acoustic correlates available for comparison are limited to RI, which can be used to measure the intensity of the production of each consonant in relation to the following consonant. Since voiced consonants /bdg/ inherently show 100%V, the %V portion of this investigation only includes data on voiceless consonants /ptk/. Therefore, RI and %V are the only two variables used to determine the results of my investigation. Ideas for further investigation of voiced and voiceless stop consonant weakening and other possible methods for analysis will be discussed in the upcoming section on directions for future research.

4.5.3. Directions for future research

This dissertation's innovative approach to analyzing voiceless and voiced stop consonants in multiple varieties of Spanish has answered the research questions set forth at the beginning of this chapter. However, the results have raised additional questions that are valuable for continued work on stop consonant lenition variability in Spanish and other Romance languages and offer many avenues for further research on this topic: expansion and more detailed analysis of sociolinguistic variables that affect the degree of consonant lenition, improved distribution of the data set, perceptual tasks both inter- and intra-dialectally to determine comprehensibility and identification of underlying segments, as well as incorporation of data from other Romance languages.

The sociolinguistic factors of gender and age, both of which experienced limitations in the current study, are two important directions for future research, given that the raw data and the statistical tests show some promising trends for both RI and %V. The use of the corpus *Atlas de la entonación del español* (Prieto & Roseano 2009-2013) lent itself to a natural division of the participants into two groups: younger vs. older speakers. This is useful to identify different patterns according to speaker age but could be problematic since the younger age group ranges in age from 19-29 years and the older age group ranges in age from 35-53 years. In the younger group, there are only 10 years separating the youngest and oldest speaker, but for the older group, there is an 18-year age gap between the youngest and oldest speaker, almost double the age range of the younger group. In addition to the difference in age ranges, the mean ages of the participants of the current data set and their standard deviations are not well distributed within each group. Therefore, for future work on how consonant lenition might be affected differently in different generations, it would be helpful to divide participants into three primary age groups representing first generation (i.e., grandparents), second generation (i.e., parents) and third generation (i.e., children) speakers to gain clearer insight to the changes that happen through time with respect to consonant lenition. In particular with this data set, younger Mexican Spanish speakers showed a preference for weaker variants, a conclusion that merits further investigation to determine whether this is evidence of a change in progress. A larger sample size with speakers from different generations, as just mentioned, would be a great first step to see if the Mexican Spanish variety, which seems to be more conservative with respect to the other varieties investigated in this study, is experiencing movement toward less occluded consonant productions among younger speakers.

One of the most surprising results of the current study is the data from the Canary Island speakers, which was a considerable outlier on the whole since it did not yield the high proportions of surface voicing of /ptk/ that one might predict based on previous work. As we recall from Chapter 1, Oftedal (1985) found that only 6.8% of his 1900 tokens of Canary Island data of /p t k tʃ/ were *non-lenited.* Although Oftedal's (1985) study was not acoustically-based as is the current study, my data set offers only 162 total tokens for Canary Island Spanish from only two speakers from Las Palmas on the island of Gran Canaria. My results, therefore, cannot be used to generalize to Canary Island Spanish on the whole, and more speakers are needed to figure out exactly what is happening regarding stop consonant production in this variety of Spanish. In addition, the islands that make up the Canary Islands do present considerable phonetic variation as well; therefore, speakers that are from a more conservative island such as La Gomera could potentially yield much less voicing of underlying /ptk/. Furthermore, as mentioned in the previous section, the two Canarian speakers analyzed for this study are older speakers, so it is possible that younger speakers would have produced higher degrees of %V given a better distributed data set with more /ptk/ tokens. However, further exploration and acoustic analysis of voicing of /ptk/ in Canarian Spanish is warranted, especially given that the analyses by Oftedal (1985) and Trujillo (1980) were carried out roughly 30 years ago, and more recent investigation and acoustic analysis of stop consonant production in Canarian Spanish would contribute greatly to our knowledge on the topic. Another direction, to zero in more specifically on sociolinguistic factors like gender and age, would be to collect data from all groups using a more controlled task where other independent variables could be better managed. Given the trends in my data and the significance of gender and age as sociolinguistic variables in Mexican and Andean Spanish, this is an important area of future research that could further our knowledge of stop consonant weakening in Spanish and how variation affects language evolution through time. One of the disadvantages to using a pre-prepared corpus for this study is that the data that I have recorded here is frozen in time. Therefore, in order to further pursue sociolinguistic variables that could affect language change through time (e.g., age), it would be advantageous to create my own corpus. In doing so, I would be able to account for various social factors within the same study, obtain longitudinal data, and be able to contact participants for further information in case I needed clarification about their personal data or their participation in the study.

The consideration of other sociolinguistic variables such as level of education, life status and socioeconomic status could also prove fruitful for the investigation of consonant lenition across different varieties of Spanish. The younger speakers in the current data set are exclusively university students whereas the older speakers have a range of professions from bakers and secretaries to PhD students, professors, dieticians, and entrepreneurs. Education and life status, that is, whether a participant is in a school, work, or home environment could potentially have effects on their speech production. Previous studies such as Acosta-Martínez (2014), Alba (1988), Cedergren & Sankoff (1974), Labov (1966, 1972, 1978), Malaver & Samper Padilla (2016), Poplack (1978), and Rojas (1981) have shown that these sociolinguistic variables are key to exploring phonological variation.

In addition to an improved distribution of and addition to the sociolinguistic variables of the study, statistical tests run on the data set indicate that, in some cases, the number of the tokens were not sufficient to explore possible interactions between variables. More tokens per consonant per speaker would allow for a more in-depth analysis. For example, in my dissertation, some of the regions had so few total tokens and even fewer tokens per each stop consonant, that the interactions between variables would not have been sufficient on which to run a statistical test. Exploring the combinations of independent variable interactions in my data set would involve 28 two-two interactions and 58 combinations of three level interactions. For many of these, there is not enough data to yield statistically significant results. In order to build a data set big enough to yield reliable results, it would be necessary to collect data in a more controlled way to assure that there are enough tokens in each category. The negative trade-off, therefore, to using corpus data to analyze semi-spontaneous speech is the difficulty in balancing the data set and the quantity of data available for analysis.

The results of my dissertation show a great range of variability in the production of stop consonants across the Spanish-speaking world and, in some cases, the surface realizations of voiceless stops are voiced and even reach approximant productions, thus overlapping with the production of the underlyingly voiced segments. From this surface overlap, the following question arises: How does the allophonic overlap and variability between voiceless and voiced stop consonants affect their perception within each variety and between speakers of different varieties? While context has been shown to be a determining factor in the correct identification of underlying segments by interlocutors (Martínez Celdrán 2009), if the context were ambiguous or removed completely, it is possible that speakers would incorrectly identify underlying segments. Work on stop consonant production and perception of Spanish-English bilinguals shows that monolingual Spanish speakers exhibit greater sensitivity to closure duration of /ptk/ than English monolinguals, which is related to the voiced and voiceless stop VOT overlap and closure durations of stops in English and Spanish (Dmitrieva, Shultz, Llanos & Francis 2012; Green, Zampini & Magliore 1997; Williams 1977; Zampini, Clarke & Norrix 2002). The incorrect identification of underlying segments is evidence of language change in progress, or at the very least, evidence of the different stages of consonant lenition of different varieties of Spanish. Therefore, an important next step in the study of consonant lenition would be to create perceptual tests where participants must identify underlying segments based on recordings that they hear. Executing these perceptual tests would be two-fold: testing speaker perception of the stop consonants of their own variety and testing speaker perception of the stop consonants of other varieties to determine speaker sensitivity to consonant weakening and comprehensibility.

A final direction for future research that merits investigation is the incorporation of other Romance varieties within the study of consonant lenition, which could ultimately help expand the Spanish lenition continuum of stop consonants to a Romance continuum. Other Romance varieties, such as Italian, have been shown to have more conservative intervocalic productions, but recent synchronic research shows that intervocalic lenition (e.g., geminate stops to single consonants, the voicing and even spirantization of underlyingly voiceless stops) may be more widespread than we know, depending on various linguistic and extralinguistic factors (Blasco Ferrer 1986; Canalis 2013; Cravens 2002; Giannelli 2000; Sanga 1987; Troncon & Canepari 1989). Therefore, it may be the case that the lenition phenomena that occurred historically from Latin to Romance is still present today in the form of synchronic variation all across the Romance-speaking world. A more complete analysis that includes other Romance varieties could shed further light on traditional labels associated with the phonology of Romance languages, such as "conservative" for Italian or "innovative" for French. A reevaluation of the current state of stop consonant lenition in Romance overall would contribute further to our understanding of overarching issues related to language variation and change.

Appendix I – Pilot Study Tasks: Spanish

The production of each word in the carrier phrase: *Yo digo* ____ *para ti*. Words taken from Casteñada Vicente (1986).

Voiceless occlusive Tonic position	Voiceless occlusive Atonic position	Voiced occlusive Tonic position	Voices occlusive Atonic position
/p/	/p/	/b/	/b/
paso	pasó	bajo	bajó
peso	pesó	beso	besó
pillo	pilló	birlo	birló
podo	podó	boto	botó
punzo	punzón	busco	buscó
/t/	/t/	/d/	/d/
talo	taló	dato	dató
tela	telón	dejo	dejó
tira	tiró	dicto	dictó
toco	tocó	dono	donó
tubo	tumbó	dudo	dudó
/k/	/k/	/g/	/g/
casa	casó	gano	ganó
quedo	quedó	guerra	guerrero
quito	quitó	guiso	guisó
cobro	cobró	gozo	gozó
cura	curar	gusto	gustó

Demographic Questionnaire

Demographic information

1) Where are you from? (country, city and/or region)
2) How old are you?
3) Are you married? If so, what language(s) does your spouse speak?

Education level

4) What is your highest level of formal education?

Language background

5) What is your native language?
6) What other languages do you speak?

Additional questions

7) Have you lived in other countries where Spanish is spoken? If so, where and for how long?
8) How long have you lived in the United States?

Appendix II – Token counts per speaker

Participant	Sex	Age	Region	p				t				k				b				D				g				Totals
Tonic (T)/Atonic (A) Initial (I)/Internal (S)				S	I	T	A	S	I	T	A	S	I	T	A	S	I	T	A	S	I	T	A	S	I	T	A	
Lima_LS	F	23	Andes	5	4	6	3	6	5	6	5	3	6	0	10	7	3	7	3	11	6	3	14	0	12	3	9	69
Lima_KM	F	21		4	2	2	4	2	5	2	5	1	2	1	2	5	3	6	2	9	4	8	5	0	2	0	2	38
Mérida_ESP	F	29		7	5	5	7	48	24	43	29	21	50	22	49	26	35	34	27	12	58	22	48	9	35	11	33	331
Bogotá_ACR	F	45		2	1	0	3	0	5	0	5	3	6	1	8	5	8	4	9	4	9	4	9	1	5	1	5	49
Quito_EST	F	36		1	3	0	4	20	5	19	6	5	7	10	2	12	12	14	10	2	11	1	12	1	24	0	25	103
Buenos Aires_PLF	M	19	Argentina	8	2	9	1	3	9	3	9	15	21	13	23	11	14	15	10	38	28	22	44	3	18	9	12	170
Buenos Aires_ODF	M	20		2	0	0	2	0	0	0	0	3	5	4	4	2	1	3	0	2	4	2	4	2	1	1	2	22
Buenos Aires_APS	F	35		1	2	0	3	6	8	0	14	5	3	4	4	25	6	24	7	11	11	4	18	7	5	4	8	90
Neuquén_FSN	F	22		7	0	2	5	11	2	9	4	7	4	7	4	4	9	8	5	8	24	1	31	8	12	3	17	96
Palmas_AAG	F	38	Canary Islands	3	0	3	0	12	4	12	4	10	7	13	4	8	6	7	7	1	5	4	2		12	6	6	68
Palmas_AAH	M	38		8	4	8	5	18	10	22	7	8	5	6	7	6	13	13	6	2	7	2	7	0	11	6	5	94
San Juan_ZD	F	22	Caribbean	26	16	17	25	16	47	10	55	14	55	18	51	45	84	81	48	41	60	22	81	1	23	15	9	432
San Juan_SS	F	22		2	0	2	0	4	6	4	6	1	4	3	2	0	3	2	1	5	9	2	12	0	1	1	0	38
Santiago de Chile_NEF	F	53	Chile	11	5	2	14	9	12	7	14	28	22	30	18	23	11	24	10	16	21	13	26	0	21	7	14	176
Santiago de Chile_SLY	F	43		6	1	2	5	5	11	6	10	14	13	17	11	19	8	25	5	12	14	7	23	0	14	8	7	131
MéxicoDF_HMZT	M	24	Mexico	2	0	2	0	1	3	0	4	0	6	0	6	2	1	2	1	1	8	4	5	2	6	3	5	35
MéxicoDF_AAPA	F	50		8	0	0	8	6	23	7	23	13	14	16	11	37	10	39	9	10	17	9	18	6	17	9	14	163
Guadalajara_AB	F	25		0	2	2	0	2	7	1	8	7	6	4	9	21	10	22	9	2	4	2	4	0	10	5	5	71
Jerez_MGA	F	41	Spain	0	0	0	0	5	5	3	7	1	4	0	5	3	4	3	4	6	8	6	8	2	7	1	8	45
Jerez_PM	M	46		2	0	1	1	5	3	4	4	3	15	8	10	15	16	16	15	12	24	18	26	6	12	7	10	120
Jaén_SBJ	F	22		2	3	3	2	2	0	3	3	1	5	4	2	10	17	19	8	17	18	1	34	1	17	5	13	94
Jaén_DG	M	21		0	0	0	0	1	0	1	0	0	1	1	0	1	3	2	2	4	1	4	1	1	0	0	1	12
Vigo_LL	F	38		8	5	4	9	3	12	4	11	16	7	13	12	10	9	18	1	7	24	6	25	2	7	4	5	114
Vigo_SBV	F	38		1	1	1	1	2	3	1	4	4	3	5	2	9	2	9	2	4	5	3	6	1	2	1	2	40
Madrid_FMH	F	25		8	0	6	2	8	5	8	5	4	2	3	3	11	0	9	2	10	19	1	28	2	11	3	10	80
Madrid_CBS	F	26		5	0	3	2	5	3	5	3	4	1	4	1	15	4	15	5	16	6	8	13	0	6	1	5	66

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