Changing Perceptions: The Sociophonetic Motivations of the Labial Velar Alternation in Spanish

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1. Introduction[1]

The labial-velar alternation is a prevalent feature of widely dispersed Spanish dialects (Colombia, New Mexico, El Salvador, Ecuador, Chile, and Mexico among others). The bilabial approximant [β] alternates with its velar counterpart [ɣ] when preceding the vowel [u] and the diphthongs [we], [wi]. Thus, a word such as *abuelo* 'grandfather' is realized as a[ɣ]uelo[2] by children and speakers with low education. This phenomenon is intriguing, because it has been noticed long ago in the historical development of the language and it is still observed in speakers from disparate geographical areas. Although the labial-velar alternation has been observed within historical linguistics (Lloyd 1987, Penny 1991), it has not yet been subject to synchronic analysis neither within phonetics nor within sociolinguistics. Yet, the only way to truly understand the motivations and the mechanisms of sound change is to analyze the physical (articulatory and acoustic) characteristics of the sounds involved (i.e. phonetics), as well as the social aspects of language use (i.e. sociolinguistics).

The purpose of this study is twofold: 1) to investigate the acoustic and perceptual motivations of the [β] > [ɣ] alternation and, 2) to examine its subsequent spread through the speech community. In other words, the aim is to study both the causes and the propagation of this variable linguistic phenomenon. I propose that the labial-velar alternation is triggered by the perceptual similarity of /b/ and /g/ in the context of round vowels and diphthongs [u], [we], [wi]. Articulatory and perceptual similarity cause confusion and confusion can lead to synchronic variation and eventual sound change (Ohala, 1992). I hypothesize that the spread of this variation to the upper layers of society is blocked by literacy, since orthography can help to resist perceptually driven sound changes.

My work on consonants combines three methods of data collection: sociolinguistic interviews, production and perception experiments. A sociolinguistic interview aims at eliciting vernacular speech from different social groups. Thus, it provides important information on the degree of intra and inter-speaker variation of a certain linguistic form. Since it is meant to be an informal conversation, the sociolinguistic interview is never conducted in a soundproof booth. Thus, a main disadvantage of interviews for the study of sounds is the lack of clarity of the recordings generally performed in people's houses, work places or outdoors. Phonetic instrumental experiments, on the other hand, record data with high fidelity equipment in soundproof booths. However, the controlled activities (such as repetition and listening tasks) used to elicit speech and the intimidating environment of soundproof booths make it difficult, if not impossible, to obtain naturally occurring speech. This study combines all these methods of data collection (sociolinguistic interviews with acoustic and perceptual experiments) to overcome the limitations of using a single technique.

This article is organized as follows; in section §2 I begin with a summary of the development of Latin /β/. Section §3 reviews the acoustic and perceptual characteristics of the approximants [β] and [ɣ]. I present my research questions and I review the theories of sound change upon which I base my analysis in section §4. The hypotheses are discussed in §5. The methods of data collection, the subjects

[1] The author wishes to thank Prof. Laura Colantoni, for her comments on earlier drafts of this paper, to Martin Lazzari, for his support and useful feedback and to Virginia Mazzaro for her enormous effort in transcribing the interviews. All errors and omissions are mine.

[2] Notice that /b/ and /g/ are realized as [b] and [g] after a nasal consonant and a pause, and as [β] and [ɣ] in all other environments (Quilis, 1993:201).

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and the setting are outlined in §6. The results are presented in §7, followed by the discussion and conclusion in §8.

2. Diachronic evidence

Relative consistency of the spelling and rhyme in Old Spanish verse suggests that a contrast was kept between a voiced bilabial plosive [b] (spelt <b>) and a voiced bilabial approximant [β (spelt <v>) (Penny 1991:96):

[b]: cabe (pres. ind. caber; < CAPIT)

[β]: cave (pres. subj. cavar; < CAVET)

However, in consonant clusters and in initial position confusion of spelling between <b> and <v> (e.g. *alba ~ alva* 'dawn') were commonplace. For instance, in the *Poema de mio Cid* (early thirteenth century), initial <b> and <v> are contrasted in the expected way, however there is a subset of cases (Menéndez Pidal 1964 in Penny 1991:97) in which this distinction was not kept: *vando~bando* (<b> expected), *bistades~vestidas, ban~van, boz~voz* (<v> expected), etc. By the end of the fourteenth century, it is likely that initial [b] and [β] were neutralized in all environments and the contrast survived only in intervocalic position. It is in the fifteenth century that the merger is completed (Penny 1991:97). Despite this merger, contemporary Spanish continues to use both <v> and <b> in spelling (e.g. *vienes* 'you come' and *bienes* 'possessions'). The variant [β] is used in most contexts of speech, except after a nasal consonant and a pause, where [b] is often found.

To the best of my knowledge, the earliest record of the labial-velar alternation in Argentine Spanish dates back to 1872, in the epic poems by the Argentine writer José Hernández (1979) '*El Gaucho Martín Fierro'*[3]. The *gaucho Martín Fierro* is a cowboy with no education. His speech presents cases of labial-velar alternation in /f/ and /b/ followed by /u/, /we/ and /wi/[4]. For the layman, non linguist reader, these features are associated with rural type of speech. For instance, the gaucho says *güeno* instead of *bueno* 'good' (Hernández 1979:25). This is not to say that the labial-velar alternation originated with the gauchos in the nineteenth century. As is the case with most synchronic variation, it lingers in speech for a considerable amount of time before it is reflected in writing.

The following section discusses the acoustic and perceptual characteristics of the approximant [β] and [ɣ], especially those that pertain to the determination of place of articulation.

3. The acoustic characteristics of the labial and velar approximants [β] and [ɣ]

Martínez-Celdrán (2004) summarized different definitions for approximants in his article "Problems in the Classification of Approximants":

> Ladefoged (1964) was the first one to use the term 'approximant' in his *Phonetic Study of the West African Languages*. He defined it as "a sound that belongs to the phonetic class vocoid or central resonant oral, and simultaneously to the phonological class consonant in that it occurs in the same phonotactic patterns as stops, fricatives and nasals." Catford (1977), reflecting on this usage gives a different definition for approximants: "An articulation in which one articulator is close to another but without the vocal tract being narrowed to such an extent that a turbulent air stream is produced". The IPA usage in the *Handbook* follows this description. Trask (1996) in the *Dictionary of Phonetics and Phonology* defines it as "A segment […] articulated with a constriction which is typically greater that that required for a vowel but not radical enough to produce air flow and hence friction noise, at least when voiced …" (Martínez-Celdrán 2004:1)

[3] Since writers often manipulate language to create a certain effect, it is often arguable that works of literature can be used as linguistic evidence to characterize speech. However, it is a fact that José Hernández spent many years of his life as a gaucho and that his representation of rural speech is not meant to make fun of gauchos; on the contrary, it is meant to be a romantic evocation of rural life.

[4] For instace, the gaucho says *__gü__eno* instead of *__b__ueno* 'good' (Hernández 1979:25).

Martínez-Celdrán (2004) argued that there is confusion and lack of consistency regarding which sounds constitutes the category of approximant. Catford (1977) and Ladefoged (1975) included high vowels in the category of approximants. However, Ladefoged (2001:52) only commented on the segments that coincide with the English sounds [w, j, l, r], omitting the possibility of classifying high vowels as approximants. In this paper, I refer to the labial and velar variants of /b/ and /g/ as approximants, since there is no complete obstruction in the vocal tract to call them obstruents and there is no turbulent air flow, and hence friction noise in the spectrograms, to call them fricatives.

Martínez-Celdrán (2004) used the symbols [β̞] and [ɣ̞] with a small T diacritic below them for the labial and velar fricatives. The small T diacritic is used to differentiate approximants from voiced fricatives with the same place of articulation. In this paper, I will simply use [β] and [ɣ] for the sake of simplicity and because I am not interested in keeping a distinction between voiced fricatives and approximants.

The word *abogado* 'lawyer' [aβoɣaðo] includes the three Spanish approximants [β, ɣ and ð]. As shown in the spectrogram below (see Figure 1), the relevant features are short duration and weakened glottal pulses between vowels. Martínez-Celdrán (2004:3) claimed that in approximants "there is no noise at all perceptually", yet the spectrogram below shows some energy above the 4,000Hz for [β] and [ɣ]. Concerning their spectral characteristics, there is a dark band corresponding to the first formant in the lower part of the spectrogram for [β] and [ɣ], suggesting that the sounds are voiced. In the case of [β], there is a loss of energy in the second and third formants, which shows that a constriction has been formed. For [ɣ], there is a faint formant at 1,342 Hz. In both approximants, there is some energy present above 4,000Hz. However, the intensity of this friction is very weak.

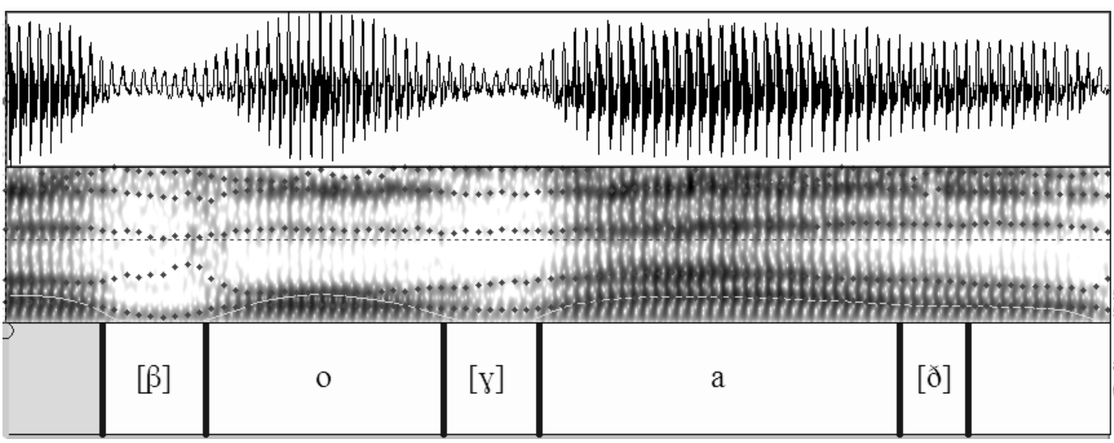

Figure 1: spectrogram of *abogado* 'lawyer' containing the three Spanish approximants [β, ɣ, ð].

In Figure 1, the duration of [β] and [ɣ] is 41ms and 33ms, respectively. However, duration tends to change in stressed and unstressed syllables, unstressed syllables being longer than stressed ones (Quilis 1993). The average duration of [β] in stressed syllables is 67ms, while [ɣ] is longer 85ms. These durations were measured from a total number of fifty nine words that comprised the stimuli from the perception experiment[5] (see Section 6.1.3.). On the other hand, the average duration of [β] in unstressed position is 55ms, and the duration of [ɣ] is 41ms. It is interesting to note that there is a marked difference in the duration of [ɣ] according to whether it is in stressed and unstressed position in the word, whereas in [β] this difference is not so marked.

[5] I understand that the recorded stimuli was done with a clear articulation of [β] and [ɣ], so it is possible that the actual duration of such sounds in real time speech is shorter to the ones reported here.

The mean-energy intensity of [β] and [ɣ] in the word *abogado* is 48.65dB and 49.07dB, respectively. However, on an average the intensity of [β] in stressed position in the syllable is 65dB, while in unstressed position is 66dB. On the other hand, the average intensity of [ɣ] in stressed position is 66dB, whereas in unstressed position it is 67dB. The average intensity reported here was also calculated on the perception stimuli. Overall, the values of intensity for [β] and [ɣ] in stressed and unstressed positions in the word are strikingly similar. Thus, intensity is not used to identify place of articulation in approximants.

The parameter that has been used to determine place of articulation in consonants such as stops, fricatives and approximants is the second formant (F2). Since the spectral characteristics of the approximants are heavily influenced by following vowels, the use of F2 as an acoustic parameter to identify place of articulation in approximants presents some problems. In a study that examined the acoustic properties of the Argentine Spanish fricatives [f, s, x, ʃ, ʒ, ɕ] and the approximants [β, ɣ, ð], Borzone de Manrique & Massone (1980) stated that "the identification of fricatives and approximants is in most cases affected by the following vowel and that the amount of influence exerted by each vowel varied according to the fricative that preceded it". The sounds for which the vocalic transitions played the most crucial role are the velars [x] and [ɣ]. Sussman *et al.* (1991) investigated Locus Equations as a potential metric capable of illustrating relational invariance for place of articulation in voiced initial stop consonants independently of vowel context. Locus equations are "straight line regression fits to data points formed by plotting onsets of F2 transitions along the *y* axis and their corresponding midvowel nuclei along the *x* axis". Their results showed 82%, 78% and 67% classification rates for labial, alveolar and velar place, respectively. In the present study, I have used Locus Equation to identify place of articulation for [β] and [ɣ]. Since Sussman *et al.* used Locus Equation for the discrimination of English voiced stops, it was necessary to adapt this metric to use it with Spanish approximants, since such sounds lack release bursts. Thus, instead of measuring the "frequency value of F2 at the first discernable glottal pulse after the release burst" as Sussman *et al.* did, I measured the *F2 at the max intensity slope in a CV transition*. The procedure for measuring Locus Equation is discussed in detail in section 6.3.2.

4. On the origin of sound change

Ohala (1989) argued that many regular sound changes can be accounted for with reference to natural constraints of the vocal tract and its acoustic output. These natural constraints pertain to the physical aspect of the vocal tract: anatomical, elasto-inertial, neuro-muscular, aerodynamic, acoustic. Thus, the speech that emerges from the vocal tract is the product of the effect of physical constraints. Henry Sweet (1874 in Ohala 1989:182) was among one of the first who proposed that "the mapping between vocal tract shape and the output sound is a many-to-one mapping, i.e. the same or similar sound may result from two or more different vocal-tract configurations". He exemplified this with the variant forms of English 'through' as [θɹu] and [fɹu].

One of the most important discoveries of instrumental phonetics is the large amount of variation in pronunciation, not only between speakers but also in the speech of a single speaker. Ohala (1989) argued that synchronic variation in speech bears a striking parallelism with sound change manifested in dialect variation. By variation he does not refer to, for instance, the alternation between *siŋ* vs. *sin* in English, since this is the result of a change that has already taken place. Instead, he refers to "hidden variation", that is, the variation in the pronunciation that speakers and listeners do not usually recognize as variation (Ohala 1989:175). This misperception of the target sound is a changed pronunciation and a good candidate for sound change. In a normal speech situation, however, listeners are able to factor out potential distortions due to coarticulatory effects, environmental noise, etc. In other circumstances, such as in the case of inexperienced listeners, or illiterate people, listeners are unable to apply corrective rules and they end up taking the misleading signal at face value (Ohala 1989). Thus, what was noise in the signal is interpreted as the intended pronunciation.

Since there is so much variation in speech we should be able to find many more sound changes that we actually witness in the normal development of languages. However, the listener has many sources of correction of his pronunciation: other speakers' pronunciation, other listeners' reactions to his attempts at pronunciation, and, in literate cultures, spelling (Ohala 1989). All these factors can act as blocks of potential sound changes. But the most important source of error correction is the listener's experience with speech. Listeners can "factor out" or normalize predictable variation in speech (Ohala 1993:245). For instance, one of the main acoustic differences between [s] and [ʃ] is the lower centre frequency of the latter. But the centre frequency can also vary due to contextual influences from a following vowel. Mann and Repp (1980 in Ohala 1993:245) found that a synthetic fricative that would be identified as /ʃ/ before a following /ɑ/ is identified as [s] when the following vowel is [u]. This is due to anticipatory assimilation of lip-rounding from a following rounded vowel, which serves to lower the centre frequency of /ʃ/. Thus, when the sibilant has a lower centre frequency and the following vowel is heard as round, listeners can factor out the expected low frequency and "reconstruct" a higher centre frequency characteristic of /s/.

Ohala (1989) stated that this theory of sound change can be easily tested in the laboratory. When the visual representation of two sounds reveals similarity in the spectrograms, their perception will also reveal closeness. In Ohala's terms (1989:183) "what looks similar to the eye in these displays will sound similar to the ear and thus be subject to confusion". To test the level of confusability of certain sounds, listeners are presented with spoken syllables or words (i.e. usually nonsense words to avoid the effect of lexical knowledge) and they are asked to identify what they heard. A high level of confusion of two sounds in the tests will confirm their auditory closeness. Concerning this Ohala stated that (1989:184) "when listeners confuse these sounds in listening tests they are, in effect, duplicating sound change in the laboratory".

To sum up, Ohala (1989, 1993) locates the mechanism of sound change centrally in the phonetic domain and primarily within the listener. Many sound changes are the result of hidden variation in pronunciation. When misperceived pronunciation is taken as the intended form, as in the case of inexperienced listeners, it may result in sound change.

Ohala's idea of sound variation and change is similar to the one proposed by Blevins (2004) in her theory of Evolutionary Phonology. According to Evolutionary Phonology, synchronic sound patterns are a direct reflection of their diachronic origins and regular phonetically based sound change is the common source of recurrent sound patterns. The precise model of sound change incorporates two observations regarding human language: all spoken language is characterized by a wide range of phonetic variation, some of which is language specific, and some of which is determined by physical properties of the human vocal apparatus. A second observation is that, though language transmission from one generation to the next is constrained by perceptual, articulatory, cognitive, and social factors, "language transmission is, by its very nature, indirect and imperfect. Within this imperfect system of transmission, sound change may be viewed as the norm not the exception" (Blevins 2004:8). Similarly to Ohala's theory (1981), the general model of sound change proposed by Blevins (2004) makes reference to two main ideas: sound changes have their source in misperception, ambiguous segmentation, and ambiguity due to variation, i.e. there is a phonetic pre-condition in regular sound changes. Where sound changes appear to defy this typology, they can be shown to have non-phonetic origins. According to both Ohala and Evolutionary Phonology sound change is non-optimizing.

The term 'Evolutionary Phonology' refers to "the study of sound systems as a function of language evolution in the historical sense". Changes in the sound and shape of languages come as a result of cultural evolution. Language change is as natural as it is unavoidable; this is the major sign of a living language. However, some sound changes can be reversed or stopped, giving rise to abnormal forms or patterns. One example is the contrast between /w/, the voiced labio-velar glide and /ʍ/, the voiceless labio-velar glide, which very few languages maintain. This is because a voiceless sonorant like [ʍ] has very little acoustic energy, is hard to hear, or is reinterpreted as contextual variant of its voiced counterpart (Blevins 2004:30). As a result, the /w, ʍ/ contrast was lost in British English many centuries ago, leaving /w/ as the only survivor. Thus, words such as 'witch' and 'which' pronounced with /w/ and /ʍ/, respectively, became [wɪʧ]. However, the /w, ʍ/ contrast survived in some dialects of Scots and English (Ladefoged and Maddieson 1996:326 in Blevins 2004:29) and many varieties of American English (Labov 1994:314 in Blevins 2004:29). The merger of /w/ and /ʍ/ was seen as a sign of language decay by prescriptive grammarians, who set as an important enterprise to reintroduce the contrast in American schools. For some speakers, the prescriptive enterprise was successful and the contrast between /w/ and /ʍ/ was reestablished, though not in all the places it occurred historically, and for other speakers, the contrast was lost.

In the context of sound patterns at large, the contrast between /w/ and /ʍ/ is seen as comparatively "useless" and "cumbersome" (Blevins 2004:29); /ʍ/ is difficult to perceive, there is a low functional load of the w/ʍ contrast and other voiced/voiceless sonorant pairs in English are non-contrastive. In other words, the w/ʍ contrast is seen as an unnatural development in the current state of English. This is just one example of a case where the natural process of language acquisition is directly influenced by prescriptive laws or by spelling pronunciation, where literacy skills may give rise to pronunciations which are altered in line with orthographic representations.

But, many sound changes go unnoticed and they follow their natural course of development. The great majority of regular sound changes in evidence in the world's languages appear to be phonetically motivated. Evolutionary Phonology associates errors in transmission of sound patterns with a general typology of phonetically conditioned sound change. This typology highlights three distinct natural phonetic sources of sound change, which Blevins (2004:32) referred to as CHANGE, CHANCE and CHOICE:

> One factor is the probability of an acoustic signal being misheard by the listener/learner in the course of language acquisition. *If some signal A can be misheard as B, a change of A > B is phonetically motivated on the basis of perceptual similarity. If a sound change has perceptual similarity as its primary basis, it is classified as an instance of CHANGE.* A distinct source of sound change involved the localization of non-local percepts. All speech involves some degree of coarticulation between adjacent segments (Hardcastle and Hewlett 1999).

If in the course of language acquisition, a segmental representation is acquired, long-domain acoustic properties will give rise to ambiguities involving segmentation. If a sound change has ambiguous segmentation as its primary basis, it is classified as an instance of CHANCE. A third source of sound change is the intrinsic variability of speech along the hyper-to-hypoarticulated continuum (Lindblom 1990a). In all languages, speech varies according to rate. If, from the pool of variants, a listener chooses, as basic, a form which was non-basic for the speaker, sound change can occur. If a sound change has phonetic variation as its primary basis, it is classified as an instance of CHOICE (emphasis mine) (Blevins 2004:32). The first type of phonetically conditioned sound change, called CHANGE, is relevant to the present study. This type of phonetic change involves misperception, due to perceptual similarity. This point is related to the hypothesis proposed in §5.

The theories of language change proposed by Ohala (1981) and Blevins (2004) give an important role to the listener. However, other theories of sound change recognize that not only the listener but also the *speaker* is important in the process of speech perception. Perceivers appear to be sensitive to coarticulatory and timing influences that alter the articulatory patterns and thus the acoustic structure of speech signals. The idea that listeners appear to base their perceptual judgments not on the acoustic patterns *per se.*, but rather on the underlying articulatory gestures that gave rise to those acoustic patterns is supported by 'articulatory theories' of speech perception. The Motor Theory of Speech Perception is one such theory, which sustains that "we perceive the speaker's intended gestures" (Pickett 1999:200). However, since the hypothesis I am testing is related to the listener's misperception of similar sounds, I have focused on the theories of speech perception as proposed by Ohala (1989, 1993) and Blevins (2004).

These theories of speech perception address the pre-conditions of sound change; however, they do not attempt to explain the propagation of these sound changes to the larger speech community. In Ohala's (1989) terms, the focus is on the origin of a mini-sound change, not on how it develops into a maxi-sound change. To explain how an innovation spreads, it is necessary to look at the theories of the transmission and diffusion of phonetic changes (Labov 2007) within sociolinguistics. The main question to address here is: What are the social and linguistic factors that impinge on the labial-velar alternation? With the analysis of sociolinguistic interviews it is possible to answer this question by comparing the percentages of occurrence of the labial-velar alternation in different social groups.

5. Hypotheses

I propose that [β] and [ɣ] are good candidates for synchronic variability due to their acoustic similarity which makes them difficult for discrimination. I further propose that this acoustic similarity is not so much due to labials being similar to velars, but to velars becoming similar to labials due to coarticulation with a following round vowel. Round vowels add a secondary labial articulation to [ɣ], making it perceptually similar to the [β]. Acoustic similarity introduces variation in perception, which can potentially lead to sound change (Ohala 1993:243). I argue that this labial-velar alternation will be less frequent in the higher stratum of the population due to a higher level of literacy, as orthography helps to clarify ambiguous speech signals.

6. Methodology

The methods of data collection described below were designed to answer the main research questions that motivate this study:

- What are the acoustic and perceptual motivations of the labial-velar alternation?
- What are the social and linguistic factors that impinge on this alternation?

One-on-one interviews are one of most effective ways to collect samples of informal speech from a specific community. Since the tokens are embedded in a natural conversation, they give an approximation of how sounds occur in real life. However, one of the disadvantages of sociolinguistic interviews is that they may not provide enough tokens of the relevant sounds to perform an appropriate analysis. Or, the sounds may not appear in the required phonetic contexts. To supplement data from the interview, I included a production experiment designed to elicit tokens in specific phonetic environments. The discrimination of sounds was tested in a subsequent perception experiment, where participants were required to listen and discriminate between [[β] and [ɣ] in the different phonetic environments. A more detailed description of the design and application of these methods of data collection follow.

6.1. Data Collection

The procedure of data collection was performed in three different stages:

6.1.1. Sociolinguistic interviews
6.1.2. Production experiments
6.1.3. Perception experiments

Participants in this study were born in Caá Catí and lived there for most of their lives. Thus, those who were away from Caá Catí for more than five years were not considered. Children and adolescents were excluded because they either have not completed the acquisition of the language or their speech may not be representative of standard adult varieties. Since the main purpose of this study is to analyze speech sounds, participants with hearing difficulties were excluded. Those participants with primary school complete (seven years of schooling) and beyond were considered literate, while those with no schooling or with primary incomplete were considered illiterate. Two age groups were arbitrarily devised: Young (18-33) and Adult (34-65). All the participants were male, four of them young and four adult. As shown in Table 1, Literate and Illiterate participants were evenly distributed in each age group:

	Literacy	
	Literate	Illiterate
Young	2	2
Adult	2	2

Table 1: distribution of participants according to Age and Literacy

One of the reasons for choosing Caá Catí as the location for my study has to do with the low level of education of most of its residents. Although Caá Catí is one of the oldest settlements in the province, information from the census in 2004 shows that the population in Caá Catí not only remains stable, but it actually tends to decrease in time. One of the causes for the reduction in the population has to do with the lack of economic prosperity in the city. Unemployment drew large percentages of the younger population to bigger urban centres, mainly Corrientes city and Buenos Aires. Another important reason why young people leave Caá Catí is the lack of possibilities to pursue college and university education. Caá Catí has only one primary school and one secondary school. There is also a brand new school for special children, but no college or universities. Thus, those students who want to further their education are forced to leave to the big cities. While some of them return to their native town when they finish, most of them find jobs in the big cities and remain there. The social mobility in Caá Catí is, therefore, unidirectional; many people emigrate, but very few immigrate to the town. Thus, the people who remain in Caá Catí do not reach high education levels and many remain illiterate. Since I hypothesize that education or, rather the lack of it, favours the spread of the labial-velar alternation to other speakers, I needed to test this hypothesis on a population that would have an important number of illiterate or semi-illiterate speakers. These speakers are not so easily found in larger cities where there are more and better options for education. Thus, Caá Catí was the most appropriate place to carry out this investigation; since both types of participants, literate and illiterate, could be found.

6.1.1. Sociolinguistic Interviews

Interviews lasted approximately 1 hour and they were conducted at the researcher's place, a house rented for the purpose of this study. The original plan was to do it at the participants' own homes to make them feel more comfortable. However, some rural houses do not have a living room where people can talk, so inhabitants tend to gather in the entranceway or in the backyard, which generally have loud background noise (e.g. wind, animals, traffic, music/radios). Since the object of this study is the analysis of sounds, which in this case are not easy to perceive even face-to-face, the change of place was necessary to obtain a better recording quality.

In recruiting participants for this study I used the 'friend-of-a-friend' (Milroy 1987) sampling technique. This technique consists in having a group of contacts that will serve as an initial contact to approach prospective participants[6]. The friend-of-a-friend technique for recruiting participants is especially appropriate for this community. In my experience as a member of the Argentine society, I find that the best services, products, prices, seats, etc. are obtained through friends of friends. Having a network of good contacts can make life much easier and more convenient. Likewise, defining myself as a friend of X acted as an implicit guarantee of good faith and ensured a better exchange with participants. As Milroy (1987:54) explains, "knowledge of X's name is received as a claim by X that obligations to her/him should be fulfilled in the form of help for her/his friend". Moreover, knowing the informant beforehand helped recreate the informal and friendly atmosphere necessary to obtain a close-to-vernacular language.

Sociolinguistic interviews are useful for determining the development of the labial-velar alternation in the speech community in general and in each participant in particular. The data collected in this way informed how external factors such as literacy and age and internal factors such as neighboring sounds, stress, position and word frequency influence the process of variation. With questions organized into modules, the interviews were designed to elicit not only the vernacular, but also the more formal style of speech (Labov, 1984). Since the aim of a sociolinguistic interview is to elicit natural speech, the interviews were performed as if they were informal conversations between two friends, where the participant was free to deviate from the topic introduced by the interviewer. The interviewer was then willing to remit control over the direction of the conversation and follow the participant's lead. In this way, I tried to minimize the 'observer's paradox' (Labov 1984), since "the aim is to observe how people talk when they are not being observed".

The production and perception experiments described below were intended to suit the speech community under study; since half of the participants were illiterate, it was necessary to include tasks that could be equally performed by all participants.

6.1.2. Production experiment

The purpose of the description task was to increase the number of tokens for each consonant and also to make sure that they would appear at least once in every relevant phonetic environment. The production experiment provides the data on which the acoustic analysis was performed. This data was used to test the hypothesis that a following back[7] vowel influences the acoustic characteristics /b/ making it more similar to its velar counterpart.

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[6] During my first trip to Caá Catí, I made initial contact with a local family that hosted me and help me find prospective participants for the study.

[7] Notice that back vowels are also round in Spanish, so I refer to back for economy, but the 'round' feature is implied.

In the production experiment participants were asked to describe a set of pictures that contained visual cues to elicit words with the target sounds /b/ and /g/ in syllable onset position. Coda position in words such as *abnegado* 'unselfish', *subrayar* 'underline' for [β] and, *magnifico* 'wonderful' and *indignado* 'angry' for [ɣ] will not be considered. The consonants are followed by the five Spanish vowels and the diphthongs [we] and [wi] in medial stressed and unstressed position (Appendix 9.1). The description task took place after the interviews and it lasted approximately 15 minutes. The number of tokens elicited per consonant was 12 for /b/ and 12 for /g/. Notice that it was not possible to elicit tokens for each consonant in all possible phonetic environments.

6.1.3. Perception experiment

For the perception experiment, participants performed an AX discrimination task, i.e. they listened to pairs of nonsense words and they said whether they were different or the same. Appendix 9.2 includes a list of 56 nonsense words. The words contain /b/ and /g/ in initial and medial position followed by the five Spanish vowels and the diphthongs <ue> and <ui>. For instance, on the headphone subjects would hear 1) [b]odan ~ [g]odan and they would say 'different', 2) pa[ɣ]üin ~ pa[[β]üin , and they would say 'same'. Because some of the speakers were illiterate, I wrote down their answers on an answer sheet. The use of nonsense words was intended to avoid the effect of lexical priming on the selection of words.

I used PowerPoint to play the recording of words, with each pair of words being attached to a new slide that changed automatically after 5 seconds. The slides were completely blank, i.e. without any visual cues. The stimuli were heard only once, unless some external noise (e.g. dogs barking, loud cars) or interruption (e.g. cell phones, knockings on the door, etc.) prevented the subject from properly hearing it the first time. The stimuli were distributed randomly over a total of 84 slides. The order was re-arranged 3 times and saved in different documents: Perception_A, Perception_B and Perception_C. Subjects were exposed to either one of these tests at random. This was done to determine whether factors such as tiredness play a role in perception. Thus, if subjects from the 3 groups made increasing errors in the last portion of the experiment, regardless of the sounds being played, then tiredness rather than perceptual difficulty was a factor involved. Before doing the production experiment, participants performed a training task, which was also the time when adjustments of volume were done. The recording equipment was played nonstop throughout the interview and the two experiments. Reaction time in the perception experiment is not reported here. The perception experiment followed the production experiment and it took approximately 15 minutes to complete.

The interviews and the experiments were recorded using an M-Audio Microtrack 24/96 professional 2-channel mobile digital recorder and a lavaliere unidirectional microphone. Sound files were downsampled at 22050Hz, 16Bit. For the listening experiment I used a Logitech USB headset 350.

6.2. Procedure and analysis

6.2.1. Sociolinguistic interviews

I extracted and coded all the tokens containing /b/ and /g/ from the interviews and I analyzed their overall occurrence in Excel. The following are the social and linguistic factors considered in the analysis:

External (social) factors:

Age:

- Young (18-33)
- Adults (34-65)

Literacy:

- Literates (primary complete and beyond)
- Illiterates or Semi-Illiterates (no schooling or primary incomplete)

Sex: Males

I hypothesize that the labial-velar alternation will be more frequent amongst (semi)illiterate people, due to the effect of orthography in preventing the spread of perceptually driven variation (Steele forthcoming). I will corroborate this hypothesis with results from the perceptual experiment. Thus, if most speakers, regardless of their education, confuse labials and velars in the perception test, then education may be a factor blocking the spread of the change.

Internal (linguistic) factors:

Following context:

- Vowels /a/, /e/, /i/, /o/, /u/
- Diphthongs /we/, /wi/

Position: Medial

A preliminary study of the labial-velar alternation (Mazzaro 2005) showed that it is constrained by following back round vowels /o/ and /u/ and the diphthongs /we/ and /wi/. That is, [ɣ] is articulatorily similar to [β] when followed by [u], since both [ɣ] and [β] have a double articulation, rounding of the lips and back of the tongue. Acoustically similar sounds lead to variation in perception; such variation is a potential sound change (Ohala 1993:243). Stress and Frequency are two other factors to be considered in the analysis of the sound variation and change; however, they will not be explored in this study.

6.2.2. Production Experiment

Target words were extracted from the signal, and analyzed with Praat 4.0.41. The following are the acoustic measurements performed to identify relational invariance for place of articulation in Spanish voiced approximants [β] and [ɣ] independently of vowel context: (i) Second formant onset (F2 onset) defined as frequency value of F2 at the *max intensity slope* in a CV transition and (ii) Second formant target (F2 vowel) defined as the frequency value of F2 at the centre of the vowel. Sample points for diphthongized vowels [we] and [wi] were taken in F2 onset and F2 in midpoint of [w]. These measurements are based on the concept of Locus Equation, originally conceived by Lindblom (1963) to derive relationally invariant acoustic properties for place of articulation in Swedish /b, d, g/. Lindblom (1963) derived Locus Equation from the following formula: $F2_{onset}=k*F2_{vowel}+c$, where k and c are constants (slope and y intercept, respectively). Figure 2 exemplifies how these measurements were taken:

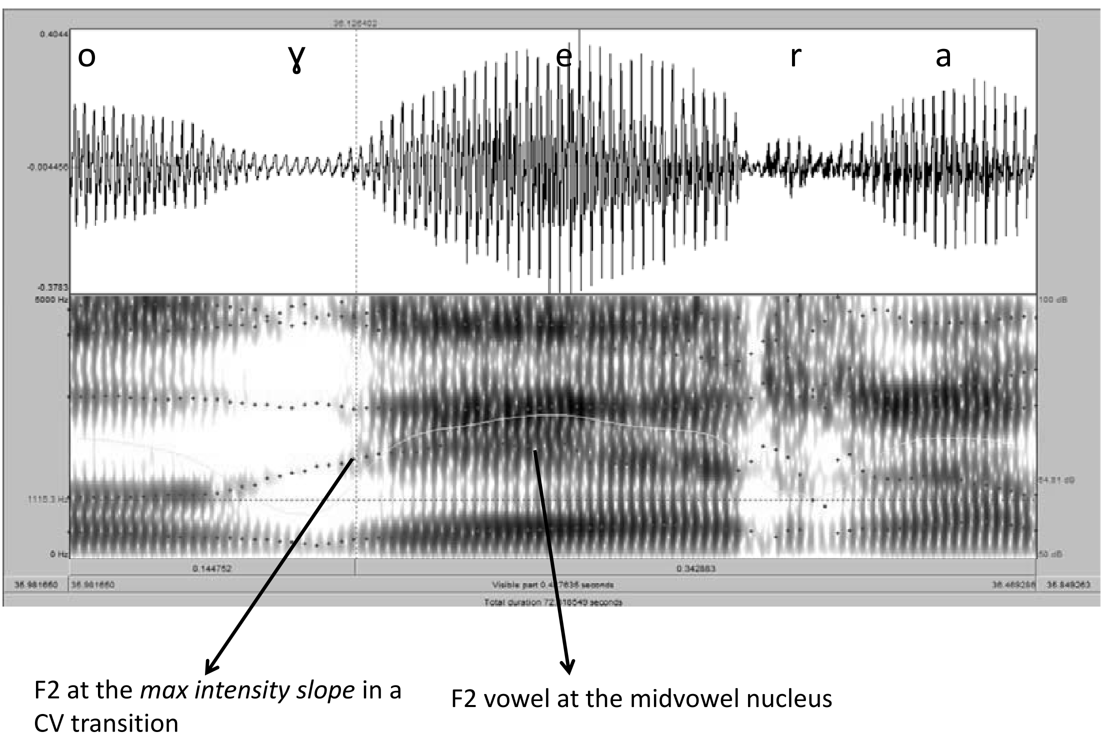

Figure 2: measurements taken to derive Locus Equation in /b/ and /g/

The data extracted was exported to Excel and statistical tests were carried out in Minitab (statistics software for Windows XP).

6.2.3. Perception Experiment

To calculate degree of discrimination scores for [β] and [ɣ], I counted the number of correct and incorrect responses in all the speakers. To test the hypothesis that following round vowel and diphthongs affect the perception of approximants, I analyzed the degree of confusion per individual context. Thus, if the confusion between [β] and [ɣ] increased with a following [u], then this would confirm the hypothesis that the +back feature of the vowel influences the discrimination of these sounds. If there is no difference in the discrimination of approximants in different vocalic contexts, then this might suggest that labial and velar approximants are similar, and thus likely to be confused, regardless of the nature of the following vowel.

7. Results

In this study I am reporting the results coming from eight speakers only. Although I am aware that the number of speakers is low, the main aim of this research is to compare the performance of participants in the three different tasks. This comparison allows us to understand the relationship between speech production and perception. To this aim, I am presenting the results in three parts: (i) Sociolinguistic interviews (ii) Production experiment (iii) Perception experiment. For all three experiments I performed 2 sample T-tests (two-tailed) to determine if there were statistical differences between groups (Literate vs. Illiterate) across vowel contexts. The results of all statistical tests were considered significant at the 0.05 level. Results are presented as mean (M) and standard deviation (SD), unless otherwise indicated.

7.1. Sociolinguistic interviews

Table 2 shows the total percentage of occurrence of the labial approximant [β], labial-velar alternation [ɣ] and deletion [ø]. While I was doing the auditory classification of tokens, it was not always easy to discriminate labial-velar alternation from deletion [ø]. For instance, *abuelo* 'grandfather' could be realized as a[ɣwe]lo or a[we]lo, but these two forms are auditorily very similar. Although I could perform an acoustic analysis of confusing tokens in the interviews, this would be extremely time consuming and impossible to accomplish with so many tokens. Therefore, I collapsed the variants [ɣ] and [ø] into one group. Thus one group contains the standard variant [β] and the other group contains those instances of pronunciation that differ from the standard realization of /b/, that is [ɣ] and [ø]. I am aware that collapsing [ɣ] and [ø] has an important drawback; it may obscure the individual patterns of behavior of each variant. However, when they were kept separate, [ɣ] and [ø] revealed similar distributions across the linguistic and extralinguistic factors considered. Moreover, since [ɣ] and [ø] happen in the same phonetic contexts and they are difficult to discriminate from each other, by collapsing them I avoided having to exclude so many ambiguous [ɣ] and [ø] tokens.

The results from Table 2 show that from a total of 3078 tokens, almost 80% were realized as [β] compared to 20% of [ɣ] and [ø]. Results per vowel context suggest that there is a significantly higher occurrence of [β] when followed by [a] (M=68.1, SD=23.7) t(14)=3.05, *p*=0.0087; [e] (M=76, SD=24.7) t(10)=5.94, *p*=0.0001; [i] (M=90.7, SD=13.9) t(13)=11.68, *p*=0.0000; and [o] (M=81.7, SD=19.4) t(14)=6.53, *p*= 0.0000. A following [u] increases the occurrence of labial-velar alternation and deletion to 46.6%, while [we] presents an even higher percentage of labial-velar alternation and deletion (54.4%). The data shows no significant difference favouring the occurrence of alternation and deletion when followed by [u] (M=39, SD=38.9) t(14)1.13, *p*= 0.28), however there is a significant difference favouring labial-velar alternation and deletion with a following [we] (M=69.8, SD=34.9) t(14)2.27, *p*=0.039). Unfortunately, there were no cases of alternation and deletion with a following [wi] in the data, so results could not be computed for this context.

		[β]		[ɣ] and [ø]		
		%	Count	%	Count	TOTAL
All		79	2107	21	568	2663
	[a]	73.9	676	26.1	239	915
	[e]	84.7	527	15.3	95	622
Following	[i]	94.7	461	5.3	26	487
	[o]	87.7	313	12.3	44	357
	[u]	53.3	16	46.6	14	30
	[we]	45.6	115	54.4	137	252
Literacy	Literate	83.9	1496	16.1	286	1782
	Illiterate	69.3	611	30.7	270	881
TOTAL			2107		555	

Table 2: total count and percentages of occurrence of [β], labial-velar alternation and deletion for all the speakers and according to vowel context and literacy.

Higher level of literacy has a positive effect on the occurrence of [β] (literate 83.9% vs. illiterate 69.3%). This difference is statistically significant (M=71.5, SD 11.1) t(6)5.49, *p*=0.0015. On the contrary, illiterate speakers favour the use of [ɣ] and [ø] more than illiterate speakers. However, the increase in the rate of alternation and deletion by illiterate speakers is not statistically significant (M=47.6, SD=11.2) t(6)=0.60, *p*= 0.57.

7.2. Production Experiment

The slope values for /b/ and /g/ across speakers are listed in Table 3. The average slope for /b/ is 0.61 with a *y* intercept=456Hz (s.d.0.29); /g/ slope= 0.65 with a *y* intercept=403Hz (s.d.0.23). 2 sample (two-tailed) T-tests comparing slope values for individual speakers for /b/ and /g/ showed no significant difference (/b/ M=0.61, SD=0.087 and /g/ M=0.65, SD=0.061); t(14)=1.02, *p*=0.33.

Participant	/b/ slope	/g/ slope
S114	0.592368	0.686738
S131	0.660901	0.709877
S130	0.800123	0.73247
S101	0.543835	0.651818
S117	0.510445	0.590501
S124	0.60326	0.553345
S121	0.631546	0.636509
S106	0.604735	0.693692
Average	0.62	0.65

Table 3: Summary of locus equation slopes for individual subjects for /b/ and /g/

To quantitatively determine how vowel place affected consonantal coarticulation, I calculated locus equation for /b/ and /g/ for +back vowels and diphthongs [o, u, we] vs. -back vowels [a, e, i]. Table 4 summarizes /b/ and /g/ slope values for each subject across vowel contexts:

Subject	/g/ +back	/g/ -back	/b/ +back	/b/ -back
S131	0.814658	0.452559	0.406902	0.790766
S130	0.915341	0.443733	0.656639	0.829285
S117	0.649495	0.181039	0.210257	0.741606
S124	0.728747	0.337618	0.276064	0.85755
S121	1.114385	0.631947	0.588201	0.641833
S106	1.149261	0.697516	0.697415	0.500739
S101	1.068182	0.746823	0.542865	0.539849
S114	1.101491	0.800524	0.654698	0.496493

Table 4: Summary of slope for individual speakers for /g/ and /b/ followed by +back vowels vs. -back vowels

A paired 2 sample (2-tailed) T-test performed on the slope values for vowel contexts (+back vowels vs. -back vowels) showed a significant main effect for /g/ followed by +back vowels (M=0.94, SD=0.19) as opposed to -back vowels (M=0.53, SD=0.21); t(14)=3.95, *p*=0.0015. No significant effect was found on /b/ for +back vowels (M=0.50, SD=0.18) and -back vowels (M=0.67, SD=0.15); t(14)=2.03, *p*=0.062. A locus equation scatterplot was generated to illustrate the difference in the degree of coarticulation between /b/ and /g/ across vowels contexts. The regression line equation showing slope and *y* intercept is indicated above each plot as well as the r^2 value.

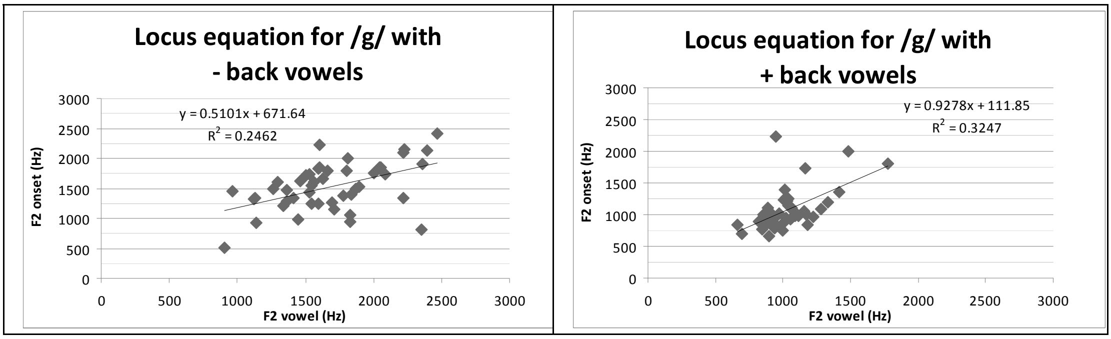

Figure 3: Locus equation for /g/ according to vowels contexts (-back vowels vs. +back vowels and diphthongs)

Two distinct data clusters can be seen for /g/ corresponding to -back vs. +back vowels. The slope for /g/ is steepest in the context of +back vowels (slope=0.92) with a low *y* intercept (111 Hz) and characterized by a tight clustering of points around the regression line. Krull (1988 in Sussman 1991:1311) pointed out that "locus equations quantify the extent of CV coarticulation. Flatter regression slopes indicate a relatively more invariant 'locus' ($k = 0$, $y = c$) as $F2_{onset}$ is stable across vowel changes, while steeper slopes ($x = y$, $k = 1$, $c = 0$) indicate maximal coarticulation as $F2_{onset}$ changes as a direct and linear function of the following vowel". The velar locus equation with -back vowels is flatter (slope=0.51) with a higher *y* intercept (671 Hz) and a more scattered cluster of points around the regression line. In Figure 4, the scatterplots for /b/ do not reveal such a marked difference in the slope values for +back vowels (slope=0.52) and -back vowels (slope=0.66). This means that the degree of coarticulation of /b/ remains more stable across vowels contexts. As with /g/ in the context of +back vowels and diphthongs, /b/ reveals the same tight clustering of points around the regression line.

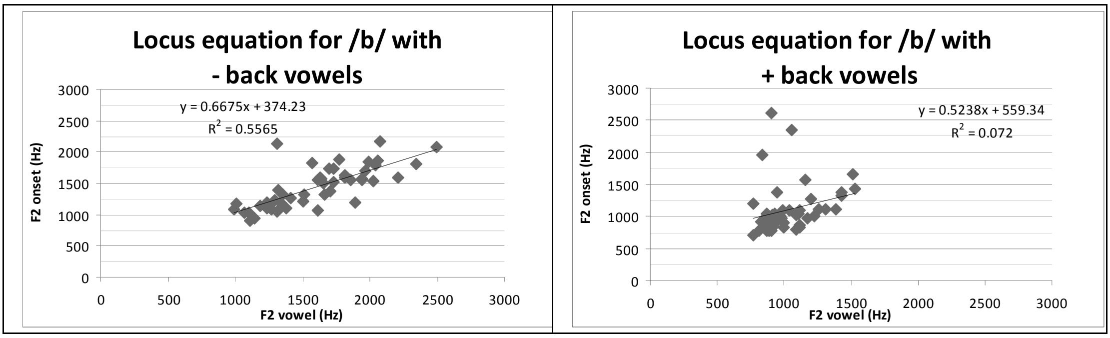

Figure 4: Locus equation for /b/ according to vowels contexts (-back vowels vs +back vowels and diphthongs)

A third analysis was done to explore the influence of literacy on the realization of /b/ and /g/. The results show a significant difference in the degree of coarticulation of /g/ for literate (M=0.084, SD=0.02) and illiterate subjects (M=0.48, SD=0.10); t(6)=6.30, *p*=0.0007, however there was no significant difference in the degree of coarticulation of /b/ for literate (M=0.65, SD=0.03) and illiterate participants (M=0.57, SD=0.11); t(6)=1.33, *p*=0.23. The slope values for /g/ and /b/ in Literate and Illiterate subjects are listed in Table 5.

Subject	**/g/ lit**	**/g/ illit**	**/b/ lit**	**/b/ illit**
S114	0.877		0.661	
S101	0.825		0.611	
S121	0.814		0.699	
S106	0.853		0.662	
S117		0.340		0.449
S124		0.473		0.533
S131		0.543		0.590
S130		0.592		0.731

Table 5: summary of slope values for /b/ and /g/ according to Literacy

I analyzed the influence of literacy and vowel context on the slope values of /b/ and /g/. I averaged the slope values of /b/ and /g/ for +back vowels ([o], [u], [we]) and for -back vowels ([a], [e], [i]) for literate and illiterate participants.

Literacy	consonant	vowel	Mean, SD		Probability
Literate	/b/	+back	0.62	0.06	$p < 0.0001$
	/g/	+back	1.10	0.03	
Illiterate	/b/	+back	0.38	0.19	$p = 0.014$
	/g/	+back	0.77	0.11	
Literate	/b/	-back	0.54	0.06	$p = 0.012$
	/g/	-back	0.71	0.07	
Illiterate	/b/	-back	0.80	0.05	$p = 0.0006$
	/g/	-back	0.35	0.12	

Table 6: results of the paired 2 sample (2-tailed) T-tests comparing the slope values of /b/ and /g/ in the context of +back vowels for literate and illiterate participants, and for /b/ and /g/ in the context of -back vowels for literate and illiterate participants

As explained in section 6.1, the data collected in the production experiment was used to test the hypothesis that a following +back vowel influenced the acoustic characteristics [ɣ] making it more similar to [β]. Thus, if the slope values of /b/ and /g/ were similar in the context of +back vowels, then this would explain why speakers confuse them in perception. Since the labial-velar alternation is more frequent in the illiterate population, I expected that there would be no significant difference between /b/ and /g/ in the context of +back vowels for illiterate speakers. As Table 6 shows, this is not what I found. When literacy and vowel type are combined, the statistical test showed significant difference in the coarticulation of /g/ and /b/ followed by -back vowels for literate and illiterate speakers. Contrary to what I had expected, the statistical tests also showed a significant difference in the coarticulation of /g/ and /b/ followed by +back vowels and diphthongs for both, literate and illiterate speakers. However, when more factors are taken into consideration for the analysis, the number of tokens per cell becomes smaller, which in turn reduces confidence in the results obtained. In this analysis, there were only 4 tokens per cell, thus the reliability of the results obtained diminishes considerably. In the future, it will be necessary to add more data to the analysis. Nevertheless, there is a clear tendency for /g/ to show a high degree of variability in the slope values across vowels contexts, which was not evidenced in the results of /b/. This finding was also reported in Sussman et al. (1991).

7.3. Perception Experiment

To evaluate the influence of individual vowels on the degree of discrimination of /b/ and /g/, I counted the number of errors per vowel context. Figure 5 illustrates how the number of errors increases when the approximants are followed by either [u], [we] and [wi].

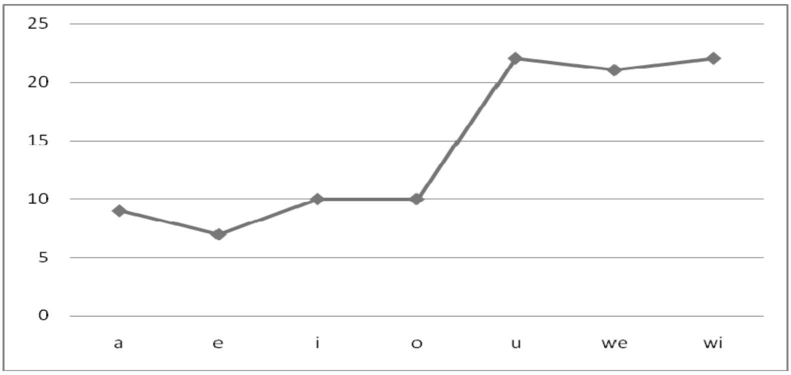

Figure 5: Number of discrimination errors for /b/ and /g/ according to following context.

Two sample T-tests (two-tailed) were used to determine if there were statistical differences in the degree of discrimination across different types of vowels. To maintain consistency, I included -back vowels [a, e, i] in one group and +back vowels and diphthongs [o, u, we, wi] in another. The results show a significant difference in the level of discrimination of /b/ and /g/ in the context of -back vowels (M=3.25, SD=3.24) as opposed to +back vowels and diphthongs (M=9.37, SD=4.69); t(14)=3.04, p=0.0088.

Literate speakers have fewer discrimination errors than illiterate speakers (39 vs 62, respectively). The statistical tests from 8 participants do not show a significant difference t(3)=1.08, p=0.36 in the level of discrimination of /b/ and /g/ for literate (M=9.7, SD=3) and illiterate subjects (M=15.5, SD=10). Subsequent analysis of a larger number of participants (42), however, does show a significant difference (t(17)=2.23, p=0.04) in the level of discrimination for literate (M=12.67, SD=4.52) and illiterate (M=27, SD=27) groups. In this study, I presented data from eight speakers to keep consistency along the three experiments.

8. Discussion and Conclusion

Blevins (2004) stated that it is only through detailed study of speech perception and production that we come to understand the range of phenomena which underlie regular sound change. The main purpose of this paper was to analyze and explain the origin as well as the spread of the labial-velar alternation, which is a pervasive and widespread variation in Spanish. This section will be used to explain and draw a connection between the results obtained from the sociolinguistic interviews, production and perception experiments.

The sociolinguistic analysis of interviews showed a significant higher occurrence of [β] with a following [a], [e], [i] and [o]. However, the occurrence of [β] decreased considerably with a following [u] (54.4%). On the other hand, the labial-velar alternation was significantly favoured by [we]. The analysis of the influence of education on the occurrence of the labial-velar alternation showed that literate speakers favoured the use of [β], whereas illiterate speakers favoured the use of [ɣ] and [ø]. However, the difference in the rate of [ɣ] and [ø] by literate and illiterate speakers was not significant. This suggests that the labial-velar alternation may occur below the level of consciousness and social awareness. With more data that compares the occurrence of this variation in younger and older groups, it will be possible to determine if this variation is a case of sound change in sociolinguistic terms. However, the number of speakers used in this paper does not allow us to determine language change at the moment.

The acoustic analysis of tokens in the production experiment showed that the slope values for /b/ are flatter while those of /g/ are steeper. As previously stated, a steeper slope translates into a higher degree of coarticulation with $F2_{onset}$ varying as $F2_{vowel}$ changes, whereas a flatter regression slope indicates a relatively more invariant locus as $F2_{onset}$ is stable across vowel changes (Sussman *et al.* 1991). These results further confirm Sussman's (1991:1314) findings regarding the locus equation of /g/ "Two vowel subsets with different orientations can be noticed. Front vowel $F2_{onsets}$ are fairly stable (at approximately 2200 Hz) and horizontally aligned. The back vowel cluster is much steeper with $F2_{onset}$ varying as $F2_{vowel}$ changes. This palatal/velar dichotomy was typical of all speakers." The statistical tests comparing the slope values of /b/ and /g/ for +back vowels and diphthongs and -back vowels showed a significant difference. To corroborate my hypothesis that /b/ and /g/ become more similar in the context of +back vowels, I was expecting to find no significant difference in their slope values in this specific context. However, as stated earlier, these results were obtained with a low number of tokens per cell, which might change as new data is added.

Finally, the results of the perceptual analysis showed an increased level of discrimination of /b/ and /g/ in the context of -back vowels, while following +round vowels and diphthongs significantly reduced the degree of discrimination of these consonants. The results of perception confirmed the hypothesis that /b/ and /g/ are more difficult to discriminate, thus are more likely to be confused, in the context of +back vowels and diphthongs. Regarding the influence of education on the discrimination of sounds, literate participants were better able to discriminate between /b/ and /g/.

When the results from the interviews, production and perception experiments are tied together, there is a clear connection between speech and experiments in that:

- Sociolinguistic interviews: labial-velar alternation is highly constrained by +back vowels and diphthongs. More labial-velar alternation was found in the speech of illiterate participants.
- Production experiment: the regression slope of /g/ became steeper in the context of +back vowels and diphthongs. A steeper slope indicates maximal coarticulation. In Sussman *et al.* (1991:1317), the slope of /g/ followed by back vowels overlapped with the slope of /b/.
- Perception experiment: the percentage of discrimination of /b/ and /g/ is lower in the context of +back vowels and diphthongs. Literate participants are better discriminators of /b/ and /g/ than illiterate participants.

This article presented an analysis of the labial-velar alternation, a widespread phenomenon in disparate Spanish varieties. I hypothesized that this alternation originated in the misperception of acoustically similar sounds. The analysis of locus equation showed that the regression slope for the velar approximant varied considerably as a function of the following +back vowel and diphthong. The results from the perception experiment further showed that /b/ and /g/ become difficult to discriminate in the context of +back vowels and diphthongs. In addition, the results from the sociolinguistic interviews showed that the labial-velar alternation is clearly favoured by +back vowels and diphthongs. Literate participants presented a lower rate of this non-standard variant, which further confirms the idea that orthography can help to resist perceptually driven variation. On the whole, speakers tend to confuse /b/ and /g/ in the context of +back vowels and diphthongs. Experienced or, in the present case, literate speakers can normalize the speech signal better than inexperienced or illiterate speakers. According to Ohala (1993), children and illiterate speakers who do not have the written form of words to confirm their perceptions will take the signal at face value. If the right social conditions are met, this variation in the pronunciation will propagate in the larger speech community. However, the sociolinguistic results of the labial-velar alternation in Caa Cati Spanish reveal that literacy seems to block the propagation of this perceptually driven variation.

With the sociolinguistic and experimental (acoustic and perceptual) analysis of the labial-velar alternation, it was possible to elucidate its initiation and propagation. As previously stated, this variation has lingered in speech for a long time and, with the present study, I have offered an explanation of the perceptual and acoustic motivations of the labial-velar alternation. The science of linguistics advances as we come to understand the range of variation occurring within and across dialects. This understanding is possible by examining language in its social and cultural context.

9. Appendix

9.1. Production Test

List of real words with /b/ and /g/ in medial stressed and unstressed position

Stressed		Unstressed	
/b/	/g/	/b/	/g/
Ca**ba**llo	Alpar**ga**ta	La**va**rropa	Ci**ga**rrilo
Cer**ve**za	Ju**gue**te	Cer**ve**cita	Hambur**gue**sero
Be**bi**da	Jue**gui**to	Ha**bi**tación	Do**gui**
De**bo**ca	A**go**sto	A**bo**gado	Ma**go**
Di**bu**jo	La**gu**na	Di**bu**jo	A**gu**jero
A**bue**lo	Ver**güe**nza	**<bue>**	**<güe>**
<bui>	**<güi>**	Distri**bui**dora	**<güi>**

9.2. Perceptual Test

List of nonsense words with /b/ and /g/ in initial and medial position

Initial Position			
Stressed		Unstressed	
/b/	/g/	/b/	/g/
Bado	**Ga**do	**Ba**pero	**Ga**pero
Beco	**Gue**co	**Be**sano	**Gue**sano
Bipa	**Gui**pa	**Bi**daco	**Gui**daco
Boña	**Go**ña	**Bo**dan	**Go**dan
Budo	**Gu**do	**Bu**cano	**Gu**cano
Buello	**Güe**llo	**Bue**ron	**Güe**ron
Buira	**Güi**ra	**Bui**mano	**Güi**mano

Medial Position			
Stressed		Unstressed	
/b/	/g/	/b/	/g/
Se**bá**no	Se**gá**no	Da**ba**ciar	Da**ga**ciar
Ti**bé**la	Ti**gué**la	La**be**ricia	La**gue**ricia
Sa**bí**ña	Sa**guí**ña	Te**bi**nal	Te**gui**nal
Re**bó**da	Re**gó**da	Sa**bo**dan	Sa**go**dan
Te**bú**men	Te**gú**men	Ta**bu**ción	Ta**gu**ción
Pa**bue**ro	Pa**güe**ro	Ta**bue**cado	Ta**güe**cado
Pa**bui**n	Pa**güi**n	Pa**bui**ñal	Pa**güi**ñal

References

Blevins, J. 2004. *Evolutionary Phonology. The Emergence of Sound Patterns*. Cambridge, CUP.

Borzone de Manrique, A. M. & M. I. Massone. 1981. Acoustic analysis and perception of Spanish fricative consonants. *Journal of the Acoustical Society of America,* 69(4). 1145-1153.

Catford, J. C. 1977. *Fundamental Problems in Phonetics*. Edinburgh: Edinburgh University Press.

Hardcastle, W. J. and N. Hewlett (eds.). 1999. *Coarticulation: Theory, Data and Techniques*. Cambridge: CUP.

Hernández, J. 1979. *Martin Fierro*. Cuba: Casa de las Américas.

Labov, William. 1984. Field methods of the project on linguistic change and variation. In Baugh J. & Sherzer J. (eds.), *Language in Use: Readings on Sociolinguistics*. Englewood Cliffs, N.J.: Prentice-Hall. 28-54.

-----. 1994. *Principles of Linguistic Change*, vol 1, *Internal Factors*. Cambridge and Oxford: Blackwell Publishers.

-----. 2007. *Transmission and diffusion***.** Language 83: 344–87

Ladefoged, P. 1964. *A Phonetic Study of West African Languages*. Cambridge: CUP.

-----. 2003. *An Introduction to Fieldwork and Instrumental Techniques*. USA: Blackwell Publishing.

Ladefogued P. and I. Maddieson. 1996. The Sounds of the World's Languages. Oxford: Blackwell.

Lindblom, B. 1963. On vowel reduction. Rep. No. 29, *The Royal Institute of Technology, Speech Transmission Laboratory*, Stockholm, Sweden.

-----. 1990a. Explaining phonetic variation: a sketch of the H & H theory. In Hardcastle W. and A. Marchal (eds.), *Speech Production and Speech Modelling,* pp. 403-39. Dordrecht:Kluwer.

Lloyd, P. 1987. From Latin to Spanish. *Memoirs*, vol 173. Philadelphia: American Philosophical Society.

Mann, V.A., and Repp, B.H. 1980. Influence of vocalic context on perception of the [sh]-[s] distinction. *Perception & Psychophysics*, 28, 213–228.

-----. 2005. Aspiration and velarization of /f/ in Argentine Spanish. *Toronto Working Papers in Linguistics,* volume 25, pp. 58-67.

Martínez-Celdrán, E. 2004. Problems in the classification of approximants. *Journal of the International Phonetic Association,* 34. 201-210.

Menéndez Pidal, Ramón. 1964. Cantar de mío Cid, vol 1, Gramática, 4th ed. Madrid: Espasa-Calpe.

Milroy, L. 1987. *Language and Social Networks*. Oxford: Blackwell.

Ohala, J. J. 1989. Sound change is drawn from a pool of synchronic variation. In L. E. Breivik and E. H. Jahr (eds.), *Language Change: Contributions to the Study of its Causes.* New York: Mouton de Gruyter.

-----. 1992. What's cognitive, what's not, in sound change. In Kellermann, G. and M.D. Morrissey (eds.), *Diachrony within Synchrony: Language History and Cognition.* Frankfurt am Main. Peter Lan Verlag, pp. 309-355.

----- 1993. The phonetics of sound change. In Charles Jones (ed.), *Historical Linguistics: Problems and Perspectives.* London: Longman. 237-278.

Penny, R. 1991. *The History of the Spanish Language*, 2nd ed. Cambridge: CUP.

Pickett, J. M. 1999. *The Acoustics of Speech Communication. Fundamentals, Speech Perception, Theory, and Technology*. Boston Allyn and Bacon.

Quilis, A. 1993. *Tratado de Fonética y Fonología Españolas.* Madrid: Editorial Gredos.

Steeles, J. (Under revision) *Perceptually-driven deletion and the positive role of orthography in L2 phonological acquisition.* 32pp.

Sussman, H. M., McCaffrey, H. and S. A. Matthews. 1991. An investigation of locus equations as a source of relational invariance for stop place classification. *Journal of the Acoustical Society of America*. 90 (3), pp. 1309-1325.

Sweet, H. 1874. *History of English Sounds*. London: Trübner.

Trask, R. L. 1996. Dictionary of Phonetics and Phonology. London: Routledge

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