

Article

An Examination of Social, Phonetic, and Lexical Variables on the Lenition of Intervocalic Voiced Stops by Spanish Heritage Speakers

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Abstract: The lenition of Spanish intervocalic voiced stops, commonly grouped as /bdg/, has increasingly been examined within Spanish as a Heritage Language research. This study seeks to identify social, phonetic, and lexical factors that predict the degree of lenition of /bdg/ among heritage speakers of Spanish. We analyzed 850 intervocalic productions of /bdg/ by 20 adult Spanish heritage speakers of various generations in an oral word list production task. Using spectrographic analyses, productions were categorized as full approximant, tense approximant, and occlusive. Results from linear mixed-effects models indicated that the phonetic context and the number of family generations residing in the US significantly predicted the degree of lenition of intervocalic voiced segments while age of acquisition of Spanish, current contact hours, and cognate status did not predict changes in the degree of lenition. Specifically, as the speaker's number of family generations residing in the US increased, fewer segments were lenited. We conclude that variations in /bdg/ lenition among heritage speakers of Spanish reflect the changes in pronunciation of other segments of heritage speakers over generations.

Keywords: heritage speakers; heritage language acquisition; bilingualism; generation; phonetics



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1. Introduction

Given individual differences in linguistic and cultural experiences, the speech practices of heritage speakers of Spanish (HSS) are often described as “heterogenous”. HSS in the United States can be defined as an individual who was raised in a home where Spanish is spoken, who speaks or at least understands Spanish, and who is to some degree bilingual in Spanish and in English, the societally dominant language (Valdés 2001, p. 38). This definition also encompasses individuals who have a cultural connection to the heritage language (Fishman 2001). HSS may be *simultaneous bilinguals* with exposure to both the majority language, English, and the heritage language, Spanish, before the onset of schooling. They may also be *sequential bilinguals*, who receive exposure to Spanish until they start preschool or kindergarten when a shift towards primarily using English may begin. The sequential or simultaneous acquisition of Spanish and of English, the frequency of use of Spanish, and the number of family generations in the United States have all been identified as factors contributing to linguistic variation among heritage speakers (Escobar and Potowski 2015). This paper will examine some of the social and linguistic factors that may affect the degree of lenition of /bdg/, among HSS. Many factors have been presented in the literature to account for this phonetic variation. Here we focus on the effects of age of acquisition of Spanish, generation, current use of Spanish (social factors), and the phonetic context (linguistic factor). Additionally, we examine the role of cognate status in /bdg/ production.

2. Literature Review

2.1. Intervocalic Voiced Stops in Spanish and English

Spanish is described as having six stop segments, three voiced and three unvoiced. Here we focus on the three voiced segments, /bdg/. The segments differ in their place of articulation: /b/ is a bilabial, /d/ is classified as a coronal segment, and /g/ is a velar. In the present study, we focus on the phonetic process of lenition, which is variable in both frequent and infrequent English contact varieties of Spanish (Simonet et al. 2012; Rao 2014, 2015). Lenition is defined as the weakening of an intervocalic voiced stop (Hualde 2014). For that reason, they are phonetically considered approximants. In intervocalic contexts, /bdg/ often lenite, as in examples 1a–3a. Lenition of these segments occurs over word boundaries as well (Hualde 2014; Rao 2015), as in examples 1b–3b. Additionally, lenition is less likely in the word-initial position, after a nasal consonant, and, for the coronal segment, when it is preceded by a lateral segment (Hualde 2014; Simonet et al. 2012). In examples 1a and 2a, the first segments would more likely be articulated as occlusives.

- | | |
|---|--|
| 1a. Word medial: <i>él bebe</i> [el-ˈbe-βe] ‘he drinks’ | 1b. Word initial: <i>yo bailo</i> [jo-ˈβaj-lo] ‘I dance’ |
| 2a. Word medial: <i>el dedo</i> [el-ˈde-ðo] ‘the finger’ | 2b. Word initial: <i>la dama</i> [la-ˈða-ma] ‘the lady’ |
| 3a. Word medial: <i>él llega</i> [el-ˈje-ɣa] ‘he arrives’ | 3b. Word initial: <i>ella gana</i> [ˈe-ja-ˈɣa-na] ‘she wins’ |

On the other hand, the English /bdg/ are articulated as occlusives in word medial (Examples 4a–6a) and initial (Examples 4b–6b) positions. There is a full stopping of the articulators and a subsequent burst of airflow. The weakening phenomena of these stops do not result in the same approximant segments as in Spanish (Thomas 2011).

- | | |
|--|---|
| 4a. Word medial: <i>a baby</i> [ə-ˈbeɪ-bi] | 4b. Word initial: <i>a baby</i> [ə-ˈbeɪ-bi] |
| 5a. Word medial: <i>today</i> [tə-ˈdeɪ] | 5b. Word initial: <i>a dance</i> [ə-ˈdæns] |
| 6a. Word medial: <i>wagon</i> [ˈwæ-ɡɪn] | 6b. Word initial: <i>a ghost</i> [ə-ˈɡoʊst] |

Given that the majority of HSS in the United States speak English, it is natural to wonder if the variability of /bdg/ in their speech varieties is influenced by the non-lenited characteristics of these segments in English. In the following sections, we will examine past research on linguistic and social factors that can affect the degree of lenition.

2.2. Linguistic Factors Affecting /bdg/ Lenition

Various linguistic factors contribute to variation in the degree of lenition of /bdg/ in HSS and in other bilingual populations (Ronquest and Rao 2018; Simonet et al. 2012). Rao (2014) examined the lenition of /b/ in the speech of 11 adult HSS. He found that tense approximants and occlusives were pronounced at a higher rate in stressed syllables, and full approximants were articulated at a higher rate in unstressed syllables. Word position (initial or medial) did not have a main effect, but the speakers who reported using English more frequently than Spanish at home had significantly lower rates of full approximant productions in word initial position.

These patterns were found again in Rao (2015) when all three voiced stops were analyzed in a read-speech task and in an image description task. There were lower rates of occlusion in the spontaneous speaking task than the read-speech task for each segment. The researcher again found that stressed syllables and word boundaries decrease the likelihood of lenition. Interestingly, these segments were not homogeneously influenced by the phonetic context, because /b/ was distinctly more lenited than both /d/ and /g/. The coronal segment had a slightly lower rate of approximant production than /b/, and intervocalic /g/ had the lowest rate of full approximant production. While these studies demonstrate how word boundaries and syllable stress affect the degree of lenition, other research on Spanish-Catalan bilinguals finds additional effects of vowel height on the degree of lenition.

In an acoustic analysis of intensity differences and ratios between segments of /d/ and the adjacent vowel, Simonet et al. (2012) found that articulations of /d/ by Spanish-Catalan speakers in Mallorca were the least constricted when preceded by low vowels. The intensity difference and ratio between vocalic and /d/ realizations was larger for

sequences of mid and high vowels and /d/, thus the segments were less lenited. The study also again demonstrated that /d/ realizations are less constricted in unstressed syllables. However, to the authors' knowledge, no previous work has examined these vowel height effects on the lenition of /bdg/ among HSS. In the present study, we examine the effect of vowel height on /bdg/ variation using Rao's (2014, 2015) three-scale classification of production types of intervocalic voiced stops: full approximant, tense approximant, and occlusive. Besides this, we will examine the effects of various social factors.

2.3. Social Factors Affecting /bdg/ Lenition

The imposed hegemony of English, negative attitudes toward minority languages, and the persistent societal belief that one must acquire the dominant language, in this case English, can contribute to the displacement of Spanish in the United States. Language shift, the displacement of one language over another typically over three generations, is a common result of these pressures. Therefore, the children and grandchildren of Spanish-speaking parents and grandparents growing up in the US can sometimes exhibit greater listening comprehension than speaking abilities. This is partially due to the adults' attempt to prevent further discriminatory experiences for younger generations (MacGregor-Mendoza 2000). Then, in some cases, the (grand)children's Spanish production differs from their older relatives, because their first languages can be different, and the children may spend less time using Spanish (Silva-Corvalán 2014). Cases of changes in variability in Spanish grammar over generations are widely documented in morphosyntax work examining variable subject pronoun expression (Otheguy and Zentella 2011). If these aspects of language change, pronunciation can too.

In an analysis of the production and duration of Spanish rhotics of first- and second-generation Spanish speakers, Henriksen (2015) found that second-generation speakers who were born and grew up in the United States produced fewer full taps than first-generation speakers. G2 speakers also had a lower mean occlusion for trills than G1 speakers. The duration of the segments did not change over one generation. His results point towards changes in pronunciation that affect the manner of a segment more than the duration. Spanish rhotic pronunciations by G2 were less similar to Spanish speakers who had not grown up in situations of daily English language contact, but the segments were not more English-like, because there were no English-like r- realizations. If generational differences are evident in these segments, it seems possible that this could also happen with the intervocalic voiced stops.

Besides a generational effect, the age of acquisition, the order of acquisition of the speaker's languages, and the continued use of Spanish can contribute to variation in /bdg/ productions by HSS (Leeman 2005; Rao 2014, 2015). For example, in Rao (2015), the participants were classified by their age of acquisition, level of education, and by their lived linguistic experiences. His *regular speakers* (henceforth, adulthood speakers) were HSS who consistently spoke Spanish through childhood and adolescence, and the *childhood speakers* were HSS who did not report speaking Spanish after late childhood/early adolescence. The third group was composed of individuals whose linguistic experiences fell between those of adult- and childhood speakers. The adulthood speakers produced /bdg/ as full approximant in at least 80% of their tokens, and the childhood speakers were more variable. One speaker produced /bdg/ as occlusive in over half of the tokens and the other two childhood speakers most often articulated the segments as full approximants. Like Rao (2015), Rao (2014) found that HSS with more at-home language contact and daily use of Spanish produced significantly more approximants than HSS who do not use Spanish frequently. The findings suggest that while an early age of acquisition of Spanish contributed to the likelihood of realizing /bdg/ as a full approximant, the consistent use of Spanish is another important factor.

In addition to differences in production over generations and differing levels of Spanish use among HSS, Ronquest and Rao's (2018, p. 167) survey of heritage speaker phonology reminds us that HSS are different from Spanish speakers in infrequent language

contact settings in the perception of these segments. They state: “discrimination of the voiced and voiceless stops and front and back vowels revealed that [heritage speakers] were just as accurate as the control group in discriminating /p/ and /b/, /t/ and /d/, and vocalic contrasts, but patterned with long-term immigrants in being less accurate with respect to /k/ and /g/”. Kissling (2015) also notes a link between perception and production of the Spanish voiced stops in L2 Spanish speakers, which could be observed among HSS as well.

Previous research on /bdg/ lenition has come from a relatively small pool of participants, and the changes in pronunciation have only been examined over one generation. Also, we have yet to examine the effect of the preceding and following phones on the lenition of intervocalic voiced stops among HSS. To address these gaps, this study will identify social (generation, age of acquisition of Spanish, contact hours) and phonetic factors (vowel height) affecting the lenition of these intervocalic voiced stop segments by HSS in the western United States. Additionally, the current study analyzes a lexical factor (cognate status) that could account for higher rates of occlusion of /bdg/ productions.

2.4. Cognate Status Effects in Spanish-English Speakers

Carroll (1992, p. 93) defines cognates as “lexical items from different languages which are identified by bilinguals as somehow being ‘the same’.” For example, the word *cognado* in Spanish and *cognate* in English would be considered equivalent if the speaker is aware of both of their like meanings and forms. Boada et al. (2013, p. 191) state that cognates “are systematically more frequent than non-cognates, thus suggesting that the cognate effect may be confounded by a frequency difference between cognates and non-cognates”. Therefore, the relative frequency of cognates and non-cognates could contribute to a speaker’s different behavior for the respective word types. While word frequency was not controlled for in Boada et al. (2013) nor in the present study, it is important to keep in mind that word frequency and word familiarity may be another factor operating over the cognate effects presented in the following literature.

Research into cognate status effects on phonetics-phonology is largely focused on L2 and ESL learners, yet this research has not disambiguated the relationship between cognate status and phonetic transfer (Flege and Munro 1994; Flege et al. 1998). Flege and Munro (1994) found that Spanish-English bilinguals pronounced the /t/ in *taco* with a less English-like VOT¹ compared to other words in English without a Spanish cognate. Further, their acoustic analysis showed that if one segment of the word *taco* was pronounced with more English-like characteristics, the other three segments followed suit. However, a later study by Flege et al. (1998) reported no effect of cognate status, word familiarity, nor the learned order of words on the VOT of initial /t/ by L1 Spanish ESL learners. L1 Spanish speakers’ pronunciation was not affected by the increased use of English. Together, these studies demonstrate that lexical factors, such as the word’s cultural status, can play a role in the realizations of phonetic segments in bilingual speakers. To compare cognate-status results with Flege and Munro (1994), who solely studied productions of the cultural cognate *taco*, the present study included similar words such as *empanada*.

Cognate status has also been examined in populations of HSS. Amengual (2012) found that adult HSS, advanced L2 English learners, and L2 Spanish learners produced higher rates of longer (more English-like) VOT of /t/ within cognates than in non-cognates. The cognates, as compared to non-cognates, had prolonged VOT. The author attributed the pattern to cross-language transfer given that the longer VOT is characteristic of English sound patterns. If cognate status affects the VOT of the Spanish voiceless stops, the status of the lexical item may also affect the voiced stops.

An underlying factor in cognate status is language dominance. Robinson Anthony and Blumenfeld’s (2019) analysis of receptive and expressive vocabulary and spatial Stroop

¹ In Spanish, the voiceless stops have a short period between the release of the consonant and the onset of vowel voicing. In English, word position and cluster position affect VOT (voice onset time), but in general, English voiceless stops have longer VOTs than the same segments in Spanish (Hualde 2014; Thomas 2011).

tasks demonstrated a relationship between language dominance and cognate status. Similar to Amengual (2012) and Flege and Munro (1994), these researchers concluded that the more dominant language saturated the pronunciation of the cognate. This conclusion was based on a word-level analysis rather than a segmental analysis, which led Robinson Anthony and Blumenfeld (2019) to argue that the word entirely reflected the dominant language of the speakers. The lack of segmental analysis calls into question which specific segmental and/or suprasegmental aspects of the lexical item contribute most to the saturation. Both individual and sequences of segments are pertinent to cognate effects, and the present study focuses on the former.

Knowing that a combination of linguistic and social factors can contribute to differences in pronunciation, we contribute to research on Spanish pronunciation among HSS by comparing these factors simultaneously. The specific social factors we will assess are generation, age of acquisition of Spanish, and current contact hours. The examined linguistic factor is the height of the preceding and following vowel. In addition, we will examine if the degree of lenition changes depending on the cognate status of the word. The aim of this study is to identify social, linguistic, and lexical factors that predict phonetic variation in the production of /bdg/ by HSS. Therefore, we ask these three research questions.

1. Which social factors (age of acquisition of Spanish, number of family generations in the US, and weekly contact hours with Spanish) have an impact on heritage speakers' lenition of /bdg/?
2. Does vowel height affect the lenition of /bdg/ among heritage speakers?
3. Does the cognate status of the lexical item have an impact on heritage speakers' lenition of /bdg/?

3. Materials and Methods

3.1. Participants

The participants for this study were 20 students from a university in the western US. The heterogeneity attributed to heritage speakers as a population is strongly represented in these participants' wide range of ages, ages of acquisition, family generations, weekly contact hours with Spanish, course enrollment, and experience abroad.

While all participants were enrolled in university classes, not all were traditional college-aged students ($M = 21.65$, $SD = 3.79$, range 17 years). Participants reported anywhere from 1.2 h of current weekly language contact with Spanish to over 20 h of contact ($M = 6.61$, $SD = 6.57$, range = 18.8). Fourteen participants were concurrently enrolled in Spanish classes on campus at the time of this study, while six had not taken a Spanish language course in 1.5–6 years. Two participants were Spanish minors, and one was a Spanish major. Participants were between generation 1.5 and generation 4 in the United States ($M = 2.5$, $SD = 0.8$, range 2.5). The present study did not include any first-generation speakers who immigrated to the United States after age 12, as they would be considered native speakers of Spanish rather than heritage speakers (Escobar and Potowski 2015). We considered any speakers who moved to the United States before age 12 as generation 1.5.

Fourteen participants reported acquiring Spanish from birth, but six participants reported acquiring Spanish in childhood or adolescence. All participants reported having L1 Spanish-speaking relatives. There was still an early age of acquisition of Spanish ($M = 1.67$, $SD = 2.68$, range 15 years). The six participants who did not report learning Spanish in their immediate home were from generations 2 through 4. These participants heard/used Spanish with other relatives who did not live with them in childhood. These participants' answers also reflect the age that the participant started Spanish classes in school or the age the participant feels that they started speaking Spanish, that is, produced the language. These participants are sequential HSS whose L1 is English. Participants who reported their age of acquisition of Spanish as 0 and reported acquiring both languages from birth are simultaneous bilinguals.

3.2. Instruments

Participants completed a background survey based on the survey used in [Beaudrie et al. \(2015\)](#). The survey asked participants with whom they spoke Spanish and with what frequency. Participants also reported their age of acquisition of Spanish (AoAS), language acquisition order, their weekly use of Spanish, and their comfort when speaking in Spanish before the recording sessions. Additionally, participants reported which relatives speak Spanish and how many generations of their families have lived in the United States. See Appendix A for the survey.

Next, participants read a list of words out loud in a quiet room with the first author. The first author is an English-dominant bilingual. The instructions were verbally given in the language that the participant was most comfortable with. Some of the participants did not feel comfortable speaking spontaneously in Spanish, so the word list facilitated their comfort with the study. Each word included one or more of the consonants in question in the intervocalic position. The words were presented individually on index cards so as to not confuse the participants, who otherwise might see the words directly above and below on the list and lose their spot. There were 34 words on the list, with 14 possible elicited tokens of /b/ and /g/ and 15 possible tokens of /d/, resulting in a maximum of 43 tokens per participant. For the purposes of examining the degree of lenition in speakers who potentially make the phonological /b/ vs. /v/ distinction, instances of “v” were not included in the analysis².

While all segments were in word-medial position, their stress and the height of the preceding and following vowel varied. The word list also included 16 cognates and 18 non-cognates. There was a subset of cognates that are considered cultural cognates: a lexical-cultural item in Spanish incorporated into English, i.e., *empanada*. The cognates are marked with an asterisk in Appendix B. They were not marked on the word list given to participants. The distribution of /bdg/ throughout these variables is presented in Table 1.

Table 1. Distribution of /bdg/ throughout word list.

	n /b/	% b	n /d/	% d	n /g/	% g
Total	252		292		276	
Syllable Stress						
Atonic syllable	172	68.3	195	66.8	197	71.4
Tonic syllable	80	31.7	97	33.2	79	28.6
Preceding vowel height						
Prec-low vowel	132	52.4	115	39.4	59	21.4
Prec-mid vowel	60	23.8	77	26.4	158	57.2
Prec-high vowel	80	23.8	100	34.2	59	21.4
Following vowel height						
Foll-low vowel	132	52.4	78	26.7	138	50.0
Foll-mid vowel	60	23.8	155	53.1	79	28.6
Foll-high vowel	60	23.8	59	20.2	59	21.4
Cognate Status						
Cognate	99	39.3	176	60.3	99	35.9
Non-cognate	153	60.7	116	39.7	177	64.1

3.3. Analysis

This study utilized PRAAT ([Boersma and Weenink 2018](#)) to investigate the gradience between full approximant and occlusive realizations of intervocalic voiced stops by the

² Some speakers of varieties of Colorado and New Mexican Spanish have retained the labiodental realization of [v] that corresponds to the grapheme “v” in a word like *universidad* ([Waltermire 2017](#)). This feature has been passed down throughout younger generations although the younger generations use them less “since many of them do not speak Spanish and largely possess receptive skills in this language” (2017, p.180). While a reviewer pointed out that this feature may apply more directly to third generation speakers and beyond, it is also possible that younger speakers have adopted the feature if it is frequent enough in their speech community. It is also possible that the influence of these bilinguals’ other language, English, maintains the phonological contrast. Regardless of the justification of labiodental maintenance, its phonetic characteristics fall outside of the spectrum of lenition we are investigating.

participating HSS. Following the three categories used in Rao (2014, 2015) each token was assigned a value of 1–3, which represents a continuous scale of the degree of lenition. Productions labeled as ‘1’ are occlusives, and productions labeled as ‘2’ are tense approximants. The productions labeled as ‘3’ are full approximants, and, while the tokens were ultimately excluded, a value of ‘4’ was assigned to realizations that fell out of the scale.

Segments were rated as 1 when they were produced most like an occlusive with a large, abrupt decrease in amplitude, no continuity between the adjacent vowel formants, and/or a distinct stop burst. As can be seen in Figure 1, the formant structure is not maintained in the segment. Segments like that in Figure 2 were rated 3 when there was minimal to no amplitude decrease and minimal to no break in the formant structure of the vowels adjacent to the segment. In Figure 2, there was only a slight decrease in the amplitude, and the formant structure was maintained between the vowels. When the realization fell in between these two extremes, as is the case for the segment in Figure 3, it was scored as a 2. In Figure 3, the amplitude did decrease over the duration of the coronal segment, but the formant structure is maintained and there is no stop burst.

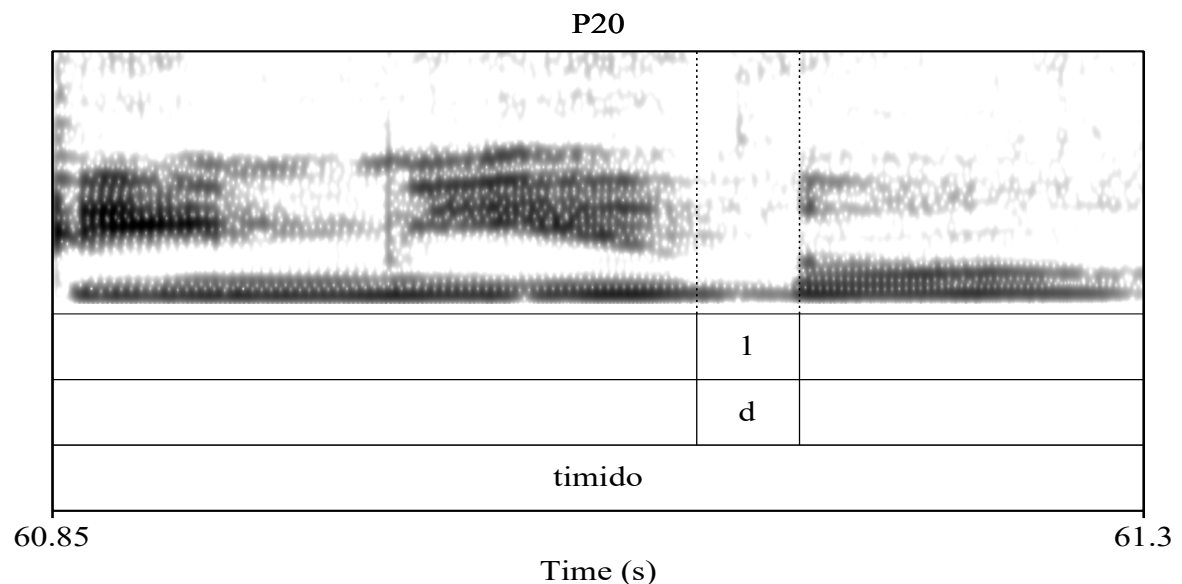


Figure 1. /d/ segment with a score of 1 (occlusive).

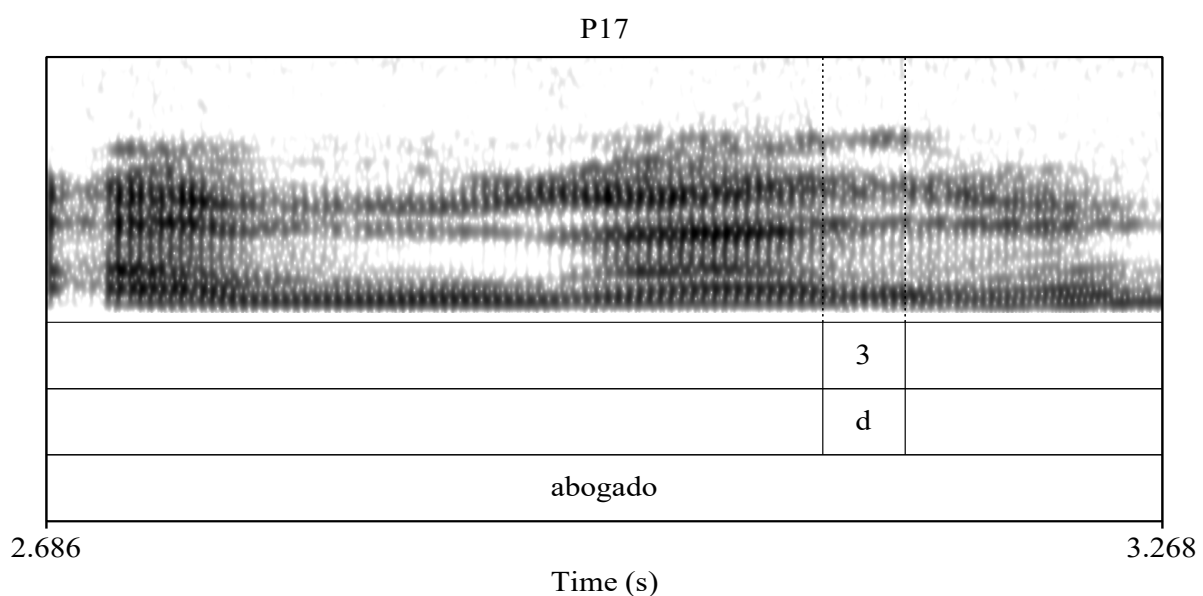


Figure 2. /d/ segment with a score of 3 (full approximant).

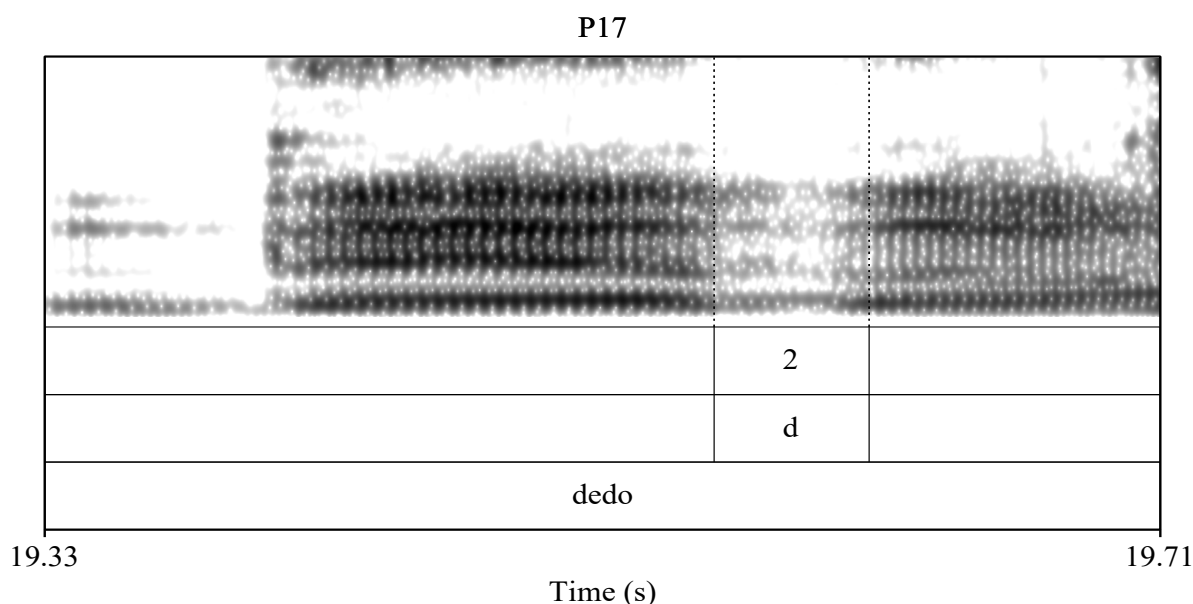


Figure 3. /d/ segment with a score of 2 (tense approximant).

In addition to these types of productions, participants sometimes produced different sounds or omitted the segments in question: [ˈde̞bo] instead of [ˈde̞ðo] for *dedo* and [tra-ˈba-xa] instead of [tra-βa-ˈxa-βa] for *trabajaba*. Per [Kissling \(2013, p. 728\)](#) these instances were excluded. After excluding 21 segments for these purposes, we were left with 850 tokens in the analysis.

Statistical analyses were conducted to determine the relationship between production type, age of acquisition of Spanish (AoAS), weekly contact hours, generation, current age, and phonetic context. Using R statistical software ([RStudio Team 2020](#)) and the lme4 package ([Bates et al. 2015](#)), three separate linear mixed-effects models were created for each segment based on its place of articulation, and one model was created that combined all segments. These models allow for a comparison between continuous and categorical variables with a continuous dependent variable. The dependent variable should be interpreted as the degree of lenition, which ranges from 1 (occlusive) to 3 (full approximant). The independent variables and fixed effects were AoAS, weekly contact hours, generation, current age, preceding vowel height, and following vowel height. Participant was included as a random effect in mixed linear-effects models. Variables that were not significant were dropped from the model until the lowest AIC value was obtained. Finally, the likelihood of non-lenited productions in cognates and non-cognates for each segment were computed using Chi-squares ([Preacher 2001](#)). To carry out these tests, only productions categorized as 1 (occlusive) were analyzed. Using the occlusive productions will best demonstrate any differential influence of English in cognates and non-cognates.

4. Results

4.1. Overall Lenition Rates

Each of the three segments analyzed was either most frequently articulated as full approximants or tense approximants. For the bilabial segment, 46% of the 252 tokens were articulated as tense approximants. Of the 276 velar segments, 41% were also realized as tense approximants, and 36% of the 292 coronal segments were articulated as full approximants. Interestingly, the second most common productions of the coronal and velar segments were occlusives. That is, /d/ and /g/ were more often occlusive than fully approximant, while occlusive and full approximant productions were just as likely

for the bilabial segment. For segments of /d/, only 30% of tokens were realized as tense approximants. Finally, the velar segment was only produced as a full approximant in 25% of the tokens. Figure 4 visualizes the rates of each production category for each segment.

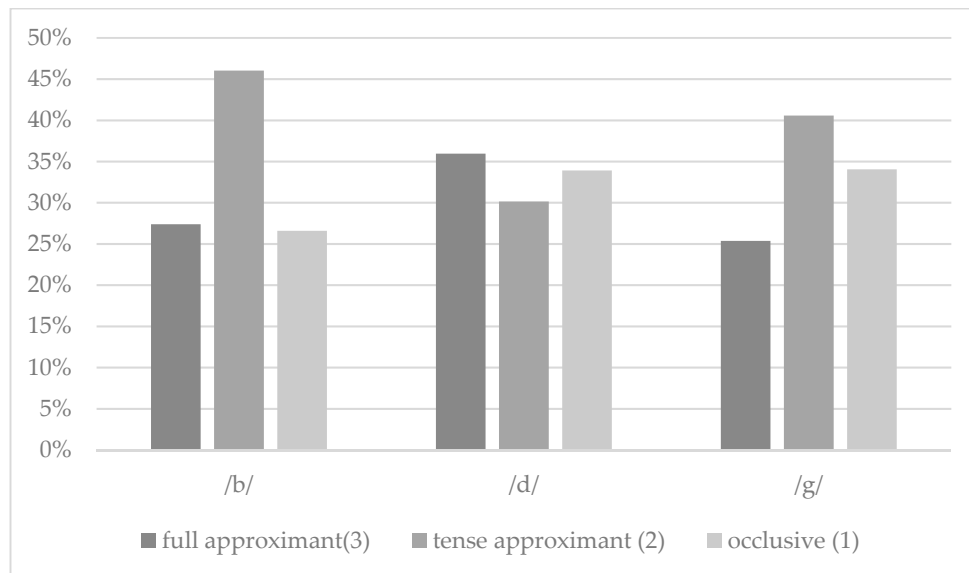


Figure 4. Rates of production types for all segments.

4.2. Research Question 1: Effects of Generation, Contact Hours, and Age of Acquisition of Spanish

There were changes in the frequency of production types over generations, and the changes are first visible in Figure 5. Speakers in generation 1.5 (G1.5) produced full approximants in 69% of their tokens. Of their productions, 24% were tense approximants, and only 7% were occlusive. Speakers from generation 2 (G2) produced full approximants 33% of the time, and they produced tense approximants in 41% of their tokens. These speakers only produced occlusive sounds in 26% of their tokens. Speakers from generation 3 (G3) produced full approximants 23% of the time, and they produced tense approximants in 46% of their tokens. These speakers only produced occlusive sounds in 30% of their tokens. Different from these generations, speakers in generation 4 (G4) did not produce full approximants at all. They produced tense approximants in 17% of their tokens and in 83% of their tokens, they realized /bdg/ as occlusive.

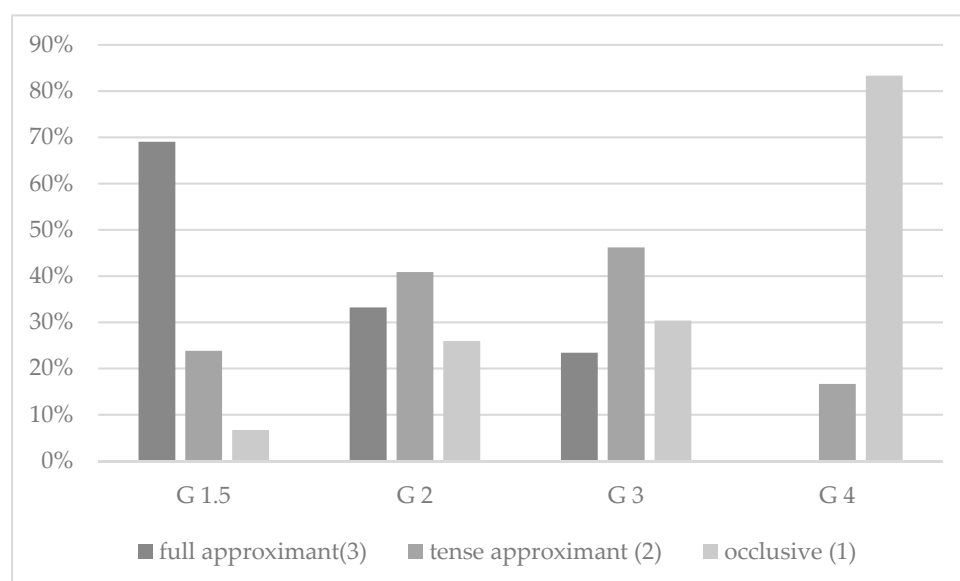


Figure 5. Rates of production types for each generation.

For the statistical analysis, the dependent variable (degree of lenition) was analyzed continuously from 1 (occlusive) to 3 (full approximant). Appendix C has the full statistical models. A summary of significant and not significant effects is available in Table 2, where each significant effect of each of the three segments is indicated by a checkmark. Through linear mixed-effects models, we observed that contact hours, age of acquisition of Spanish, and the speaker's current age have no significant bearing on the lenition of these segments. However, the generation of the speaker had a significant effect on the degree of lenition of each segment. As the number of family generations residing in the United States increased, lenition of these intervocalic segments is significantly less likely to occur for the coronal ($p = 0.003$), the velar segment ($p = 0.002$), and the labial segment ($p = 0.001$). Speakers who have more family generations residing in the US produce fewer lenited segments.

Table 2. Summary of significant effects on lenition of /bdg/.

Segment	Age	AoAS	Contact Hours	Generation	Phonetic Context	Cognate Status
/b/				✓	✓	
/d/				✓	✓	
/g/				✓	✓	

Figure 6 has the rates of production types for the bilabial segment across generations. The increasing production of non-lenited /b/ as the generation increases is striking. In G1.5, 46% of productions were full approximants, and 46% were tense approximants. G1.5 speakers produced occlusives in only 8% of their tokens. Both G2 and G3 speakers are variable in their productions, but both generations most often produce tense approximants, 47% and 59%, respectively. In G2, 34% of productions were full approximant and 19% were occlusive. By G3, occlusives account for 27% in this population of HSS. Finally, the speakers of G4 produce no full approximants. Of their productions, 15% are tense approximants, and 85% are occlusives. From G1.5 to G4, the rate of occlusive productions increased by 80%.

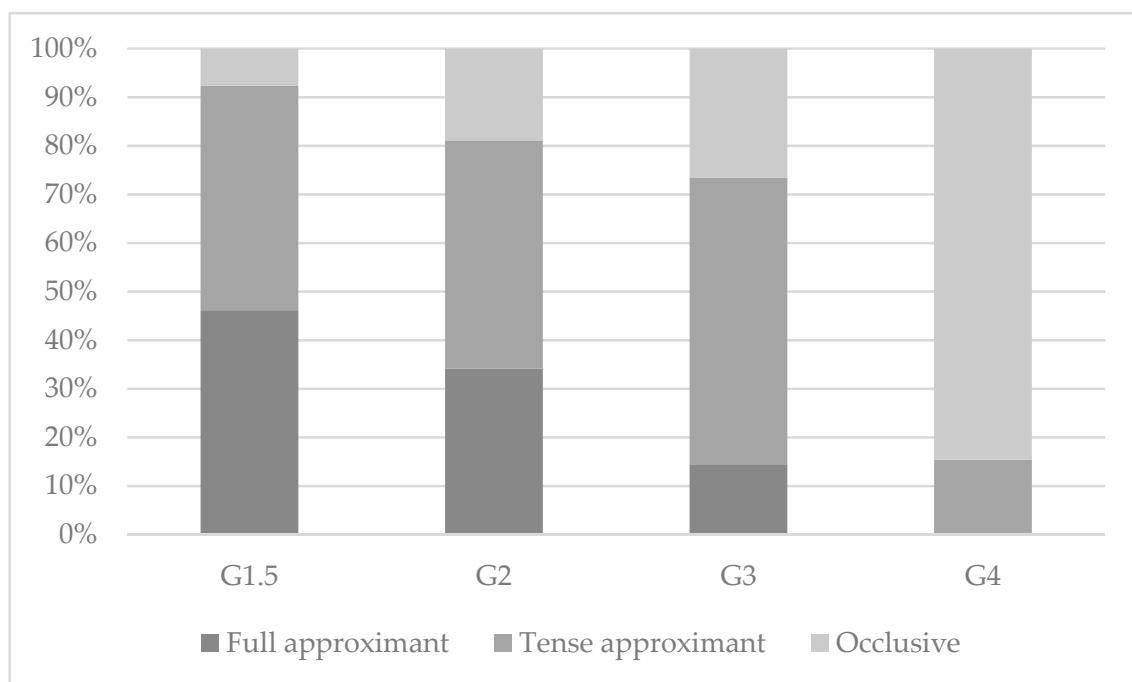


Figure 6. Rates of /b/ production types by generation.

Over the course of four generations, the same phonetic shift is visible for the coronal segment in Figure 7. However, the change in /d/ productions is more pronounced than in /b/. In G1.5, 100% of the speakers' productions are realized as full approximants. In G2 and G3, the production types are all well represented. Specifically, G2 speakers produce full approximants in 29% of their words, and they produced tense approximants in 33% of their tokens. From G1.5 to G2 the rate of occlusive productions moves from 0% to 38%. Likewise, G3 speakers produce occlusives in 32% of their tokens, and they produce tense approximants in 37% of their words. Finally, like the /b/ segment, G4 speakers produce no full approximant coronal segments. In 17% of their tokens, they produce tense approximants, and 83% of their productions are occlusive.

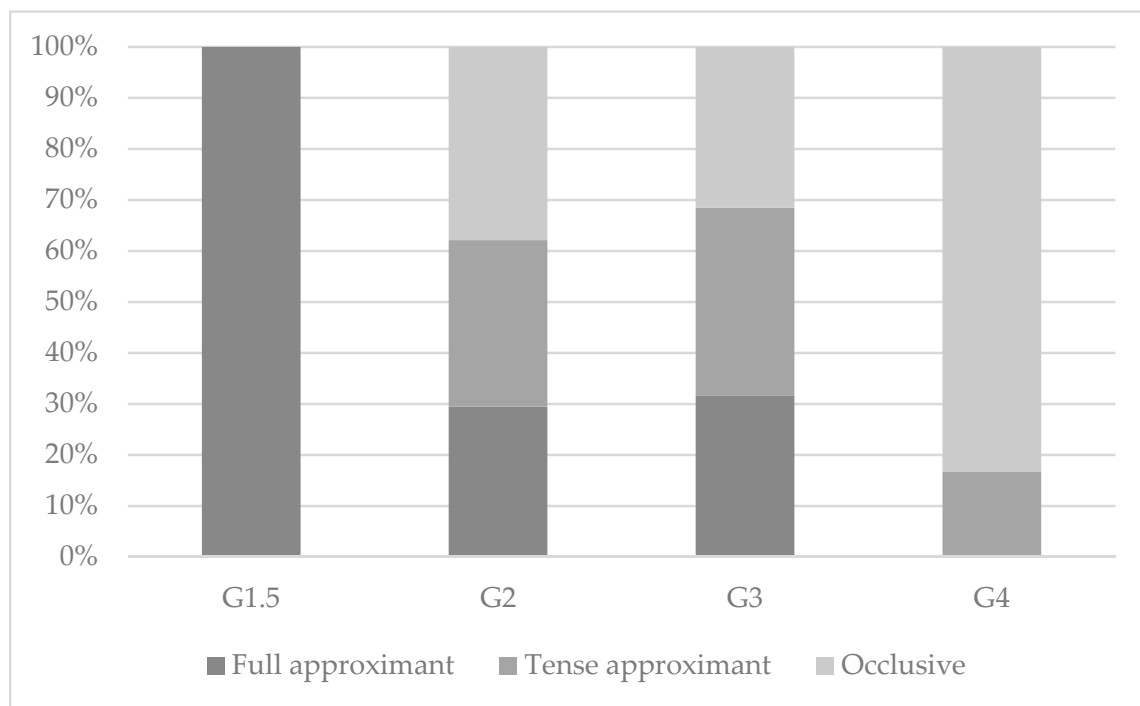


Figure 7. Rates of /d/ production types by generation.

In Figure 8, the rates of production types for the velar segment across generations are presented. Like the previous two segments, there is a decrease in the rate of full and tense approximant segments over the course of four generations. The G4 speakers produce occlusives 82% of the time, and they produce tense approximants in 18% of their tokens. G2 and G3 speakers, again, use a variety of production types, but they most commonly use tense approximants. Both speaker groups produce tense approximants in 44% of their tokens. However, G2 speakers produce more full approximants, 27%, than G3 speakers, 23%. From G2 to G3, the rate of occlusive productions increases by 4%. Unlike the /b/ and /d/ segments, the speakers in G1.5 produced more occlusive segments for velars. However, occlusive productions only accounted for 14% of productions. These speakers produced tense approximants in 29% of their words, and they produced full approximants in 57% of their tokens.

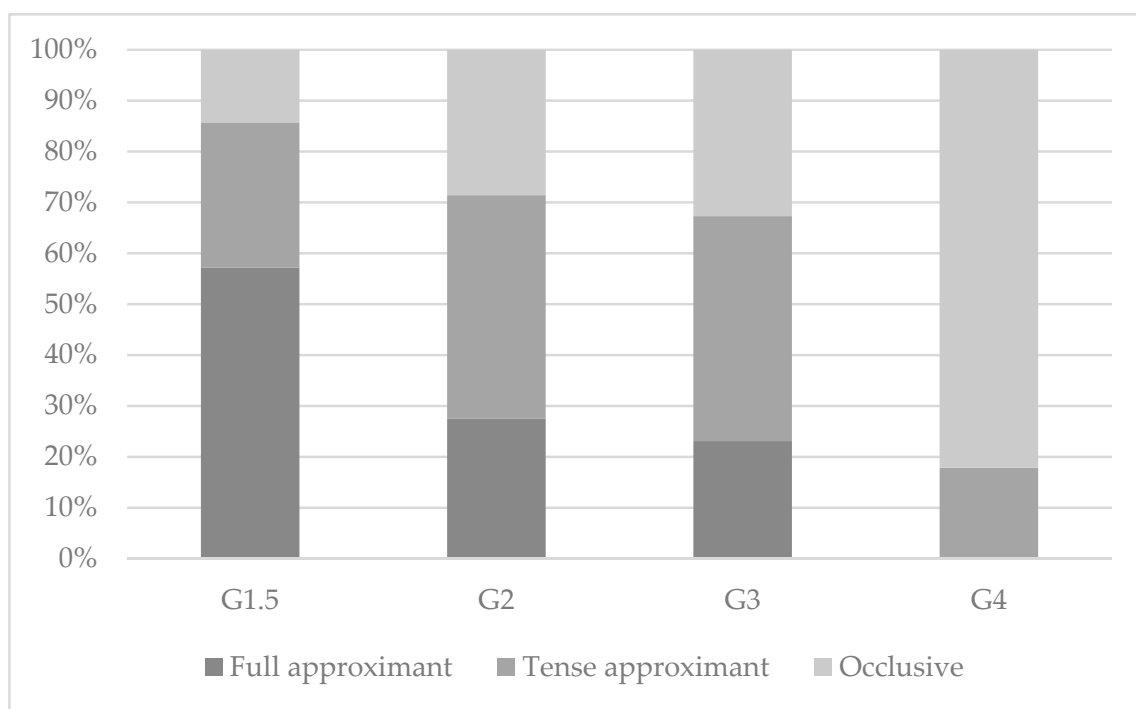


Figure 8. Rates of /g/ production types by generation.

In summary, the degree of lenition of /bdg/ among these speakers is primarily predicted by their generations, but not by the other social factors. As the number of family generations living in the US increases, productions vary more and ultimately are most frequently occlusive.

4.3. Research Question 2: Phonetic Context

As indicated in Table 2, the phonetic context of /bdg/ significantly predicts the degree of lenition. In the statistical models, the baseline condition was set as a ‘high’ vowel, because we wanted to examine what predicts lenition. The linear mixed-effects models showed that when preceded by a mid vowel, the bilabial segment was significantly less likely to lenite ($p = 0.03$). However, after a mid vowel, the bilabial segment was produced as occlusive only in 31% of contexts. The velar segments were significantly more likely to lenite when preceded by mid vowels ($p < 0.001$). After a mid vowel, the velar segment was articulated with high constriction in only 24% of contexts. The coronal segment was also significantly more likely to lenite when preceded by low vowels ($p < 0.001$). After a low vowel, 49% of /d/ segments were articulated as full approximants. When examining the following phonetic context with the linear mixed-effects models, we found that the bilabial segment was significantly more likely to lenite when followed by a middle vowel ($p = 0.02$). Before a mid vowel, only 23% of /b/ tokens were occlusive. Productions of intervocalic /d/ and /g/ were not significantly affected by the following segment in this analysis. Thus, even though the generation primarily predicted the degree of lenition, so did the phonetic context.

4.4. Research Question 3: Cognate Effects

While the speaker’s generation and the phonetic context of the segment significantly affected the degree of lenition, the cognate status of the word did not significantly affect the rate of occlusive productions. While Figure 9 shows the rates of production types in cognates and non-cognates for each segment, our analysis focused on the occlusive productions as the variation between full and tense approximants is less telling of English-language influence. A chi-square showed that there were not significantly more occlusive productions of the labial segment in cognates than in non-cognates, ($X^2(1) = 0.335, p = 0.56$).

Only 30% of productions of the labial sound in cognates were occlusives, and 27% of productions of this segment were occlusive in non-cognates. There was also not a significant difference between the number of occlusive productions of /d/ in cognates and non-cognates ($X^2(1) = 0.455, p = 0.49$). Moreover, 32% of cognate /d/ tokens were occlusive, and 36% of non-cognate /d/ tokens were occlusive. Finally, like the two other segments, there was no significant difference between the number of occlusive productions of /g/ in cognates and non-cognates ($X^2(1) = 0.013, p = 0.91$). In both cognates and non-cognates, 32% of the productions were occlusive.

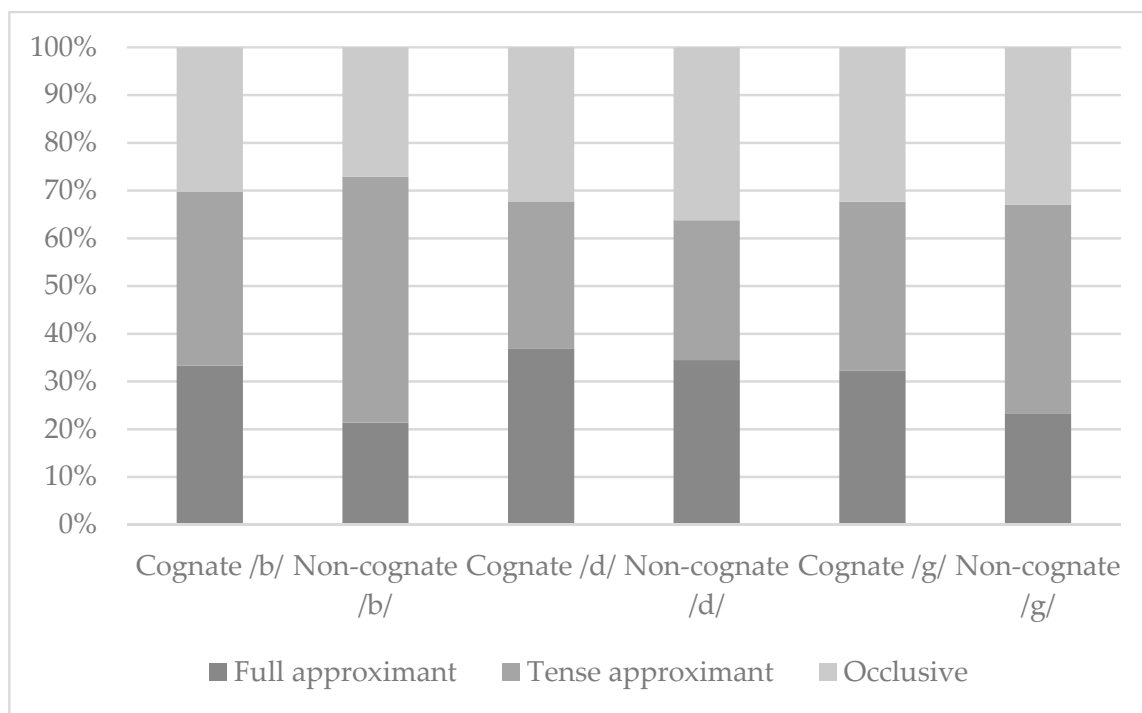


Figure 9. Rates of production types by segment in cognates and non-cognates.

As explained in the literature review, the type of cognate could affect the way the word is produced. Rates of production types in cognates and non-cognates in non-cultural cognates are presented in Figure 10. When these cognates (*Cuba*, *Colorado*, *Galápagos*, *empanada*) were excluded from the Chi-square analyses, there were still no significant differences between occlusive production rates in cognates and non-cognates. In 34% of cognates, /b/ was articulated as an occlusive, and 24% of /b/ in non-cognates were occlusive, but the difference was not significant ($X^2(1) = 2.605, p = 0.11$). The difference between occlusive productions of /d/ in cognates and non-cognates was also not significant ($X^2(1) = 0.078, p = 0.78$). For /d/ cognates, 35% of productions were occlusive and for /d/ non-cognates, 36% were occlusive. Finally, there was not a significant difference between occlusive /g/ productions for cognates and non-cognates ($X^2(1) = 1.109, p = 0.74$); 33% of /g/ cognate tokens and 35% of /g/ non-cognate tokens were occlusive.

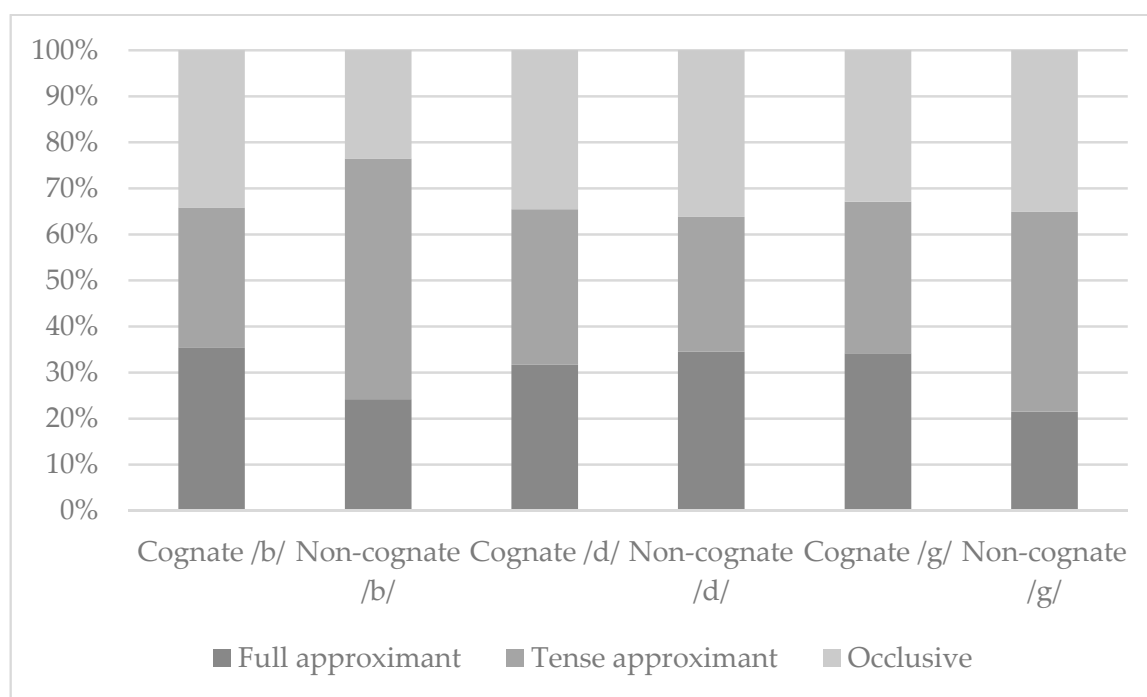


Figure 10. Rates of production types for all segments in cognates and non-cognates excluding cultural cognates.

In summary, while the height of the preceding and following vowels predicts the degree of lenition of each segment, one social factor, the generation of the speaker, also significantly impacts the lenition of each analyzed intervocalic segment. Finally, the cognate status of the word, in this speaker population, does not significantly influence the degree of lenition.

5. Discussion

5.1. Research Question 1: Effects of Generation, Contact Hours, and Age of Acquisition of Spanish

Among the four social variables evaluated in the present study, age of acquisition of Spanish, current weekly contact hours, and the speaker's age were not significant predictors of the degree of lenition of /bdg/. However, the number of family generations living in the United States significantly predicted the lenition of these segments.

This particular study was cross-sectional by evaluating participants' current weekly contact with Spanish, and while many participants verbally reported that their use of Spanish since childhood had decreased, we did not obtain a quantitative measure. As pointed out by a reviewer, longitudinal measures of contact could be better predictors of lenition than use measurements at any one given point in time. The AoAS variable may also have been not significant because these sounds are generally early acquired (Acedo 1993), which could make them less likely to change over time. These variables may also have had non-significant effects because, unlike many studies, our speakers were spread out over four generations. The speaker's generation, which was not a binary factor, most likely ended up accounting for more variability than the other social variables.

Unlike these three social variables, non-lenited segments were increasingly common as the number of family generations of the speaker increased. This follows findings for Spanish rhotic segments that change over generations as speakers continue to acquire and use language in different linguistic and social contexts in the US (Henriksen 2015). In Figure 5, 83% of productions of each segment by speakers from G4 were occlusive, and speakers from G1.5 produced occlusives in 14% of their tokens. When each segment was analyzed within its own model, generation predicted the degree of lenition in each segment. That is, as the number of generations increased, lenited segments were significantly less frequent.

Henriksen (2015) found a similar change in the production of Spanish rhotics over one generation, but again, in the present study, the change in /bdg/ production occurs over four generations. In contrast to Henriksen (2015) and the results of the present study, Ronquest et al. (2020) did not find a significant main effect for generation on the level of constriction for /bdg/ when lenition changes were assessed over one generation. This shows that changes in pronunciation over generations occur at different rates.

We speculate that the rate of change could partially depend on the sounds in questions and when they are acquired. In studies on phonological development of bilingual children, Acevedo (1993) found that segments of /bdg/ and the Spanish rhotics become adult-like at different ages. The bilabial segment was articulated as an approximant in intervocalic position by 3;06. The coronal segment followed at four years, but the lenition of the velar segment was somewhat variable into the sixth year. Fabiano-Smith and Goldstein (2010) also found that adult-like /b/ productions are acquired earlier than /d/ and /g/ in bilingual children. The Spanish rhotics were considered ‘late-acquired’ in both of these studies because the lingual precision to articulate rhotics as full taps and full trills took longer to develop. These differences in time and order of acquisition of the segments could explain why significant changes in lenition of /bdg/ are borne over four generations as opposed to two generations for rhotics. Interestingly, in both cases, the latest acquired articulations, /g/ and the rhotics, have the most varied productions among adult HSS. So, earlier acquired sounds, like the intervocalic voiced segments, appear to be less likely to shift over one generation than later acquired segments.

Additionally, while Ronquest et al. (2020) did not observe a significant main effect on lenition over two generations, the individual analysis of HSS and speakers who acquired Spanish in an infrequent English contact setting showed that more HSS produced the ‘contact-induced’ pattern, that is, less lenited /bdg/. Ronquest et al. (2020, p. 17) suggest that “HSs tend to precede IMs (foreign-born immigrants) in favoring contact-induced realizations”. This echoes the position brought forth in Potowski (2013) that HSS in the US may acquire contact varieties as compared to their older family members who may have acquired a variety of Spanish with little English contact.

The position applies to the current study. In addition, our study shows that the rate of contact-induced realizations of /bdg/ is not stagnant over subsequent generations, which further suggests that contact varieties of Spanish vary as more of the societally dominant language is introduced to the speaker earlier in acquisition. Speakers of later generations appear to be even more likely to favor English contact-induced realizations. Each subsequent generation receives more input from the other language, English, if the use of Spanish decreases. The likely result is the increased frequency of activating English-like /bdg/ sound patterns by the third and fourth generations and the increased presence of occlusion in intervocalic /bdg/ in Spanish. Thus, the increased rate of non-lenited productions may reflect the time spent activating the more English-like sound patterns, where occlusive /bdg/ is most frequent.

However, among the participants from G2, the rate of occlusive productions ranged from 4% to 57%, highlighting the need for further investigation into the individual experiences of each speaker. Henriksen (2015) noted substantial variation in both generations, and Ronquest et al. (2020) find similar variability. Thus, future studies can take an individualist approach to identify salient factors impacting heritage speaker pronunciation beyond or in congruence with generation. For instance, one participant reported using Spanish with their grandparents as a child, however, the passing of their grandparents decreased the participant’s input and opportunities to speak Spanish. These are types of social interactions and experiences that could help to further explain variability and changes in pronunciation among Spanish-speaking populations in the US.

5.2. Research Question 2: Phonetic Context

As found in Spanish-Catalan speakers (Simonet et al. 2012), the height of the vowels surrounding the segments in question significantly predicted the presence of lenition. In

particular, middle and low vowels promote lenition in velar and coronal segments, respectively. However, preceding middle vowels promote constriction of the bilabial segment, and following middle vowels coincided with more lenition of /b/. The relationships between vowel height and lenition or constriction are predictable when considering that speech sounds are coarticulated. The coarticulation with these preceding and following middle and low vowels positions the jaw and the tongue lower to facilitate approximants productions. Here, it is clear that the HSS are not too different from other Spanish speakers whose other language is also abundant in intervocalic lenition (Simonet et al. 2012). The effects of the phonetic context of /bdg/, at least here, appear to compare rather than contrast populations of Spanish speakers.

Further studies should combine vowel height variables with other phonetic factors (word boundaries and syllable stress), because it is not clear the degree to which all of these phonetic factors similarly predict lenition in different speaker populations. Additionally, speech rate was not analyzed here, but increasing speech rate is correlated with productions of the voiceless stops (Balukas and Koops 2014), rhotic tap lenition (Kim and Repiso-Puigdeliura 2020) and increased /bdg/ lenition in speakers of Mexican varieties of Spanish (Limanni 2009). A shortcoming of the current analysis is the lack of a speech rate measure, as the participants who spoke slower may have also produced fewer non-lenited intervocalic voiced stops. Finding the implications of speech rate on /bdg/ lenition among HSS is an endeavor for future investigation.

5.3. Research Question 3: Cognate Effects

Based on previously documented higher rates of phonetic transfer from English in cognates than in non-cognates (Amengual 2012; Flege et al. 1998; Anthony and Blumenfeld 2019), we hypothesized that we would find more occlusive productions in the cognates than in non-cognates. For example, words such as *video* would be more likely to have higher occlusive production rates than words such as *abogado*. Contrary to our predictions, we did not find significant differences between lenition rates in cognates or in non-cognates. When the dataset was restricted to non-cultural cognates, the same result was found.

The non-significant result of cognate status brings us back to the generation variable. The participants who produced more occlusive /bdg/ in cognates were also the speakers who had higher rates of occlusive productions in non-cognates, and, of course, these participants were from G4. In 74.5% of their cognate tokens, speakers from G4 produced occlusives, and 88% of their productions for non-cognate items were also occlusive. In comparison, only up to 33% of cognate productions were occlusive in the other three generations, and no more than 28% of non-cognate tokens were occlusive among generations 1.5 to 3. Thus, the generation of the speaker, and therefore, the differing frequency of activation of Spanish, predicts the likelihood of occlusion in cognates and non-cognates.

This conclusion diverges from what has been found in previous studies regarding lexical factors affecting pronunciation among HSS. For instance, in Amengual (2012) there was more English-like VOT of /ptk/ in cognates than in non-cognates. However, the results of the current study still fit into the framework provided by Robinson Anthony and Blumenfeld (2019), because the phonetic system of the more frequently activated language, in this case English, saturated the pronunciation of cognates and non-cognates equally. It is evident that the likelihood of producing English-like sounds in Spanish contexts is not solely dependent on the ‘sameness’ of the lexical item. We instead speculate that the frequent use of English over Spanish and the speaker’s generation are more telling of the degree of lenition of /bdg/ than the lexical item’s cognate status.

5.4. Limitations

Before concluding, we should take into account the limitations of this study. Given that participants in the present study read from a word list, the orthographic representations that we are taught to associate with sound patterns (Port 2010) could have affected their pronunciation, as was the case in Zampini (1998).

In addition to orthography influences, task formality could change the degree of lenition. This has been found in Spanish speakers who do not use English (Díaz-Campos 2005) and those who do frequently use English (Rao 2014, 2015). The first author originally also collected data in an image description task, but due to time constraints and the participants' reported low levels of comfort spontaneously speaking in Spanish, the present study only considered data from a read-speech task. Future studies should continue to compare lenition in spontaneous and read-speech tasks. A spontaneous speech task could also help to identify high-frequency words that participants may reduce/lenite more often than lower-frequency words. Such a comparison removes the limitations of the influence of orthography, and it introduces pertinent frequency factors.

Finally, a population of participants equally balanced between generations could give a more robust comparison of lenition and this variable. Participants in Generation 4 most often realized the segments as occlusives, but a larger pool of G4 speakers would confirm the pattern documented here.

6. Conclusions

This study has demonstrated that generation is a strong predictor of changes in the degree of lenition of /bdg/ among HSS. We found that G1.5 speakers had the highest lenition rates while G4 speakers had the highest rates of non-lenited realizations of these segments. This is similar to Henriksen (2015) in that as generation increases, pronunciations slightly shift from what is documented in infrequent English contact speech communities. However, changes in /bdg/ are slower to emerge than production changes in Spanish rhotics. We speculate that this is due to the order of acquisition and the articulatory precision of certain segments. Furthermore, our results showed that the cognate status of the lexical item does not significantly predict the degree of lenition. We attribute this back to the generation variable because the G4 speakers accounted for the majority of occlusive productions in both cognates and non-cognates. Finally, the results showed that, like other Spanish speakers, productions of intervocalic /bdg/ are constrained by linguistic factors like the height of the adjacent vowels.

One should always keep in mind that social and linguistic factors play a part in phonetic shifts. As was the case in Henriksen (2015) and Kim and Repiso-Puigdelliura (2020), careful attention should be paid to the speech patterns of individual speakers. In the present study, no speaker systematically pronounced all analyzed segments as “occlusive” or “full-approximant”, and the degree of lenition is variable regardless of the speaker's generation. Nevertheless, our findings coincide with language shifts that typically occur over three generations, specifically a shift from high lenition rates in G1.5 to high occlusion rates in G4. It is up to future investigations to firmly establish the predictors of phonetic shifts in HSS populations, and this endeavor will most certainly entail leveraging social and linguistic factors against speaker-based variation.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of University of Colorado Denver (Protocol 19–2359 14 October 2019).

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

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to participant confidentiality.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Background Survey

Please respond to the questions as they are true to you and your life experience with the Spanish language. Your sincerity will aid the success of the investigation. There are no wrong answers. Thank you for your participation.

1. What is your name?
2. How old are you?
3. Are you a current university student?
4. What language did you learn from birth?
5. What language or languages have you learned since then?
6. At what age did you start learning/speaking/hearing them?
7. Where did your family immigrate from?
8. Has your use of Spanish decreased as you got older or has it remained the same?
9. How many generations of your family have lived in the United States?
10. Does it feel like you can listen and understand but cannot speak Spanish?

Contact with Spanish A: Check the appropriate box based on your own life experiences

11. Do you SPEAK in Spanish in any of the following contexts? If yes, indicate the frequency by checking the appropriate box.

	Always	Often	Sometimes	Seldom	Never	N/A
With your mother, father, or both						
With your grandparents						
With your siblings						
With at least one of your relatives						
With at least one of your friends						
At work						
At school						
At social events						
Others: Please specify						

12. Do the following people ADDRESS you in Spanish in any of the following contexts? If yes, indicate the frequency by checking the appropriate box.

	Always	Often	Sometimes	Seldom	Never	N/A
With your mother, father, or both						
With your grandparents						
With your siblings						
With at least one of your relatives						
With at least one of your friends						
At work						
At school						
At social events						
Others: Please specify						

13. Do you listen to conversations in Spanish between the following people? If yes, indicate the frequency by checking the appropriate box.

	Always	Often	Sometimes	Seldom	Never	N/A
With your mother, father, or both						
With your grandparents						
With your siblings						
With at least one of your relatives						
With at least one of your friends						
At work						
At school						
At social events						
Others: Please specify						

Contact with Spanish B:

In this section, please circle the appropriate answer.

If your answer is MORE, indicate how many hours of contact.

*** For questions 16–18 please select if you SPEAK or LISTEN TO Spanish or both.

14. How many hours per week do you SPEAK or LISTEN TO Spanish?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
15. How many hours per week do you SPEAK or LISTEN TO Spanish with your grandparents?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
16. How many hours per week do you SPEAK or LISTEN TO Spanish with your parents?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
17. How many hours per week do you SPEAK or LISTEN TO Spanish with your siblings?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
18. How many hours per week do you SPEAK or LISTEN TO Spanish with your friends?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
19. Do you watch any TV or movies in Spanish?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More
20. Do you listen to any Spanish music?
 N/A Never 1–2 h a week 3–4 h a week 5–6 h a week More

Contact with Spanish C:

For questions 21–30 provide as much detail as possible

21. Do you attend functions or events in which the dominant language is Spanish?
22. If so, what are the events?
23. Have you ever studied in or visited Spanish speaking countries or communities such as the US /Mexico border where you were immersed in Spanish most of or all of the time?
24. If so, where did you go and how long were you there for?
25. Have you used Spanish in any other situations? (i.e., job, volunteer work, etc.)
26. Have you ever taken a Spanish class?
27. If so, when was the last time you took a Spanish class?
28. How many hours per week do/did you spend in a formal Spanish class?
29. How many quarters, semesters, or years of Spanish classes did you take?
30. What was your motivation for taking the class?

Appendix B

Word List | 34 words | 16 cognates*

Abogado	Lawyer
Aburrido	Boring
Beber	To drink
Bodega	Store
Colorado*	Colorado
Cuba*	Country
Debate*	Debate
Dedo	Finger
Dibujar	To Draw
Empanada*	Empanada (food)
Galápagos *	Ecuador Islands
Graduación*	Graduation
Grabar	To Record
Hago	I do
Hormigas	Ants
Idea*	Idea
Inseguro	Unsure/Unsafe
Legal*	Legal
Liga *	League
Madrugada	Early Morning
Murciélago	Bat (animal)
Negociar*	To Negotiate
Obediente*	Obedient
Prohibir*	To Prohibit
Quedaba	Stayed
Radio*	Radio
Regatear	To Bargain
Segundo	Second
Sílaba*	Syllable
Tímido*	Timid
Trabajaba	Worked
Universidad*	University
Vídeo*	Video

Appendix C

Table A1. Statistical results from Linear Mixed-Effects Models; the dependent variable is continuous from 1 (occlusive) to 3 (full approximant).

Segment	N	Fixed Effects	β	SE	t	p	Random Effects	Variance	SD
/b/	252	Intercept	3.03	0.32	9.33	<0.001	Speaker	0.56	0.37
		AoAS				ns			
		Generation	−0.41	0.13	−3.23	0.001			
		Age				ns			
		Contact Hours				ns			
		Preceding low				ns			
		Preceding mid	−0.29	0.14	−2.15	0.03			
		Following low				ns			
		Following mid	0.34	0.14	2.41	0.02			

Table A1. Cont.

Segment	N	Fixed Effects	β	SE	t	p	Random Effects	Variance	SD
/d/	292	Intercept	2.81	0.34	8.29	<0.001	Speaker	0.66	0.38
		AoAS				ns			
		Generation	−0.4	0.13	−2.95	0.003			
		Age				ns			
		Contact Hours				ns			
		Preceding low	0.34	0.09	3.69	<0.001			
		Preceding mid				ns			
		Following low				ns			
		Following mid				ns	Speaker	0.66	0.23
		Intercept	2.43	0.25	9.67	<0.001			
		AoAS				ns			
		Generation	−0.34	0.09	−3.55	0.002			
		Age				ns			
		Contact Hours				ns			
		Preceding low				ns			
		Preceding mid	0.46	0.1	4.56	<0.001			
		Following low				ns			
		Following mid				ns			

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