Production and perception of stop consonants in Spanish, Quichua, and Media Lengua

by

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A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

Department of Linguistics

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Winnipeg

Abstract

This dissertation explores the phonetics and phonology of language contact, specifically pertaining to the integration of Spanish voiced stops /b/, /d/, and /g/ into Quichua, a language with non-contrastive stop voicing. Conflicting areas of convergence of this type appear when two or more phonological systems interact and phonemes from the target language are unknown natively to speakers of the source language.

Media Lengua is a mixed language with an agglutinating Quichua morphology, and Quichua syntactic and phonological systems where nearly all the native Quichua vocabulary has been replaced by Spanish. This extreme contact scenario has integrated the voiced stop series into Media Lengua and abundant minimal pairs are present. If the phonological system of Media Lengua is indeed of Quichua origin however, how have speakers integrated the voiced stop series productively and perceptually? Have they adopted different strategies from Quichua speakers? If so, how do they differ?

Chapter 1 sets the scene with an in-depth description of how contact between Spanish and Quichua has mutually influenced each language at the morphosyntactic level. Chapter 2 explores voice onset time (VOT) production in all five language varieties. Statistical modeling is used to search for differences in duration while taking into account a number of linguistic and demographic factors. Chapter 3 investigates stop perception in Media Lengua and Quichua, and uses Urban Spanish as a point of comparison. Chapter 4 looks at phonetic pre-nasalization in voiced stops across Media Lengua, Quichua, and Urban Spanish. Chapter 5 describes allophonic variations in stop production. The final chapter speculates on the nature of sound change at the phonetic level and explores possible origins of Media Lengua.

Production results show that Media Lengua VOT duration values have shifted away from Quichua towards Rural Spanish. The perceptual results show an age-based effect with older Quichua speakers, which shows more random responses to the stimuli than younger speakers. This effect was not found in Media Lengua or Urban Spanish speakers. Similar age-based results were also found for stop weakening tendencies in Quichua and L2 Spanish speakers, while Media Lengua, Rural, and Urban Spanish speakers were not significantly affected by age.

Acknowledgements

For me this section is more about acknowledging those who have, in some way, positively impacted my journey through higher education rather than just my dissertation, since, in a way, this paper closes the chapter to this journey. Regrettably, I am sure there are a handful of people I have unwittingly left out. My sincerest apologies. Coffee?

From the University of Manitoba, I would to express my utmost gratitude to my advisor Dr. Kevin Russell for sharing his brilliant mind with me. If I ever gain a fraction of the clarity for understanding language as you do, I know I'll be going places. I owe much of my sanity and progress over the last few years to Dr. Nicole Rosen who has provided me with amazing insights, sound advice, encouragement, incredible opportunities for work and travel, and friendship. So few people work on mixed language phonetics and phonology! So how lucky was I when she was hired on halfway through my PhD?! I would also like to thank the internal member of my committee, Dr. Enrique Fernandez for his comments and feedback. Moreover, I would like to thank the external committee member, Dr. John Lipski for his excellent insights, feedback, and encouragement.

I would also like to thank Dr. Rob Hagiwara for his award winning personality and friendship. He is always there when I need to rack his amazing brain to make sense of that annoying acoustic detail eluding me or when I just need sixies. I also owe a debt of gratitude to Dr. Erin Wilkinson and Sherra Yorobe for their friendship and opening my eyes to signed language linguistics (and with that, their patience!) I would also like to thank Brenna Haimes-Kusumoto for her friendship from day one in Research Methods class! Thank you for all our walks and letting me rant! From the University of Manitoba, I would also like to thank Terry Janzen for his continued support in all my academic endeavours, Verónica Loureiro-Rodríguez for adding a bit of street cred to linguistics, Anna Parenteau and Adam Tallman for being awesome, Vicente Cardozo, aguyje por su amistad, and شكرا Mohammad Ahmad Al-Omari and Mutasim Deaibes for your friendship as well. I owe a lot to Debbie Spindler and Heather Lee for holding the department together and helping me out whenever I was in a bind. Grad school would have only remained a dream if were not for the gracious funding from the UMGF and MGS.

También estoy en deuda con tres lingüistas increibles, Dra. Martine Bruil, Martin Kohlberger, y Dr. Simeon Floyd por su amistad y por compartir mi obsesión con las lenguas del Ecuador. Me siento muy afortunado por haberlos conocido. Además al Dr. Jorge Gómez-Rendón y al Dr. Pieter Muysken quienes me guiaron hacia la Media Lengua a través de sus publicaciones. There is another group of linguists from the University of Victoria who have taken me in as one of their own: Marianne Huijsmans, Sky Onosson, Christiani Thompson, and Dr. Alex D'Arcy, you guys are great and I'm lucky to call you my friends. I'd also like to thank all the wonderful and amazing people I meet at CoLang 2014! You know who you are. There are also several people who have impacted my academic journey in different ways. Dr. Deborah Teed was my first linguistics professor and it was in her class I was convinced I was going to be a linguist. I owe a debt of gratitude to Dr. Marianne Bailey for mentoring me though my BA and persuading me to go to grad school. I'd like to thank Bruce Crise for all of our conversations about grad school all those years ago in Ansan. I'd also like to thank Ronaldo Bowins for his friendship and support, Mathieu Paillé for making my first university teaching experience enjoyable. También quiero agradecer a mis grandes amigos de Ecuador: Daniel Ponce, Cristian Villacrés, Sandra Quishpe, Lorena Rueda, Angelita Reyes, Alex Trávez, Cris Pulupa, Eduardo Portilla, Juan Carlos Beltran,

Wilson Rosales, Verónica Tapia, Bolívar Villacís, Judith Ayala, Dr. Luis Ayala, Dra. Rosa Ayala, y Lupe Vaca, por su amistad y por haber participado en este estudio (ya saben quiénes son).

Yoka todito ese gentikunamanmi Pijalmanta arsho agradecini. Sin ostikunaka nada no teninichu. Voskunapa idiomatapish, amistadtapish, comidatapish, kawsaytapish compartirkanguichimi yowan. Voskunaka yopa familiashinami kanguichi. Gracias Don Antonio Maldonado, Doña Luz María Gualacata, Lucia Gonza, Cynti Inuca, Juan Inuca, Bolivia Chicaiza, Isabel Bonilla, Anita Cañarejo, Elvia Gualacata, Mercedes Tabango, Miry Gonza, Luis Bonilla, Carmen Cañarejo, Homero Gonza, Rodrigo Gonza, José Antamba, Isabel Quilumba, Feliciano Inuca, Zolia Manina, María Cristina, Oswaldo Tocagon, María Maldonado, Dianita Maldonado, y Luis Fernando Pijal.

Ñukakapash, tukuy mashikunamanmi Chirihuasimantapash Cashalomatapash yupaychanata munani. Kikinkunapa shimitapash, mikuytapash, kawaytapash wakirkanguichi ñukawan. Yupaychani mashi Elvis Tuquerres, Marisol Farinango Tapia, Klever Tuquerres, Aurora Carlosama, Carlos Farinango, Hermelinda Tuquerres, José Manuel Tuquerres, Manuela Amaguaña, Rosa Guatemal, Rosa Quilla, Rosa Matilde, y María Ester. También quiero reconocer la colaboración de la facultad de la escuela Tarquino Idrobo quienes participaron en este estudio.

Finally *none* of this would have been possible without the love and unconditional support from my family. My mom, who was and is still convinced that I'm way smarter than I actually am. If I ever needed an ego boost, I always know who to call. I love you. My sister Kim, whose unconditional support has led me to take advantage of her generosity on numerous occasions, most notably the months I spent on her living room chair writing my dissertation, eating her food, driving her car, and taking up space. I wouldn't be whole without you. My sister Katie for always letting me know how she really feels about anything and everything. My sister Kelly for keeping me grounded and being a constant reminder that language is only one of many ways people communicate. My dad for supporting us growing up and for not letting me be complacent. I also owe a debt of gratitude to Brian for putting up with me with no familial obligations.

Debo mucho a mi suegra Cecilia Ayala por tratarme como si fuera uno de sus hijos. Pero sobre todo por haber creado a la persona más importante de mi vida. Gaby, no hay palabras para expresar lo que significas para mí. En el 2003 un joven e ingenuo muchacho tomó la mejor decisión de su vida dentro del cráter de Quilotoa. Gracias por acompañarme en esta vida. No sería nadie sin tu amor, amistad, sacrificios, y apoyo incondicional. Sonrio por que el camino es aún largo y nos queda mucho por hacer juntos. Te amo.

Dedication

To my mom, Sam Bates, for her unconditional love, support, and sacrificing so much for her children

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Abbreviations

CI_{95}	95% Confidence Intervals
F1	Formant 1
F2	Formant 2
F3	Formant 3
Hz	Hertz
Q	Quichua
L1	First Language
Pa	Pascal
LPC	Linear Predictive Coding
ML	Media Lengua
SOV	Subject – Object – Verb
VOT	Voice Onset Time
WAV	Waveform Audio File Format
β	Coefficient Estimate
MSLP	Modern Sri Lankan Portuguese

Glosses

1	First Person
2	Second Person
3	Third Person
ABL	Ablative
ADIT	Additive Marker
ACC	Accusative Marker
BEN	Benefactive Marker
CAU	Causative Marker
COM	Comitative Marker
COND	Conditional
DAT	Dative Marker
DEP	Depreciative Marker
DET	Determiner
DIM	Diminutive Marker
DIR	Directional Marker
DS	Different Subject
F	Feminine
FUT	Future
GEN	Genitive Marker
ID	Indirect Object
IMD	Immediate
IMP	Imperative Marker
INF	Infinitive Marker
INFORMAL	Informal Marker
INST	Instrumental Marker
LIM	Limitative Marker
LOC	Locative Marker
NEG	Negative Marker
NOM	Nominal Marker
OBJ	Object Marker
ORI	Orientation Marker
P	Intrinsic Plural
PL	Plural Marker
PST	Past Tense
PRF	Perfective Tense
POSS	Possessive
PREP	Preposition
PRES	Present Tense
PROG	Progressive/Continuous Marker
PURP	Purpose Marker
Q	Question
QUOT	Quotative
REFL	Reflexive Marker
REP	Reportative Marker
S	Singular

SG	Singular
SS	Same Subject
SUBJ	Subjunctive
TOP	Topic Marker
TOT	Totality Marker
TRANS	Translocative Marker
VAL	Validative Marker
Y/N	Yes/ no

Chapter 1

Setting the scene

1 Introduction

This dissertation describes intra-group phonetic integration and inter-group phonetic variation of stop consonants from two language families with a long history of contact and mixing–Spanish (Section 1.5) and Quichua[1] (Section 1.6). From these families, five languages/ dialects with varying degrees of contact are the focus of study.

Three primary areas of interest regarding language interactions are a general theme of this work. The first is to thoroughly describe the stop inventories of each language variety under investigation since little or no work currently exists in the literature regarding acoustic and perceptual studies of the highland languages of Ecuador. The documentation of stop consonants in these languages will help fill this gap with descriptions of voice onset time (VOT) production, stop perception, nasality in voiced stop consonants, and variation of stop consonant production in all five language varieties.

For my second area of interest, I explore how native and non-native stop consonants interact at the phonetic level across a language contact-continuum. The ground work of this research exploits phonemic conflict sites (Section 1.4) and explores empirical evidence from acoustic and perceptual data across the language varieties under investigation. Based on interactions at the phonetic level, in a third area of interest, I begin to explore whether categorical distinctions between so called 'bilingual mixed languages' (Section 1.2) and 'conventional contact languages' (Section 1.1) can still be applied at the phonetic level.

[1] The Ecuadorian variety of Quechua is known as *Quichua* or *Kichwa* /ˈki.ʧua/ by both mestizo and indigenous populations.

This examination relies on quantitative phonetic and perceptual evidence from the stop consonant inventories of each language variety under analysis in this dissertation along with past studies of phonemic conflict sites in Media Lengua and other 'bilingual mixed languages'. Results should begin to provide evidence as to whether the aforementioned categorical distinctions are still relevant at the phonetic level. One example in support of a categorical distinction would be a language division based on purely linguistic factors e.g., code-switching induced phonetic change. On the other hand, if social factors e.g., group identification, were responsible for such a phonetic division, changes affecting a 'bilingual mixed language' could just as well apply to a 'conventional contact language'. If a 'bilingual mixed language' and its 'conventional contact language' counterpart show little or no difference in how they accommodate non-native phonemes, this might suggest there is no need to differentiate between these language classifications at the phonetic level.

I specifically chose the Ecuadorian highlands for this study as there exists a well-marked language contact-continuum between Formal Spanish and Unified Quichua[2] (Figure 1). In the middle of this continuum, a rare 'bilingual mixed language' called Media Lengua (Section 1.7) formed through extreme lexical borrowing known as relexification (see Muysken, 1981, p. 94) (Section 1.3).

[2] Unified Quichua is the official variety of Quichua adopted in 1980 at a meeting of Quichua speakers from different regions of Ecuador (King, 2001). Although there are many disparities between the colloquial varieties and unified variety, perhaps the most noticeable variations concern lexicon. There are numerous ‘new’ words, which are foreign to speakers of colloquial Quichua. Many of these neologisms were created to replace Spanish loan words. King (2001, p. 93) also states “Unified Quichua also employs grammatical features that ‘colloquial Quichua’ does not” e.g., making case markers like ‘*–ta’* obligatory when they are optional in ‘authentic’ varieties. Finally, speakers of Unified Quichua tend to pronounce words as they are written e.g., *tanta* /tanta/ ‘bread’ and not /tanda/.

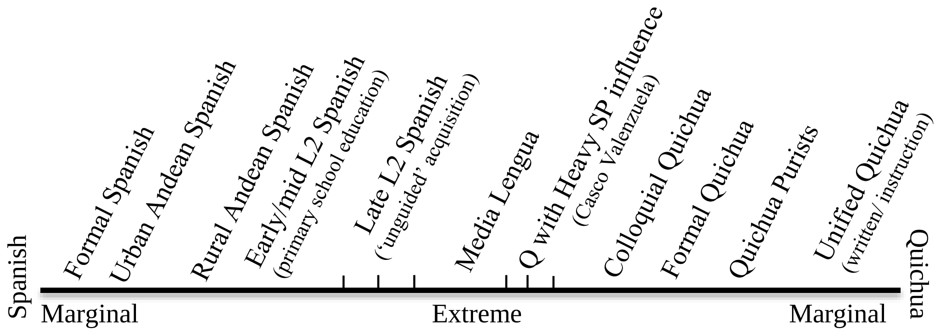


Figure 1: Language contact continuum between Spanish and Quichua in Ecuador.

Language contact often results in different registers along a contact continuum. At the far ends, opposing languages have little influence on the lexicon and structures which make up the language. These varieties are often only found in written form or formal discourse settings e.g., speeches and news broadcasts, and are often influenced by prescriptivist rules taught in classroom settings. Between the end points and mid-point, varying degrees of syncretic speech styles exist via structural and lexical influences from the opposing language. In the middle, complete lexical categories may be replaced by the superstrate language. These extreme varieties or 'mixed languages' are often unintelligible to monolinguals of both source languages who speak dialects found towards the ends of the contact continuum (Mous, 2003a, 2003b; Muysken, 1997). Languages which reach the mid-point of this continuum are rare and to date only 22 have been classified as 'bilingual mixed languages', including Media Lengua under investigation here (P. Lewis, Simons, & Fennig, 2013; Nordhoff, Hammarström, Forkel, & Haspelmath, 2013).

The five contact language varieties analyzed in this dissertation include: (1) a rural variety of L2 Andean Spanish spoken by early to mid L1 Quichua bilinguals from the northern province of Imbabura (henceforth, L2 Spanish), (2) another rural variety of Andean Spanish spoken as an L1 by monolingual Mestizos from Imbabura (henceforth, Rural Spanish), and (3) Rural Imbabura Quichua from the same province (henceforth, Quichua). In the early 20th century, these varieties gave birth to the fourth language under investigation, (4) Media

Lengua from the community of Pijal. While there are varying degrees of sociolinguistic tolerance in these communities, conversations with speakers generally suggest some level of stigmatization by both their own speakers and speakers of the fifth language variety under investigation, (5) Urban Andean Spanish (henceforth, Urban Spanish) spoken in the nation's capital, Quito. Conversations regarding Media Lengua and Cayambe Quichua with Otavaleño speakers in the artisan market in Otavalo, also suggest some degree of stigmatization of these varieties; more so for Media Lengua than Quichua. This attitude towards rural Quichua varies and appears to be more of a social phenomenon than linguistic since little, if any variation exists between the dialects. Spanish, no matter the dialect, is considered more prestigious than both Media Lengua and Quichua as noted in various conversations with parents who have decided not to pass on these languages to their children.

The phonemic conflict sites under analysis involve stop consonants and focus specifically on how Quichua, a language with non-contrastive stop voicing, adapts voiced stops into the lexicon through Spanish borrowings and whether Media Lengua applied a similar or different strategy during relexification. The second chapter specifically analyzes stop production where voice onset time (VOT) measurements are used as a diagnostic tool to explore the integration of a voicing contrast into the stop series of Media Lengua and Quichua. Voice onset time duration measurements are also used to explore any Quichua influence in both the voice and voiceless series of stops in L2 and Rural Spanish, while Urban Spanish VOT is used as a basis for comparison with the other language varieties. Linear mixed effects models are used to provide a statistical basis for the results in this section.

The third chapter uses a word discrimination task made up of Spanish-derived minimal pairs with gradient VOT shifts between voiced and voiceless stops. This experiment is used to seek out any perceptual differences regarding how Urban Spanish, Quichua, and Media Lengua speakers perceive the stop voicing contrast. Generalized linear mixed effects models are used to provide a statistical basis for the results.

The fourth chapter investigates nasality of stops using a new method dubbed 'The Earbuds Method", which can be used to explore the phonetic nasalization of voiced stops— an apparent characteristic of voiced stops in Spanish as per Solé and Sprouse (2011). This experiment makes use of time aligned recordings captured from both the nasal and oral tracts and superimposes the intensity contours. A frame-by-frame analysis is then used to determine the oral-to-nasal ratio in each stop, providing a very detailed analysis of intensity fluctuations from both tracts. Results suggest the vast majority of voiced stop consonants appear to contain some degree of phonetic pre-nasalization.

The fifth chapter describes stop consonant variations observed in the data. This chapter includes: devoicing, weakening (fricativization), affrication of word-initial 'tr' clusters, voiced stops as fillers, and post-[g] frication. Several findings from this section are also used to support the phonetic pre-nasalization of voiced stop consonants hypothesis from Chapter 4. Results from the post-[g] frication also help explain the perceptual results between [g] and [k] in Chapter 3.

The sixth and final chapter discusses the findings of this dissertation and how they help to approach the broader questions asked at the beginning of this chapter. Here, two main areas of inquiry are elaborated on: (1) how non-native stop consonants interact at the phonetic level across all the language varieties in a multidimensional space rather than in a linear contact-continuum; and (2) how such interactions may begin to be used to explore whether categorical distinctions between 'bilingual mixed languages' and 'conventional contact languages' are still applicable at the phonetic level. This chapter also provides commentary on linguistic, geographical, socio-historical, and age of acquisition factors to describe statistically significant and observational shifts in the data from one language variety to another.

1.1 Language contact

There is a large body of literature which attempts to explain what happens when two or more language varieties come into contact. As a group, contact language varieties typically exhibit similar types of changes. The degree of change, however, can vary considerably. It has been shown that when contact takes place, extra-linguistic factors place one language variety in a more favourable or 'prestigious' position over the other(s). The prestigious language variety, (henceforth 'superstrate') often has an unidirectional influence on the non-prestigious language variety (henceforth 'substrate') (Fought, 2010; Hickey, 2010a). Instances of languages with a high degree of contact induced change include: Canadian French via Canadian English, and Guaraní and Quichua via Spanish.

Under the right conditions, all linguistic elements can theoretically be subject to transfer (Thomason, 2001). Open class or content-word borrowings are the most common element copied on to the substrate language (Hickey, 2010a; Winford, 2010). The reasoning behind the higher prevalence of open class morpheme borrowings over systemic loans comes from the fact that integration to the morphosyntactic structure of the language is non-essential— an often difficult task for monolingual and adult speakers. Prolonged contact and bilingualism, however, frequently result in changes to the superstrate language and higher degrees of systemic loans are transferred (Hickey, 2010a). Often times when a negative language attitude develops among the speakers of the substrate language, learning the superstrate becomes a priority. Once attained, it is commonly the only language transferred to their children— often skipping the centre of the continuum in Figure 1. The superstrate language, however, is frequently marked since it is typically acquired by the children's parents as both an L2 and under 'unguided' conditions (Hickey, 2010a). Unguided language acquisition often leaves speakers with the need to fill in categorical gaps in the newly acquired language. Under these conditions, systemic loans from the substrate language can enter into the new superstrate dialect (Hickey, 2010b).

Another domain which is resistant to transfer is that of phonology. Under typical conditions loanwords conform to the phonological constraints of the recipient language. This adaptation not only affects a loanword's phonology, but also segmental, phonotactic, suprasegmental, and morphophonological elements (Kang, 2011). Because of phonological assimilation, loanwords often become indistinguishable from the native lexicon (Winford, 2010). However, as the contact situation intensifies and learning becomes more 'guided', phonological and phonetic features may also be come from loanwords (Thomason, 2010). In very intensive contact situations phonology from the source language may also be borrowed into the recipient language's native vocabulary (Thomason, 2010). In some cases, both language varieties become so structurally similar that it becomes difficult to classify them as belonging to separate families. These convergent varieties are known as *sprachbund* languages (Malcom, 2003) for instance, Romanian (Romance-Baltic).

1.2 Mixed languages

Language contact in rare cases may exhibit extreme convergence or 'fusion' which goes beyond the aforementioned 'conventionalized' descriptions of languid contact. Mixed languages are known to arise in bilingual settings and often mark a new ethnic identity (Matras & Bakker, 2003b). They typically inherit distinct elements from separate source languages resulting in stratified systems in the new language. There is another relatively large body of literature which attempts to define the results of these contact scenarios as 'bilingual mixed languages'.

Bakker (1997) considers four fundamental groups of mixed languages: The first group consists of intertwined or lexical-grammar languages is the largest group which includes Angloromani (Hancock, 1984) Media Lengua (Muysken, 1981) and Ma'á (Mous, 2003a). Languages of this type are often considered as prototypical mixed languages due to their number and their split between lexical and grammatical systems (Bakker, 2003; Bakker & Mous, 1994; Matras & Bakker, 2003a; Winford, 2010). Phonology is considered part of the grammatical system of these languages. This is observed in the phonological regularization of lexical items from language A to that of the grammatical source language B (Bakker, 2003). Therefore, the Spanish lexicon in Media Lengua sounds like that of Quichua while the Romani lexicon in Angloromani sounds like that of English.

The second group consists of converted or 'form-semantic' languages such as Modern Sri Lankan Portuguese (MSLP). These languages undergo radical changes to their typology while maintaining native vocabulary and systemic elements (Bakker, 2003). While little is mentioned regarding the phonological traits of this group as a whole, Smith (1978) shows the MSLP vowel system to be of Portuguese origin regarding number and place of articulation, but having eliminated the nasal contrast found in Portuguese in favour of the length contrast in Tamil.

The third group consists of mostly mixed pidgins, creoles and trade languages, includes lexically mixed languages such as Russenorsk (Broch & Hakon, 1983), Kyakhta Chinese-Russian Pidgin, and Trio-Ndjuka where roughly 50% of the vocabulary is derived from two separate source languages with no clear categorical preference (Bakker, 2003). In the case of

Russenorsk, the phonology has been 'levelled' in the sense that unshared structures between Russian and Norwegian have been avoided (Coetsem, 1988).

Finally, the fourth group consists of verb-noun mixed languages like Michif (Bakker, 1997), Mednyj Aleut (Golovko, 1990) and Gurindji-Kriol (McConvell & Meakins, 2005), make up the smallest group. Instead of showing a clear division between lexicon and grammar, these languages show splits between lexical categories. In Michif the division appears between verb phrases (Plains Cree) and noun phrases (Métis French). Mednyj Aleut separates verbal inflections (Russian) and both normal and nominalized morphology (Aleut). Gurindji-Kriol separates basic verbs, the TAM system and transitive morphology (verbal systems – Kriol) from emphatic and possessive pronouns, case markers and nominal derivational morphology (nominal systems - Gurindji). Unlike the phonological systems of the previous groups, both Michif and Mednyj Aleut are often analyzed as having two co-existing phonologies. In the case of Michif, French phonology applies to French-derived elements and Cree phonology applies to Cree-derived elements (Bakker, 1997; Rhodes, 1986). Rosen (2007), however provided a synchronic description of the Michif phonological system showing it unnecessary to focus on the source languages to accurately describe its underlying phonology. Regarding Mednyj Aleut (Thomason, 1997b), Russian borrowings maintained Russian phonology while the rest of the language maintained a Aleut phonological structure. Similarly, in Gurindji-Kriol, words from Gurindji maintain a three vowel contrast whereas words from Kriol (an English derived creole) maintain a five vowel contrast (Jones, Meakins, & Mauwiyath, 2012).

While many researchers (Bakker, 2003; Bakker & Mous, 1994; Matras & Bakker, 2003a; Winford, 2010), see the division between lexical and grammatical elements, as found in Media Lengua and Ma'á, as central to defining a mixed language, Myers-Scotton (1998) says that code-switching plays the largest role in mixed language formation. Myers-Scotton's Matrix

Language Turnover Model, based on fossilized or 'frozen' forms of code-switching vocabulary from a dominant language, suggests these elements are responsible for language mixing. This theory disqualifies Media Lengua as a mixed language due to "the absence of an abstract grammatical structure from both languages" which should, theoretically, be a prominent feature of a code-switching induced mixed language (Backus, 2003, p. 91).

Mixed languages, with the exception of group 3, are typically shown to be distinct from other extreme language contact situations such as jargons, pidgins or creoles. Pidgins typically develop between two groups that have not learned to communicate in each other's native language. They are commonly associated with limited vocabularies and simplified grammatical structures with high variability (Bakker, 1997). The prelude to a pidgin is often referred to as jargon and once the pidgin is nativized it is, circumstantially, considered a creole.

Descriptive methods for mixed language categorization claim that these languages are distinct from languages like Modern Sri Lankan Portuguese, Michif, and Media Lengua since they do not contain reduced vocabularies or simplified morphosyntactic systems. Moreover, mixed languages are not considered lingua francas, which are typically used in external communication settings among speakers of different L1s, e.g. trade, international congresses etc. Mixed languages on the other hand, are used internally among members of a speech community (Bakker, 1997) as evidenced by the fact that there was no mention in print of Michif before the 1930s and the same held true for Media Lengua until Muysken's (1980, 1981) first publications.

Regarding suprasegmental phonology, Stewart (2015) describes a variety of intonation patterns in Media Lengua and suggests that the overwhelming majority conform to Quichua-like prosody. Those that did not were argued as being either innovations or preserved patterns no longer used in present day Quichua from the region. Furthermore, there were no patterns that appeared to match Spanish-like prosody, that were not already shared with Quichua. These findings, in conjunction with Stewart (2014), demonstrate that while lower level phonological elements show varying degrees of overlap, higher level elements do not carry over information from the lexifier language. These findings concur with van Gijn (2009)'s proposal that lower level elements in Media Lengua should share phonological material since they are more likely to be made of individual linguistic parts from each language e.g., a segment, while higher level elements are more likely to be a mix of both e.g., a prosodic word. Muysken (2013) also states "Spanish stems inserted into Media Lengua may retain some of their features on the lower levels, but not on the higher levels of prosodic structure." This phenomenon is specifically related to intertwined mixed languages with lexical-grammatical splits, since other categories e.g., verb-noun mixed languages, often maintain language-specific material at higher levels e.g., a DP in Michif is often only of French origin (van Gijn, 2009).

1.3 Relexification

Relexification is a cognitive process involved in the relabeling of lexical entries from one language to another (Lefebvre, 2005, 2006; Lefebvre & Therrien, 2007; Muysken, 1981). This process, among others is often credited for word formation in both creole and mixed languages. Relexification takes place on a large scale and involves the relabeling of substantial portions of a source language's lexicon. This process, as opposed to *adlexification* in Shappeck's (2011) analysis of Quichua-Spanish contact, does not maintain a synonymic or near synonymic pairs from each language. Instead, relexification replaces the source language's phonological representation of a lexical entry. According to Muysken (1981), the only essential information needed in the relexification process is the relabeling of phonological shell, while the transfer of other linguistic elements, known as *translexification,* e.g., semantic representation and syntactic, subcategorization and/or selectional features is nonessential. Muysken (1981) describes translexification as a hybrid form of relexification where the transfer of linguistic elements takes place on an accumulative scale (Figure 2).

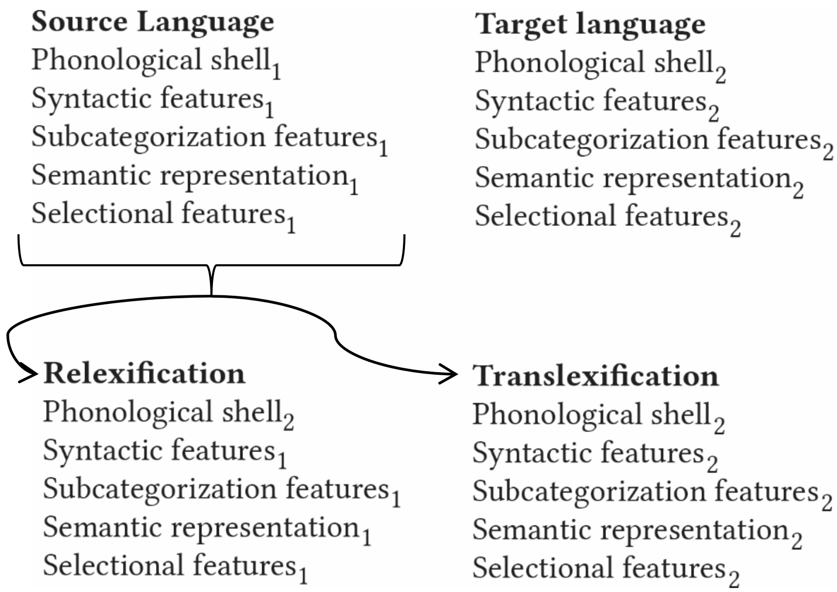


Figure 2: Translexification – Based on Muysken 1981

According to Lefebvre (1998, 2005) instead of the immediate relabeling of the source language's phonological representation by that of the target language, both representations co-exist simultaneously (Figure 3). After an indeterminate amount of time, the original phonological representation falls into disuse in favour of that of the target language. At this stage, the lexical entry of source language is made up of mixed elements from each language. As indicated by the apostrophe in the second phonological shell (2'), Lefebvre makes it clear that the phonological representation of the target language is adapted to the phonological grammar of source language.

Relexification (Stage 1)	**Relexification** (Stage 2)
Phonological shell$_1$ Phonological shell$_2$'	Phonological shell$_2$'
Syntactic features$_1$	Syntactic features$_1$
Subcategorization features$_1$	Subcategorization features$_1$
Semantic representation$_1$	Semantic representation$_1$
Selectional features$_1$	Selectional features$_1$

Figure 3: Stages of relexification according to Lefebvre (2005)

With this investigation of stop consonants, I will search for evidence that the initial phonological adaption process from the target to source language is incomplete leaving behind acoustic traces of a phoneme's language of origin. This evidence may then be activated to fill in gaps created during the adaptation of the target language's lexicon. This component of relexification could be advantageous in avoiding otherwise ambiguous lexical entries caused by the target language lexicon e.g., the creation of minimal pairs or non-words during relexification.

1.4 Conflict sites

Conflict sites are conflicting areas of convergence in the grammars of two or more language varieties in contact. The identification of conflict sites can be a useful diagnostic tool for determining the source grammar of code-switching vocabulary, lexical borrowings, structural gaps from incomplete or 'unguided' L2 acquisition and areas of grammatical convergence (Poplack, 1993; Rosen, 2007; Smith-Christmas, Davies, Parafita-Couto, & Thoms, 2013). While conflict sites are commonly used to identify areas of convergence in the morphosyntax of contact grammars, Rosen (2007) used phonological conflict sites during her analysis of phonological stratification in Michif.

I use conflict sites to identify phonemic areas of convergence regarding stop consonants based on the sound inventories of Media Lengua, Imbabura Quichua, and all three Spanish dialects. Once these areas have been identified, they will be analyzed using both acoustics and perceptual experiments to determine if there are significant differences in the production and/or perception of these elements based on the contact scenario i.e., 'conventionalized' contact or language mixing.

1.5 Andean Spanish as a contact language

1.5.1 Lexical borrowings

At both non-systemic and systemic levels, Ecuadorian Spanish, especially throughout the Andean region, has experienced its share of borrowings from Quichua. Older generations of both urban and rural Spanish may have a productive or passive knowledge of hundreds of Quichua words and/ or compound words – several of which, have completely replaced standard Spanish lexemes (Table 1).

Andean SP	Peninsular SP	Colloquial Quichua	Gloss	Frequency of usage
chuchaqui	*Resaca*	*chuchaqui*	'hangover'	Complete replacement
cuy	*cobayo*	*cui*	'guinea	Complete replacement
choclo	*maíz*	*chuclu*	'corn'	Equal use given to both
chompa	*chaqueta*	*chumpa*	'jacket'	Equal use given to both

Table 1: Quichua Borrowings in Ecuadorian Spanish

Contact with Quichua has also induced semantic shifts in several high frequency Spanish words. Examples include *saber* 'to know' expanded to 'be accustomed to' and *hablar* 'to speak' expanded to 'to scold' (Cotton & Sharp, 2001, p. 199).

1.5.2 Morphosyntactic borrowings

1.5.2.1 Diminutives

Both younger and older generations make extensive use of diminutive calques *–(c)ito/a* (*gatito*, 'kitty'), *–(c)illo/a* (*quesillo* 'little cheese'), *–ico/a* (*tintico* 'little coffee'), derived from Quichua *–gu*,(*yakugu* 'little water') *–wa* (*anacowa* 'little skirt'). In addition, interjections are also pervasive in Quichua e.g., *achachay!* 'burr!', *arrarray!* 'pew, it's hot!', *atatay* 'yuck!', *ayayay* 'ouch!', *ananay!* 'Oh, how pretty!' etc.

In both rural and L2 bilingual Spanish, the use of the diminutive is even more productive than in urban Spanish. The use of diminutives extends beyond nouns and adjectives and may attach to grammatical items like determiners (*estica* 'little thing'), pronouns (*yocito* 'little me') and adverbials (*acacito* 'right here').

1.5.2.2 Give + gerund

Systemic calques are also found in the speech of both younger and older generations and of both urban and rural varieties, especially regarding the well-known 'give' + gerund formation (Albor, 1973; Bruil, 2008; Niño Murcia, 1995; Toscano Mateus, 1953) as illustrated in examples 1 and 2.

1 Andean Spanish (Niño Murcia, 1995, p. 89)
Da-me pasa-ndo.
give-SG:IO hand-GER
'Hand it to me.'

2 Quichua (Bruil, 2008, p. 5)
Yali-shpa cu-hua-i.
hand-SS.CONV give-1SG.OBJ-IMP
'Hand it to me.'

1.5.2.3 Limitative marker

Another common calque in Urban Spanish includes the imperative expression *nomás,* roughly translated to 'just', which entered Spanish by way of the Quichua limitative marker *–lla* (Haboud, 1998). Both the expression *no más* and limitative marker provide a sense of invite rather than an imperative order (Examples 3 and 4).

3 Andean Spanish (Haboud, 1998, p. 210)
Com-e nomás, no nos esper-es.
eat-2IMP.INFORMAL no more no 3P.OBJ wait-2IMP.NEG.INFORMAL
'Go ahead and eat. Don't wait for us.'

4 Quichua (Haboud, 1998, p. 210)
Miku-y-lla
eat-IMP-LIM
'Go ahead and eat.'

1.5.2.4 Future verbal inflections

Verbal morphology from Quichua has also entered into Andean Spanish as seen in the usage of the second person future imperative calque *−ás* (Example 6, cf. 5) from Quichua *−ngui* (Example 7) (Haboud, 1998, p. 211).

5 Standard Spanish (Haboud, 1998, p. 211)
¡Ven!
come-2S.IMP.INFORMAL
'Come!'

6 Andean Spanish (Haboud, 1998, p. 211)
¡Vendr-ás!
come-2S.FUT.INFORMAL
'Come!'

7 Quichua (Haboud, 1998, p. 214)
Shamu-nki!
come-2S.FUT.INFORMAL
Come!

1.5.2.5 Perfective

Another construct borrowed from Quichua gives a perfective reading in verbal constructs which contain a conjugated verb of motion plus a subordinate gerund verb. In this construct, both verbs are semantically 'full' and denote two consecutive events (Examples 8 and 9) (Haboud, 1998, p. 204).

8 Veng-o com−iendo... (Haboud, 1998, p. 204)
come-1.PRES eat−GER
'I ate before I left...'

9 Miku−shpa−mi shamu−ni (Haboud, 1998, p. 204)
eat−GER−VAL come−1S.PRES
'I ate before I left...'

1.5.2.6 Pronominal system

According to Palacios (2005a, 2005b), the pronominal system is yet another example of Quichua influence on both urban and rural Ecuadorian Spanish. Here, it has become the norm to collapse both dative and accusative pronouns into a single form, *le* (Examples 10 and 11). This simplification, to a lesser extent, has also neutralized gender and number. Palacios attests that this form is not stigmatized and has also been adopted by the upper-middle class. It should be noted however, that since Quichua does not have a separate pronominal system for objects, this may just be a case of natural simplification rather than contact induced change.

10 Urban Andean Spanish (Palacios Alcaine, 2005a, p. 46)
Le *v-i* (referring to either *la niña* 'the girl' or *el niño* 'the boy'.)
3.DAT see-1S.PST
'I see him/her. '

11 Urban Andean Spanish (Palacios Alcaine, 2005a, p. 46)
Le *hag -o.* (referring to either *el mote* 'the hominy' o *la chicha*[3])
3.ACC make-1S.PRES
'I prepare it.'

According to Palacios (2005b), unlike urban Spanish, the pronominal system from both Llano Grande (North Quito) and Otavalo maintains the pronominal distinction between the dative and acoustic case. Like the more urban variety however, the simplification has also neutralized gender and number (Examples 12, 13, and 14).

12 *Tenemos una cas-ita de bloque, bueno los que tienen capacidad lo construimos con barilla.*
DET.F house-DIM.F (ref.) ← 3M.ACC
'We have *a house* made of cinder blocks, but those who can afford it, build *it* with rebar.'
(Palacios Alcaine, 2005a, p. 47)

13 *Porque lo voy a pasar aquí.* (ref. *las* *navidad-es*) (Palacios Alcaine, 2005a, p. 47)
3M.ACC (ref.) → DET.F.P Christmas festivity-PL.F
'Because I am going to spend *them* here.' (ref. *Christmas festivities*)

14 *Le ponemos gasolina.* (ref. *al* *muñeco*) (Palacios Alcaine, 2005a, p. 47)
3.DAT (ref.) → to.DET.M dummy
'We put gasoline on *it*.' (ref. *the dummy*)

[3] Chicha is a fermented beverage often made from corn traditionally consumed throughout South America.

1.5.2.7 Evidentiality

Quichua, which marks several types of evidentiality, has also induced changes in the perfective tenses giving them evidential readings (Escobar, 1994; Palacios Alcaine, 2005a). The simple perfective (*pretérito perfecto simple*) has adopted a first-hand information reading tied to the Quichua evidential marker *–mi* (Example 15). By the same token, a second-hand information reading is associated with compound perfect (*pretérito perfecto compuesto*), similar to the Quichua verb *nina* 'say' (Example 16). Finally, the pluperfect (*pretérito pluscuamperfecto*) suggests that the speaker deduced the information at hand, but without any first- or second-hand information – similar to the Quichua evidential marker *–shi* (Example 17).

15 *Hace un ratito dej-é mis llaves sobre la mesa, pero ahora no aparecen.*
leave-1.PST
'I left my keys on the table just a moment ago, but no they're nowhere to be found.'

16 *Yo no estaba en mi casa, pero dicen que algien h-a cocin-ado una torta.*
have-3S cook-PRT
'I wasn't at home, but it's said that someone has made a cake.'

17 *Entré en mi casa y olía bien rico, y pensé "¡Qué rico! Alguien hab-ía hecho una torta."*
have-3.IMP make.PRT
'I entered my house and it smelled really good and I thought "Yum! Someone had made a cake.'
(Palacios Alcaine, 2005a, p. 48)

1.5.2.8 Surprisal

It has also been shown that both Rural and Urban Spanish have adapted a surprisal reading of the perfective tense derived from the Quichua perfective *–shka* (Examples 18 and 19).

18 Andean Spanish (Yánez Cossío, 2007, p. 46)
¡Ya h-a ven -ido! ¿No?
already have-3 come-PRF no
'(S)he's already come, right?!'

19 Quichua (Yánez Cossío, 2007, p. 46)
Ña-mi shamu -shka! Na-chu?
already-VAL come-PRF no-NEG.QY/N
'(S)he's already come, right?!'

1.5.2.9 Word order

While Standard Spanish is prototypically considered an SVO language, in the Spanish of L1 Quichua bilinguals, it is not uncommon to find sentences with SOV word order. This is especially true with copulative and/ or gerund constructions as shown in examples 20 and 21. In many of the forthcoming examples, I reference my field data by siting the consultant who produced a given utterance or provided judgements. Demographics regarding the consultants can be found in section 2.2.1.2.

20 *Cuando salg-a de la escuela en el colegio estudio piens-o.* (Haboud, 1998, p. 201)
When leave-1S from the school in the high.school study-1s think-1S
'When I get out of [elementary] school, I think I [will] study at high school.'

In contrast, the same sentence in Urban Spanish reads:

21 *Cuando salg-a de la escuela, piens-o estudi-ar en el colegio.* Consultant #107
When leave-1S from the school think-1S study-INF in the high.school
'When I get out of [elementary] school, I think I [will] study at high school.'

1.5.2.10 Discoordinated use of gender and number

Standard Spanish, like other romance languages coordinates the gender and number of adjectives within noun phrases or referent antecedents based on the inherent properties of the noun in an NP – often morphologically marked as –*o* masculine and –*a* feminine for gender and –s. Since Quichua does not have inherent gender and pluralizers are often optional. It has been shown that L2 Spanish bilinguals often ignore exceptions to morphological markings e.g., *el mano* instead of *la mano,* a feminine noun ending 'o' or the gender of unmarked nouns e.g., *el llave* for *la llave*, a feminine noun ending in a morphologically neutral -e.

1.6 Imbabura Quichua as a contact language

Imbabura Quichua is a member of the Quechuan family which extends from southern Colombia to northern Argentina primarily along the Andean mountain range. This path, however, is not continuous and isolated language pockets dot the region. Most noticeably, isolates are found in southern Colombia (Caquetá, Nariño, Putumayo), northern Argentina (Santiago del Estero), northern Peru (Cajamarca), the Amazon (Colombia and Ecuador) and the highland variety of Ecuadorian Quechua, representing approximately a quarter of all Quechuan speakers (Adelaar & Muysken, 2004).

The Quichua language varieties spoken in Ecuador make up the Quechua BII branch which can further be divided into southern, central, northern, and Amazonian regions where Imbabura Quichua makes up part of the northern Ecuadorian dialect continuum. Quechua, however, was only introduced to Ecuador approximately 62 years before the Spanish invasion in 1532 CE. Since then both languages have been under constant contact, as Quichua had held a prominent position as the principle lingua franca among the indigenous populations until the late 18th century (Gómez-Rendón, 2008c).

1.6.1 Lexical borrowings

It is documented that nearly every semantic field, "from kinship and household to religion, education and administration" is influenced by Spanish lexical borrowings (Gómez-Rendón, 2007, p. 517). He also states, the degree of influence varies from dialect to dialect and is less prominent in regions that receive less contact with urban centres. Based on my own surveys, basic vocabulary elicited from a 200 word Swadesh list shows an average borrowing rate of 15% (9% min. 21% max.) from 5 speakers of Cotopaxi Quichua (Quilotoa). During short spontaneous conversations of no more than 5 minutes (avg. 2m28s), this number dramatically increased to an average borrowing rate of 46% (28% min. 65% max.). This data was obtained from 20 speakers from the pariches of Saquisilí, Salcedo and Pujilí in the province of Cotopaxi. Salcedo, where the first variety of Media Lengua was documented (Muysken, 1980), ranked the highest among the pariches. The only speaker in my dataset from the province of Chimborazo showed a 39% borrowing rate (For a complete breakdown of speaker details see: Stewart, 2011, p. 8).

Some examples of borrowings from Imbabura Quichua are found in tables Table 2 though Table 4, which include quantifiers, modal verbs, adverbs, and discourse markers (Gómez-Rendón, 2007, p. 503). It should be pointed out that these lexical borrowings have not replaced native Quichua words, but instead, co-exist alongside them.

Spanish	Colloquial Quichua	Unified Quichua	Gloss
Todito	*tuditu*	*tukuy*	'all'
alguno/a(s)	*alkunus/ alkunas*	*wakin*	'some'

Table 2: Spanish borrowed quantifiers

Spanish	Colloquial Quichua	Unified Quichua	Gloss
menester (archaic)	*minichina*	*muchuna*	'to need'
poder	*pudina*	*ushana*	'can'
querer	*kirina* (rare)	*munana*	'want'

Table 3: Spanish borrowed modal verbs

Colloquial Quichua	Spanish	Unified Quichua	Gloss
aura	*ahora*	*kunan*	'now'
intunsis	*entonces*	*chaymanta*	'so'
simpri	*siempre*	*wiñay*	'always, forever'

Table 4: Adverbs and discourse markers

Other loan words from Spanish also include the days of the week, months, times of the day, and the numerical system. Spanish functional borrowings in Quichua include the conjunctions *y* 'and', *o* 'or', *sinu, dino* 'if not' and *pero* 'but' (Gómez-Rendón, 2007, p. 506).

1.6.2 Morphosyntactic borrowings

Contact with Spanish has also had a large influence at the syntactic level of Quichua. Like lexical borrowings, systemic borrowings are noticeable in all the dialects of Ecuador. The percentage of borrowings, however, varies from province to province and even from speaker to speaker (Gómez-Rendón, 2007). The following examples have been attested in the province of Imbabura. Like lexical borrowings, it should be noted that the majority of systemic borrowings have not replaced their traditional Quichua counterparts, but rather co-exist allowing speakers to diversify speech styles and registers.

1.6.2.1 Determiners

One of the most noticeable changes to the Quichua noun phrase as a result of Spanish includes the use of the determiners *shuk* 'one', *kay* 'this' and *chay* 'that', instead of the traditional topic marker *−ka* Gómez-Rendón (Gómez-Rendón, 2007, p. 490).

1.6.2.2 Diminutives and augmentatives

Contact induced changes have also added Spanish diminutives and augmentatives into the language which co-exist alongside native Quichua diminutives and augmentatives (Table 5) (Gómez-Rendón, 2007, p. 490).

<table>
<tr><th colspan="2">Diminutives</th><th colspan="2">Augmentatives</th></tr>
<tr><th>Quichua</th><th>Spanish</th><th>Quichua</th><th>Spanish</th></tr>
<tr><td rowspan="4">-ku / -wa</td><td>-ito</td><td rowspan="2">-pura</td><td>-ísimo</td></tr>
<tr><td>-ita</td><td>-ísima</td></tr>
<tr><td>-cito</td><td rowspan="2">-sapa</td><td>-ote / -ón</td></tr>
<tr><td>-cita</td><td>-ota / -ona</td></tr>
</table>

Table 5: Spanish and Quichua Diminutives and Augmentatives

An example of this is shown in the Spanish diminutive ending *-ito* in the Quichua word *hausita* 'little house' corresponding to Spanish *casita* 'little house' (Gómez-Rendón, 2007, p. 485).

1.6.2.3 Agentive marker

Another morphological borrowing is the Spanish agentive suffix −*dor* as −*dur*. This morpheme is found in both Spanish borrowings and native Quichua lexemes i.e., Q *midi*<u>*dur*</u> ← SP *medidor* 'meter/gauge'; and Q *ñawpadur, 'ñawpa*' meaning before with the agentive '*dur*' literally translates to 'the one before' in reference to a 'representative' (Gómez-Rendón, 2007, pp. 484-485).

1.6.2.4 Instrumental semantic calque

The loss of distinction between the comitative morpheme −*ntin* and instrumental morpheme −*wan,* which often merges lexically into the latter, can be interpreted as a semantic calque from Spanish *con* 'with' (Examples 24, 23 and 22) (Gómez-Rendón, 2007, p. 486).

22 Unified Quichua (Inferred from: Gómez-Rendón, 2007, p. 486)
Warmi-wan tarpu-ngapak ri-rka-ni.
woman-COM sow-PURP go-PST-1s
'I went with a woman to sow.'

23 Unified Quichua (Inferred from: Gómez-Rendón, 2007, p. 486)
Warmi-ndin tarpu-ngapak ri-rka-ni.
woman-COM sow-PURP go-PST-1s
'I went with my woman to sow.'

24 Colloquial Quichua (Gómez-Rendón, 2007, p. 486)
Warmi-wan tarpu-ngapak ri-rka-ni.
womann-COM sow-PURP go-PST-1s
'I went with a woman to sow.' *or* 'I went with my woman to sow.'

1.6.2.5 Pluralizer semantic calque

The increased usage of the plural marker −*kuna* after numerals in Imbabura Quichua is yet another calque derived from Spanish (Examples 25 and 26) (Gómez-Rendón, 2007, p. 486).

25 Colloquial Quichua Consultant #77
Hambi-ka pusak hambi-kuna-ta-mi obiya-na ni-rka.
cure-TOP eight cure-PL-ACC-VAL take-NOM say-3.PST
'(S)he said the cure is to take eight pills.'

26 Unified Quichua Consultant #78
Ishkay warmi-mi chaya-rka.
two woman-VAL arrive-3.PST
'Two women arrived.'

1.6.2.6 Possessor semantic calque

The merger of the alienable (-*pak*) and inalienable (-*yuk*) possessor morphemes into the former, or the alternative replacement of the latter with lexical strategies, shows that Quichua is beginning to lose the alienability distinction in favour of the Spanish calque *de* 'of' (Examples 27, 28 and 29) (Gómez-Rendón, 2007, p. 486).

27 Unified Quichua (Gómez-Rendón, 2007, p. 486)
Ña-mi warmi-yuc ka-ni.
already-VAL woman-POSS be-1S
'I am married already.'

28 Colloquial Quichua (Gómez-Rendón, 2007, p. 486)
Ña-mi kazara-shka ka-ni.
already-VAL woman-PTCP be-1S
'I am married already.'

29 Colloquial Quichua (inalienable possession with alienable possessor) Consultant #72
Ñuka-pa ija-mi iscuyla-manda fuera-man villa-man puri-n.
1-POSS daughter-VAL school-ABL outside-DIR town-DIR walk-3
'My daughter walks from the school to the town.'

1.6.2.7 Reportative speech

Other structural influences include the usage of *dizi-*, derived from the Spanish verb *decir* 'to say, to tell', in reported speech and quotatives (Examples 30 and 31) (Gómez-Rendón, 2008a, p. 187).

30 Quotative evidential (Gómez-Rendón, 2007, p. 496)
Chayka kutichi-n "estoy buscando mi yunta de bueyes" dizin.
than answer-3 [I am looking for my yoken of oxen] QUOT
'Then he/she answers "I'm looking for my yoke of oxen.'

31 Reportative evidential (Gómez-Rendón, 2007, p. 496)
Patrun da-shca rumi-ka kuri ka-shka dizi-n.
boss give-PTCP stone-TOP gold be-PRF REP
'It was said that the rock the landlord gave [to him] was gold.'

1.6.2.8 Clause structure

Gómez-Rendón (2008c, p. 188) also argues that "traditionally Quichua uses a nominalization strategy for clausal subordination" (Examples 32, 35, and 38). And yet, due to the influence of the Spanish model of subordinate clauses (Example 33), independent clauses are often linked by Spanish connectors such as *que* /ke/ 'that' or *lo que* /lu ki/ 'that which' (Example 36 and 39). Other conjunctions, such as Spanish *porque* /porˈke/ 'because' and *si* 'if', have been borrowed in Quichua as *purki* and *si* respectively (Examples 37 and 40 respectively).

32 Traditional Quichua (Gómez-Rendón, 2007, p. 502)
Pay-kuna-lla chaya-shpa, pay-kuna muna-shka-ta apa-shka-n.
3-PL-LIM arrive-GER 3-PL want-PTCP-3 take-PRF-3
'Upon their arrival, they took what they wanted.'

33 Spanish
A su llega-da, ellos tom-aron lo que quer-ían. Consultant #107
PREP 3.POSS arrive-PART 3P take-3P.PST that which want-3P.COND
'Upon their arrival, they took what they wanted.'

34 Colloquial Quichua (Gómez-Rendón, 2007, p. 502)
Pay-kuna-lla shaya-shpa pay-kuna apa-shka-n lo-que muna-shka-n.
3-PL-LIM arrive-GER 3-PL take-PERF-3 that-which want-PRF-3
'Upon their arrival, they took what they wanted.'

35 Unified Quichua Consultant #78
Ñuka-pa wasi-man-mi ri-ku-ni, kaya punlla llanka-sha.
1-GEN house-DIR-VAL go-PROG-1.PRES tomorrow day work-1.FUT
'I am going home [because] I will work tomorrow.'

36 Spanish Consultant #107
Yo est-oy y-endo a mi casa porque trabajar-é mañana.
1 be-1.PRES go-PROG DIR 1.POSS house because work-1.FUT tomorrow
'I am going home because I will work tomorrow.'

37 Colloquial Quichua
Ñuka-pa wasi-man-mi ri-ku-ni purki kaya punlla llanka-sha. Consultant #78
1-GEN house-DIR-VAL go-PROG-1.PRES because tomorrow day work-1.FUT
'I am going home because I will work tomorrow.'

38 Unified Quichua Consultant #78
Kan kaya-kpi ñuka-pish kaya-yman.
2 call-DS.COND 1-ADIT call-COND
'If you call, I will call too.'

39 Spanish Consultant #107

Si tu me llam-as, yo también te llamar-é.
if 2 1.OBJ call-2.PRES 1 too 2.OBJ call-1.FUT
'If you call, I will call too.'

40 Colloquial Quichua Consultant #77

Si kay-manda llugshi-ngi chiri-ta-mi chari-ngi.
if here-ABL leave-2.PRES cold-ACC-VAL have-2.PRES
'If you leave here, you will be cold.'

1.7 Media Lengua as a mixed language

As mentioned in Section 1.2, Media Lengua is an intertwined or lexical-grammar language with a split between lexical and grammatical systems. The following subsections (1.7.1-1.7.2) provide details and examples of the elements which make up these systems and how they interact to form Media Lengua.

1.7.1 Lexicon

Based on both a 200 word Swadesh-list (Swadesh, 1952) and analyses of spontaneous speech, approximately 89%-93% of Pijal Media Lengua's lexicon consists of Spanish-derived borrowings. While evidence suggests that relexification was the primary process involved in populating Media Lengua's lexicon (Muysken, 1980, 1981), evidence also suggests that lexical freezing (Gómez-Rendón, 2005; Muysken, 1997; Stewart, 2011), translexification (Muysken, 1981), adlexification (Shappeck, 2011) and code-switching (Stewart, 2011) played a formative role as well.

Example 41 contains the frozen lexical item *auno* 'before' derived from Spanish *aún no* meaning 'not yet'. Number 42 provides an example relexification where the Spanish phonological shell of *querer* 'want' has mapped to the Quichua word *munana* 'like, want, need' as *kirina* 'like (42a), want (42b), need (42c)'. Number 43 provides an example of adlexification where both Spanish *perro* 'dog' and Quichua *alku* 'dog' co-exist in Media Lengua. Finally, number 44 provides an example of code-switching with the temporal expression *todas las manañas* 'every morning' which maintains Spanish number and gender agreement.

41 Lexical freezing
Auno conzi-na-shpa-llata mano-ta lava-ni. Consultant #41
before cook-NOM-SS.CONV-TOT hand-ACC wash-1S
Antes de cocinar yo me lavo las manos.
'Before cooking, I wash my hands.'

42 Relexification
a. Voz pone-ju-ngui sombero buena yo kiri-ni. (like) Consultant #44
2S put-PROG-2S hat good 1s like-1S
Tu traes un sombreo que me gusta.
'You're wearing a hat that I like.'

b. No comi-na-ta kiri-ni. (want) Consultant #43
NEG eat-NOM-ACC want-1S
No quiero comer.
'I don't want to eat.'

c. Yo-ka ayuda-chun-mi kiri-ni. (need) Consultant #50
1S-TOP help-DS.SUBJ-VAL want-1S
Yo necesito que tú me ayudes.
'I need you to help me.'

43 Adlexification
a. Perro-ka gato-wan amiguia-shka. (Spanish-derived) Consultant #42
dog-TOP cat-COM friend-PRF
El perro y el gato han sido amigos.
'As it turns out, the dog is friends with the cat.'

b. Ese alku bueno-wa-kuna-ka no mordi-n-chu. (Quichua-derived) Consultant #50
DET dog good-DIM-PL-TOP NEG bite-3-NEG
Los perros buenos no muerden.
'Good dogs don't bite.'

44 Code-switching
Vos-ka leche-ta tod-as las mañan-as toma-ngui. Consultant #43
2-TOP milk-ACC every-F.PL DET.F.PL day-F.PL drink-2S
Tu tomas leche todas las mañanas.
'You drink milk every morning.'

Media Lengua also maintains an estimated 15% of native Quichua lexical items where about 5-10% co-exist as synonyms with their Spanish counterparts. Example 45 contains the Quichua words *ñukanchi* 'our' and *llama* 'sheep' while example 49 contains its Spanish derived counterpart *nuestro* 'our'. Quichua borrowings found in urban, rural, and L2 Spanish e.g., *wawa* 'child' are almost always borrowed back into Media Lengua while their Spanish-derived counterparts are rare in my dataset (46). Finally, the Quichua copulative *kana* is always maintained in Media lengua (47) (Stewart, 2011).

45 *Ñukanchi tela-wa-gu-na-ta ocupa-nchi ese-ka ñukanchi llama-wa-kuna-manta-mi.*
1P frabric-DIM-DIM-NOM-ACC use-1P DET-TOP 1P sheep-DIM-PL-ABL-VAL
La tela que usamos viene de las ovejas. Consultant #50
'The fabric that we use comes from the sheep.'

46 *Ese wawa flaco flaco-ka no comi-n-chu.* Consultant #50
DET child skinny skinny-TOP NEG eat-3-NEG
Ese niño flaco no come.
'The skinny child doesn't eat.'

47 *Mas forza-wan sopla-na ka-ngui.* Consultant #54
More force-INST blow-NOM be-2S
Tienes que soplar más duro.
'You have to blow harder.'

1.7.2 Morphosyntax

Both Quichua and Media Lengua are agglutinating SOV languages with a highly regular inflectional verbal system containing virtually no 'irregular verbs'. With the exception of code-switching and the Spanish grammatical borrowings/ calques also found in Quichua (Section 1.6), Media Lengua's grammatical system is very similar to that of Quichua. According to Gómez-Rendón (2005) of the 63 grammatical elements found in Ecuadorian Quichua, he identified at least 49 (77%) in the Angla variety of Imbabura Media Lengua. Based on my data gathered from the Pijal variety of Imbabura Media Lengua, I have identified 55 (87%) grammatical elements found in Ecuadorian Quichua. Those that remain elusive also appear to be quite rare or may have even fallen out of use in colloquial Quichua speech e.g., *-ranti* (instead of), *-rayku* (purpose), *-kuti* (multiply) *–mana* (augmentative), *-lli* (clothing). Others appear to have been replaced by Spanish lexemes carrying the semantic form of the Quichua grammatical element e.g., the Quichua ordinal marker *–niki* is replaced by Spanish ordinal numbers in Media Lengua (and to a large extent in Imbabura Quichua), the Quichua marker –*la* meaning 'step' as in 'step-mother' has been replaced by Spanish *–drastro/a,* and the agentive marker *–kamak* has been replaced by Spanish *–dor/a.*

The following are elicited examples of Pijal Media Lengua along with the Quichua translation for comparison.

48 *Jose-ka ese palo-kuna-ta el-pa casa-manta llega-ju-n.* Consultant #43
José-TOP DET stick-PL-ACC 3-GEN house-ABL arrive-PROG-3
Jose-ga chay kaspi-kuna-da pay-ba wasi-manda apa-ju-n. Consultant #78
'José is bringing the wood from his house.'

49 *Nuestro animal-kuna-ka asequia-pi-mi agua-ta toma-ri-n.* Consultant #43
1P.POSS animal-PL-TOP canal-LOC-VAL water-ACC drink-REFL-3
Ñukanchi wiwa-kuna-ga larka-pi-mi yaku-da upia-ri-n. Consultant #78
'Our animals drink water from the canal.'

50 *Mio hermana-ka mio papa-su-ta terreno-man compaña-shpa i-ju-n.* Consultant #43
1s.POSS sister-TOP 1.POSS dad-DIM-ACC land-DIR accompany-SS.CONV go-PROG-3
Ñuka pani-ga ñuka tayta-da alpa-man kuma-shpa ri-ju-n. Consultant #78
'My sister accompanies my father to the plot of land.'

51 *Mio mama-ka siempre-mi adelante anda-n almuerzo cozna-ngapa* Consultant #43
1s.POSS mom-TOP always-VAL ahead go-3 lunch cook-SS.PURP
Ñuka mama-ga wiñay-mi ñawpa puri-n almuerzo yanu-ngapa. Consultant #78
'My mom always gets a head start to cook lunch.'

52 *No adivin-y-ta podi-nchi-ka llubi-nga-chu o no.* Consultant #43
NEG predict-NOM-ACC can-1P-TOP rain-3.FUT-NEG or not
Na watu-y-da podi-nchi-ga tamya-nga-chu. Consultant #78
'One can't predict when it's going to rain.'

The following paragraph is taken from Stewart (2013, p. 20) as an example of spontaneous speech.

53 *Ahora-ka sobre matrimonio-mi uno poqu-ito dezi-gri-ju-ni. Aqui nuestro*
now-TOP about wedding-VAL DET little-DIM say-FUT.IMD-PROG.1S here 1P.POSS

comunidad-pi-ka, como dezi-rka pedi-ngapa mano-ta i-shpa nobia-pakman
community-LOC-TOP like say-3.PST ask-SS.PURP hand-ACC go-SS.CONV bride-ORI

papa-su-kuna-paman i-shpa-ka, nobio-pa genti-ka anda-n-mi lleva-shpa pan, platano,
data-DIM-PL-ORI go-SS.CONV-TOP groom-GEN people-TOP go-3-VAL bring-SS.CONV bread plantains

naranja-mi asi po-quito-go-ta lleva-shpa anda-n, ya dentra-ngapa. Dentra-shka-pa
orange-VAL such little-DIM-ACC bring-SS.CONV go-3 *filler* enter-SS.PURP enter-PRT-BEN

despues-mi, ya vuelta, ese registro-pi-mi casara-chi-gri-n.
after-VAL again DET registry-LOC-VAL marry-CAU-FUT.IMD.3

'Now I am going to talk a little about weddings. Here in our community, it is said, in order to ask the hand [in marriage] the groom's family goes to the bride's and [bride's] parents' house bring a bit of bread, plantains and oranges in order to enter [the house]. After having entered, they go to get married in the [civil] registry.'

1.8 Phonemic inventories

The following subsections provide the standard phonemic inventories for Spanish, Quichua, and a superimposed chart showing the phonemic conflict sites found in Quichua contact varieties i.e., Media Lengua and colloquial Quichua.

1.8.1 Spanish

Table 6 provides an IPA chart containing the standard phonemes found in Ecuadorian Spanish while Table 7 provides the vowels. These charts are based on work from Resnick (1975) and Salcedo (2010).

	LABIAL		CORONAL				DORSAL			RADICAL	LARYNGEAL
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m			n			ɲ				
Plosive	p b		t d					k g			
Fricative		f		s			ʝ	x			
Affricate					tʃ						
Approximant											
Tap				ɾ							
Trill				r							
Lateral Fricative											
Lateral Approximant				l			ʎ				
Lateral Flap											

/w/ - voiced lateral-velar approximant

Table 6: IPA chart containing standard Spanish phonemes

	Front		Back
Close	i		u
Close-mid		e	o
Open		a	

Table 7: Vowel chart of standard Spanish vowels

1.8.2 Imbabura Quichua

Table 8 provides an IPA chart containing pre-Spanish-contact Imbabura Quichua phonemes while Table 9 provides the vowels. These charts are based on work from Cole (1982), Gómez-Rendón (2007), and Toapanta (2012).

	LABIAL		CORONAL				DORSAL			RADICAL	LARYNGEAL
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m			n			ɲ				
Plosive	p			t				k			
Fricative	ɸ			s	ʃ ʒ	ʐ		x			
Affricate					ʧ						
Approximant							j				
Tap				ɾ							
Trill											
Lateral Fricative											
Lateral Approximant				l							
Lateral Flap											

/w/ - voiced lateral-velar approximant

Table 8: IPA chart containing pre-Spanish contact Quichua phonemes.

	Front		Back
Close	i		u
Open		a	

Table 9: Vowel chart containing pre-Spanish-contact Quichua vowels

1.8.3 Spanish conflict sites in Quichua contact varieties

Table 10 is a superimposed IPA chart of the Spanish and Quichua charts from Section 1.8.1 and 1.8.2 while Table 11 provides Media Lengua vowels from Stewart (2011). Bold phonemes are conflicting areas of convergence via the Spanish-derived lexicon. Phonemes in bold blue italics are those under investigation in this study while those in bold red are not covered. The phonemic details in this section are based on my previous work on Pijal Media Lengua (Stewart, 2011).

	LABIAL		CORONAL				DORSAL			RADICAL	LARYNGEAL
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	M			n			ɲ				
Plosive	p *B*			t *d*				k *g*			
Fricative	ɸ	f		s	ʃ ʒ	ʐ	ʝ	x			
Affricate					ʧ						
Approximant							J				
Tap				ɾ							
Trill				r							
Lateral Fricative											
Lateral Approximant				l			ʎ				
Lateral Flap											

/w/ - voiced lateral-velar approximant

Table 10: IPA chart containing conflict sites between Spanish and Quichua. The phonemes in blue-bold-italics are those described in this thesis while those in red-bold are not.

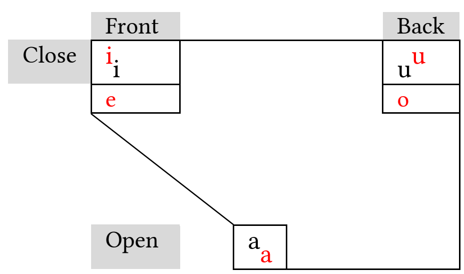


Table 11: Media Lengua vowel chart based on Stewart (2011). Red-bold vowels are Spanish in origin.

1.9 Perception

Several theoretical models of linguistic perception have been developed over the last 50 years in an attempt to understand how phonetic categories are organized and interpreted based solely on acoustic input. The Perceptual Assimilation Model proposed by Best et al. (2003) predicts that bilinguals assimilate L2 sounds based on how similar or contrastive a given sound is perceived. This theory suggests that bilinguals have only one phonological system where L2 sounds are produced on the basis of L1 patterns. Within this system, categories might (1) merge into a single category, (2) remain independent, or (3) may co-exist with varying degrees of overlap.

In more episodic, cluster, or exemplar based theories, the perception of categories is based on accumulation of stimuli which leave detailed 'traces' of each episode in memory (Goldinger, 1996; Johnson, 1997; Pierrehumbert, 1990, 2001, 2002; 2003; inter alia). The retention of these memory traces creates probability distributions which provide a comparative basis for incoming stimuli. When a receiver is presented with an audio or visual stimulus, traces activate based on their similarity to retained exemplars. Moreover, the activation of multiple exemplars allows for continuous parsing of the speech stream. It is suggested that the distribution of memory traces is responsible for the emergence of categories, which are recognizable as early as six months and continue to undergo refinement throughout a person's life time. Regarding near-mergers, an underlying phonological characteristic often associated with language contact (Labov, 1994) and found in Media Lengua phonology (Stewart, 2011, 2014), there is evidence indicating that sound change is the result of the reorganization of exemplar distributions. If such a reorganization results in the extensive overlap of sounds from distinct categories, it is predicted that listeners will encounter difficulty identifying stimuli produced within the overlapped space while differences in production are also predicted to be small (Yu, 2007).

1.10 Acoustic studies of vowels in contact languages

To provide a foundation for answering the question "Is there evidence at the phonetic level to maintain classificatory labels such as 'mixed' vs. 'conventionalized' contact languages?" proposed in Section 1.1, this section describes findings from several studies pertaining to the acoustic nature of vowels in mixed languages, contact languages, and the speech of bilinguals.

I chose to describe bilingual vowel production as a point of comparison since the few studies pertaining to phonetic conflict sites in mixed languages (Jones, Meakins, & Buchan, 2011; Jones et al., 2012; Stewart, 2011, 2014), have been analyzed within, and compared to models of bilingual language learning e.g., the distributional learning hypothesis (Anderson, Morgan, & White, 2003) for Gurindji-Kriol (Jones et al., 2012) and the perceptual assimilation model (Best, Hallé, Bohn, & Faber, 2003) for Media Lengua (Stewart, 2011, 2014). One point of comparison, for example, observed in current studies of bilingual mixed language vowel production (Jones et al., 2011; Jones et al., 2012 - for Gurindji Kriol; Stewart, 2011; 2014 - for Media Lengua) shows that, similar to bilingual input, categories with distinct formant one and formant two frequencies (henceforth F1 & F2 respectively) are available to speakers. Unlike for bilinguals who switch categories based on the language in use however, mixed language speakers make use of separate vowel categories in monolingual speech based on the language of origin of a given vowel. These types of findings provide a comparative platform with the stop consonant analysis in this dissertation and help to better understand language interactions at the phonetic level.

The first study of interest looks at the vowel systems in Gurindji-Kriol, a mixed language spoken in the Northern Territory, Australia. Here, Gurindji's three vowel system interacts with Kriol's five vowel system causing categories to shift towards each other and overlap. Jones et al (2011) show greater formant overlap (both F1 & F2) in the front vowels /æ/ & /e/ and back vowels /ʉː/ & /oː/ in Gurindji-Kriol compared to those in Kriol. They also found that the duration differences between the Gurindji-Kriol short and long vowel contrasts were reduced compared to those in Kriol. While these findings suggest vowel spaces are reduced compared to Kriol, it is unknown whether the degree of formant overlap is extreme enough to cause a loss of perception in minimal pair borrowings from Kriol resulting in homophones in Gurindji-Kriol.

Next, Stewart (2014)'s vowel space analyses of Media Lengua showed that instead of vowel inventory reduction taking place, vowels appear to have been added. Similarly to the Gurindji-Kriol study (Jones et al., 2011) however, both mixed languages show considerable overlap– Media Lengua with the emerging vowels and Gurindji-Kriol with the merging vowels. Stewart (2014) showed that Spanish-derived mid vowels (/e/ & /o/) co-existed with considerable formant (F1 & F2) overlap with both Spanish- and Quichua-derived high vowels (/i/ & /u/). The significant F1 differences between these high and mid vowel pairs were, on average, 41 Hz. At the same time, extreme mergers were also present between Quichua- and Spanish-derived high vowel and low vowel pairs e.g., Spanish /i/ vs. Quichua /i/. These mergers were so extreme that the significant distances based on language of derivation were only, on average, 13 Hz.

Stewart (2014) also showed that the same overlapping formant frequencies were dissimilar for Spanish vowel borrowings in Quichua— the phonological source language of Media Lengua. Here, Spanish-derived high vowels underwent complete merger with their Quichua counterparts, while Spanish low vowels maintain a questionable distance. High and mid vowel contrasts from Spanish borrowings were present, but at negligible distances, averaging 26 Hz— roughly half that of Media Lengua high and mid vowel pairs.

Stewart (forthcoming) suggests there is a perceptual difference in how Media Lengua and Quichua speakers also perceive high and mid vowel borrowings. While younger speakers of Media Lengua and Quichua do not show a significant cross-language distinction, older speakers do. The current hypothesis suggests younger speakers are exposed to Spanish and speak Spanish much more frequently than older Quichua speakers allowing for improved perceptual contrast via constant exposure. Unlike the older Quichua group, which shows reduced perception, the older group of Media Lengua speakers showed no significant difference from the younger group. While both groups roughly acquired Spanish at the same age, Stewart (forthcoming) suggests Media Lengua speakers gained an advantage by acquiring the mid-high vowel contrast via the Spanish-derived lexicon from birth.

Several studies have also investigated the phonological nature of vowel systems in monolingual and bilingual groups of Quechua speakers in Ecuador and Peru. One such study of importance to this investigation is Guion's (2003) paper on the phonological systems of Quichua-Spanish bilinguals from Imbabura. In this study, both cross-language and within-language production of vowel data is investigated. Her cross-language results report that simultaneous-bilinguals maintained three separate front vowels: an [i] with lower F1 frequencies for Spanish production, an [i] with higher F1 frequencies for Quichua production, and an [e] for Spanish production. Early (but not simultaneous) L2 learners on the other hand, tended to merge Spanish [i] and Quichua [i] into the same vowel space while late L2 learners merged both [i]s and the Spanish [e] into roughly the same Quichua [i] space (Figure 4).

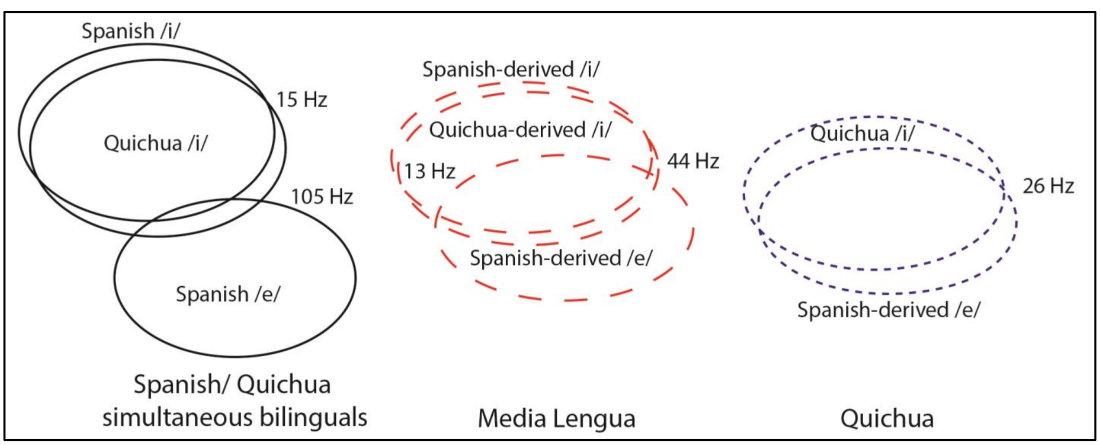


Figure 4: Scaled representation of high and mid front vowel categories in Spanish/ Quichua simultaneous bilinguals based on Guion (2003) (left), Spanish and Quichua-derived categories in Media Lengua (mid) and native Quichua and Spanish-derived categories in Quichua (right) based on Stewart (2014).

Similar trends were also reported with back vowels [u] and [o] with some variation of Quichua [u] production in early bilinguals which manifested as a rough equivalent to Spanish [o] or [u]. Her findings also suggested that both simultaneous and early bilinguals maintain separate low vowel categories where Quichua [a] production is lower in F1 frequency than Spanish [a] production. Quichua monolinguals on the other hand, merged Spanish [a] with Quichua [a]. Her within-language results suggest that simultaneous and early bilinguals show an upwards shift in vowel space away from monolingual production towards that of Spanish. Guion's findings suggest that the distinct organization of vowel categories are linked to the developmental differences related to a speaker's age of L2 acquisition. The earlier a person is exposed to their L2, the greater the chance they will acquire the necessary perceptual information required to produce native-like vowels. According to the significant differences between simultaneous and early bilingual vowel production in her study, exposure to a speaker's L2 within the first year of life appears to play a key role in acquiring such finely tuned categories for native-like vowel production.

In a 2015 study Lipski looks at the L2 vowel systems of Quichua-dominant bilinguals (late L2 learners) from Imbabura. His results show large front and back vowel systems interspersed with no clear indication of systematic separation between high and mid vowels e.g., vowel clustering, binomial distributions, voids between spaces etc. These findings are similar to similar to (Stewart, 2014), who looked at the vowel systems of Spanish borrowings and native Quichua vowels. Here, some degree of high and mid vowel clustering was revealed as suggested in the statistical analysis, but the overlapping high and mid vowel spaces were considerable and no observable evidence was apparent to indicate a systematic division. Moreover, Lipski (2015) also showed that the high vowels of L1 Quichua speakers were less dispersed than when speaking Spanish, (including mid and high vowels in the broader, yet undifferentiated acoustic space). Based on these results, he concludes the large and highly dispersed high and mid vowel systems is the result of incomplete acquisition of the Spanish-mid vowels. He suggests Quichua-dominant Spanish speakers are at least aware that Spanish relies on acoustic cues that lays between Quichua high and low vowels though they have yet to productively divide the broad vowel spaces into distinct categories—a situation similar to near-merger.

In another detailed study regarding phonological variation in a Quechuan language, Pasquale (2001) looked at cross-language changes in high front and back vowel height in bilingual and monolingual speakers of Cuzco Quechua as compared to those of monolingual Spanish speakers. His results show that Spanish interference in both Quechua-dominant and Spanish-dominant bilinguals cause lower Quechua high vowels to shift upwards to Spanish high vowel ranges. Another pertinent finding to come out this study concerns a phonological rule in southern varieties of Quechua which causes high vowels to be lowered and backed in the vicinity of uvular stops ([q, q', q^h]). Evidence suggests that monolingual speakers of Cuzco Quechua are taking advantage of this shift to produce mid vowels in Spanish-derived borrowings at roughly the same range as those constrained in this phonological rule– a range approximately equivalent to that of monolingual-Spanish [e] but shifted further back compared to monolingual-Spanish [o]. Intra-group analysis of the same phonological rule in Pasquale (2001) also suggests that Spanish-dominant bilinguals are not applying this rule when speaking Quechua while Quichua-dominant bilinguals are raising the mid vowels.

Bilingual preference of Spanish-derived high vowels over their Quechua-derived counterparts during Quechua speech in the aforementioned studies prompted me to further investigate the motivations behind such contact-induced change. Lipski (2015), Pasquale (2001), and Guion (2003) provide evidence that linguistic induced change is a driving force in the arrangement of Quechua/ Quichua vowel spaces. Guion (2003) suggests that bilinguals develop a single phonological system for both languages designed for optimal perceptual contrast. In turn, Lipski (2015) shows incomplete acquisition of the Spanish mid vowels in late bilingual L2 speech has increased the overall size of the high vowel category to incorporate the mid vowels. While Pasquale (2001) suggests a chain shift in the vowel space of Quechua-dominant bilinguals is responsible for dragging up the allophonically conditioned mid vowels in pursuit of the raised high vowels. Pasquale (2009) however, also offers social motivation as a compliment to linguistic induced change. As is the case with Quichua in Ecuadorian society, Quechua in Peru is considered stigmatized while Spanish is seen as the prestigious language used in education, government and urban society. According to Pasquale (2009), the social position of Quechua may be the driving force for setting linguistic change in motion as bilingual speakers desire, albeit subconsciously, to produce Quechua vowels more like those of Spanish.

Based on Guion (2003)'s results, Stewart (2011) concluded that Media Lengua speakers are performing the impressive task of maintaining distinct high and mid vowel categories at greater acoustic differences than monolinguals, but at roughly half the distance as simultaneous bilinguals. This conclusion was based on Guion (2003)'s results suggesting simultaneous bilinguals also maintained separate high vowel categories when speaking Spanish vs. Quichua. Stewart (2011) converted these categorical differences from Bark to Hertz based on her data, showing that high vowel pairs based on the language spoken (Spanish or Quichua), to be roughly, on average, 23 Hz higher than mid vowel pairs; 10 Hz more than the Media Lengua categories based on borrowings from Spanish and Quichua, and roughly the same as the high and mid vowel distinctions between Quichua native words and Spanish borrowings. The same conversions also showed that the simultaneous bilinguals separated high and mid vowel categories in Spanish by roughly 88 Hz, on average— about twice that of the Media Lengua categories based on borrowings from each source language and about three-fourths as large as native Quichua vowels and those derived from Spanish in Quichua.

1.11 Hypotheses

Based on the recent phonetic documentation of phonemic conflict sites in the contact and mixed language literature, I hypothesize that when speakers require the insertion of a new phoneme, due to, say increased lexical ambiguities via borrowings, they take the path of least resistance when accommodating the new articulatory gestures. This allows the insertion of new phonemes without deviating very far from the phonological structure of the speaker's native language. Minimal gestural effort can be seen in the phonemic systems of mixed languages which display high degrees of overlap while still maintaining contrast. This hypothesis also accounts for prior impressionistic descriptions of Media Lengua as having an identical sound system to that of Quichua.

To explain how such contrasts can still be maintained perceptually, I will reference exemplar theory descriptions of near-merger to show how fine grade shifts in the acoustic signal between overlapping phonemes may still allow differentiation if exemplar clusters of each signal are established. The production and perception results from this study, along with interpretations from the current body of mixed and contact language literature, will help support this hypothesis if my data suggests overlapping phonemes are present in the systems under investigation in this study. Because of the extreme lexical borrowings from Spanish in Media Lengua, compared to a more moderate level of borrowings in Quichua, I predict that the variables under investigation in Media Lengua will show subtle, yet significant trends towards Spanish values and away from Quichua. I also expect to find significant perceptual differences in the data where the Media Lengua results will suggest an extra phoneme. In contrast, Quichua will show variable perception results suggesting the phonemes under investigation have not yet been established perceptually in the language. The data from the Spanish varieties should also show influence based on the level of Quichua influence i.e., L2 Spanish should trend more towards Quichua values than Rural Spanish and Rural Spanish more so than Urban Spanish.

Chapter 2

Stop production

2 Introduction

One of the more transparent phonemic conflict sites between Spanish and Quichua involves the contrastive voicing of stops in the former and non-contrastive voicing of stops in the latter. The Spanish stop inventory includes bilabial /p/, dental /t̪/, and velar /k/ along with their voiced counterparts: /b/, /d̪/, and /g/. Intervocalic and pre-front vowel (/i/ & /e/) voiced bilabial and voiced velar stops show weakening to [β] and [ɣ] respectively (Figure 5 and Figure 6), while /d̪/ also weakens to [ð] but to a lesser extent (Figure 7).

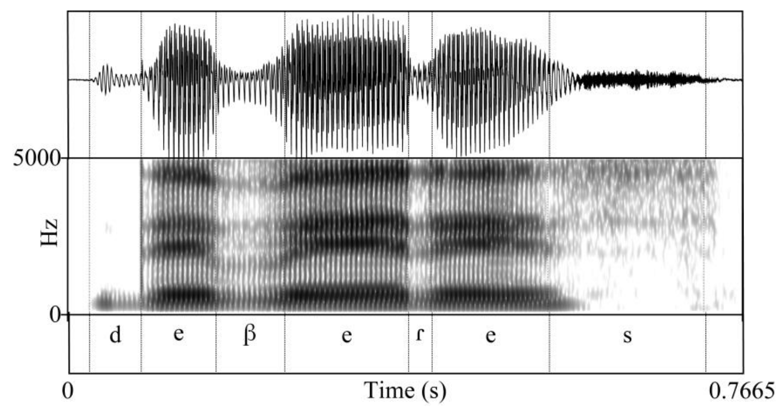


Figure 5: Intervocalic weakening of [b] to [β] in the Spanish word *deberes* [de'βeɾes] 'homework'. Consultant #107

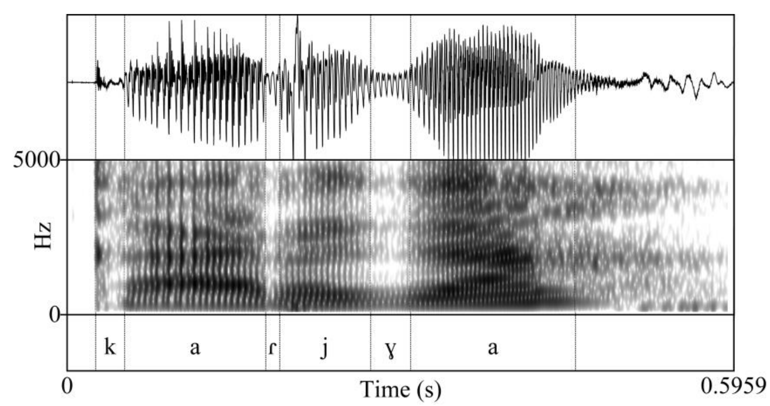


Figure 6: Inter-sonorant weakening of [g] to [ɣ] in the Spanish word carga ['kaɾʲɣa] 'load'. Consultant #107

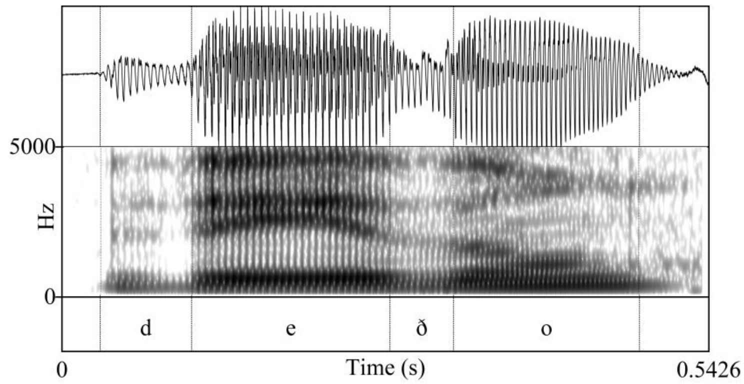


Figure 7: Intervocalic weakening of [d] to [ð] in the Spanish word *dedo* [ˈdeðo] 'finger'. Consultant #107

Spanish stops also appear to be very sensitive to word boundaries which often cause weakening in word-initial stops in utterance-medial and final positions. It is also possible however that this is co-articulation effect which overshadows the release. Intervocalic weakening has also been shown to take place in the voiceless series of stops in Central Colombian and Northern Spain varieties of Spanish (A. Lewis, 2001). Intervocalic weakening however, was not established in Argentine Spanish showing cross-dialectal variation regarding voiceless stops (Colantoni & Marinescu, 2010). Chapter 5, Section 5.2 specifically explores whether the language varieties under investigation show weakening of intervocalic voiced and voiceless stops.

The stop series found in Imbabura Quichua has virtually the same places of articulation as those found in Spanish: /p/, /t̪/, /k/, however, the exact position of the coronal stop is not documented in the Imbabura Quichua literature e.g., dental vs. alveolar (Cole, 1982). Colantoni and Marinescu (2010) however, mark [t] with a dental diacritic in Cotopaxi Quichua. With the exception of Spanish borrowings, voiced stops are non-contrastive. Post-nasal stops however, undergo voicing (Figure 8) (Cole, 1982) while intervocalic stops often voice and weaken to [β], [ð], and [ɣ], like those found in Spanish (Figure 9). In several Quechuan dialects in Ecuador, including that of Imbabura, initial velar /k/ weakens to /x/ or debuccalizes to /h/ in some words leaving no trace of release (Figure 9) (Orr, 1962; Toapanta, 2012).

Figure 8: *panka-ka* Consultant #77
paper-TOP
paper

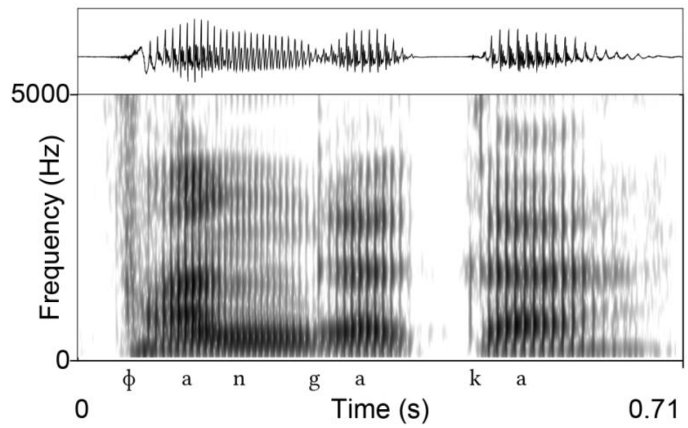
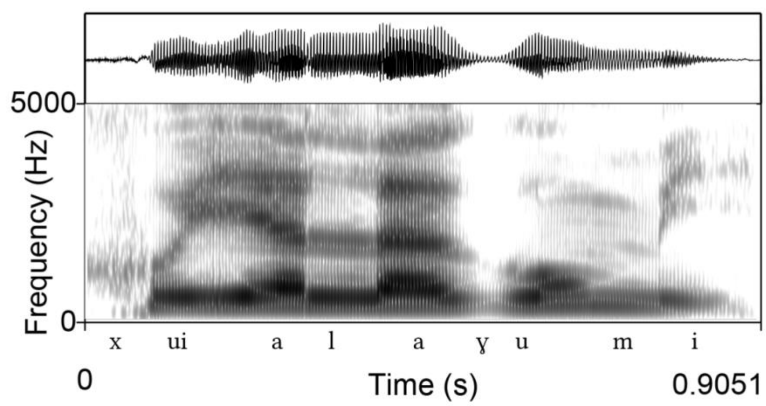


Figure 9: *kuyala-gu-mi* Consultant #69
love-DIM-VAL
pretty



2.1 Voice onset time

2.1.1 Voice onset time production

In languages that have a stop voicing contrast, one of the more common cues for differing between voicing involves voice onset time (VOT). VOT refers to the temporal duration from the moment of release of a stop to the onset of voicing in the following vowel (Lisker & Abramson, 1964). Figure 10 shows the measurement of VOT in the Media Lengua word *queta* ['keta] 'what'.

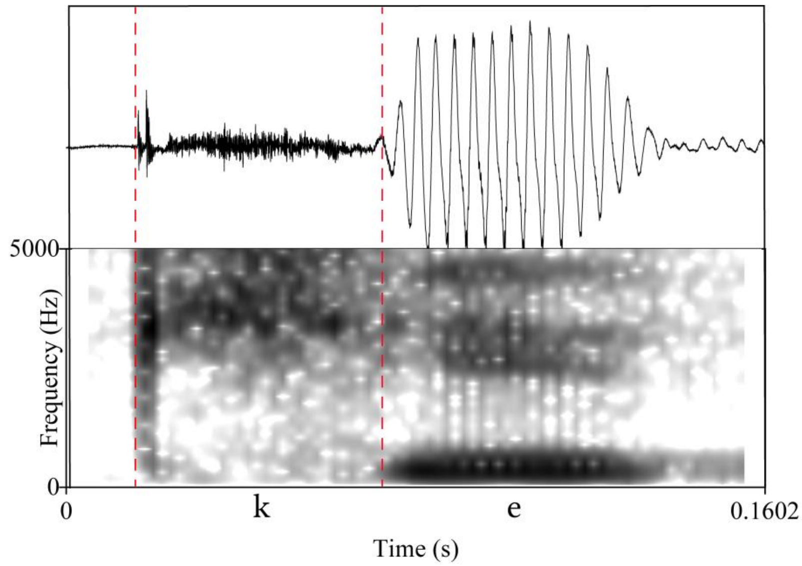


Figure 10: Measurement of a positive VOT (/k/).

Languages with such a contrast often choose between three possibilities: voiced, voiceless unaspirated, and aspirated (Keating, 1984). While the differences in duration are language specific, voiceless aspirated stops (/pʰ/, /tʰ/, /kʰ/), like those found in word-initial position in English, are shown to have overall longer durations (also known as long-lag VOTs) than voiceless unaspirated stops (/p/, /t/, /k/), while voiced stops (/b/, /d/, /g/) have shorter-lag than their unaspirated counterparts. The voiced series of stops, like those found in Spanish (Abramson & Lisker, 1973; Flege & Eefting, 1988; Lisker & Abramson, 1964) and French dialects (Caramazza & Yeni-Komshian, 1974; Hoonhorst et al., 2009), can also be negative, meaning voicing begins before the release. Figure 11 shows the measurement of a negative VOT in the Media Lengua word *deberes* [diˈβeɾes] 'homework'.

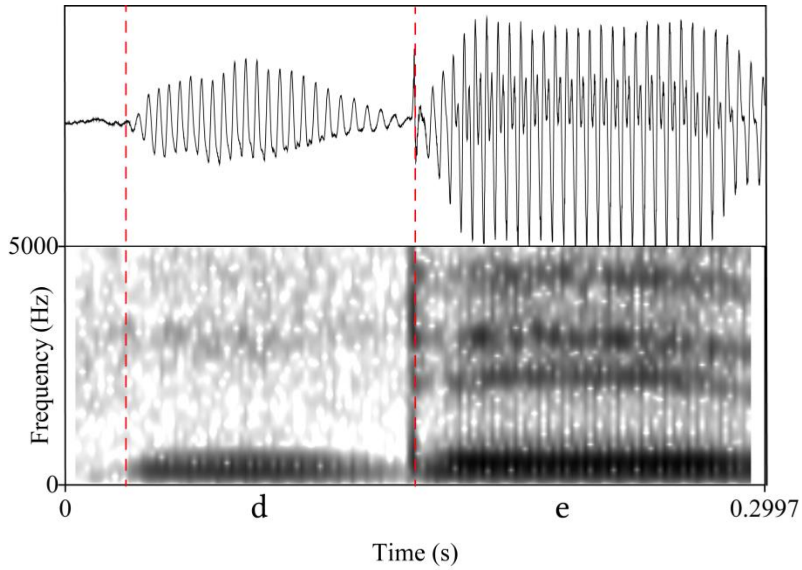


Figure 11: Measurement of negative VOT (/d/).

Other correlates used in voiced stop contrasts include F1 cutback (the loss of the initial transition of the first formant in vowels following a voiceless stop) (Liberman, Delattre, & Cooper, 1958; Lisker & Abramson, 1964), pitch (shown to be depressed following voiced stops) (Haggard, Ambler, & Callow, 1970), closure duration (shown to be longer the more fronted the place of articulation) (Zue, 1976), and post-stop vowel duration (shown to be shorter after voiceless stops than voiced stops) (Allen & Miller, 1999; Metz et al., 2006).

Another characteristic of VOT involves place of articulation which can cause overall changes in duration (Fischer-Jørgensen, 1954; Lisker & Abramson, 1964; Peterson & Lehiste, 1960; Zue, 1976). Lisker & Abramson (1964) show that unaspirated velar VOT values were longer in duration than those produced in labial and apical positions while labial VOT values were shorter than apical values in six of the seven languages they investigated. From an aerodynamic standpoint it is thought that the smaller supraglottal cavity in velars results in a higher increase in pressure compared to more fronted stop positions (Hardcastle, 1973; Maddieson, 1997). As mentioned in Cho and Ladefoged (1999), longer velar VOT may also result from the larger body of air ahead of the stop, which must be 'moved' before the released supraglottal pressure can exit the vocal track. Hardcastle (1973) proposed that longer velar VOT may be due to articulator speed where faster articulators e.g., lips & tongue apex, release the post-articulator pressure quicker than slower articulators e.g., tongue body. Finally, it has also been shown that place of articulation, as a cause of VOT duration may in fact have more to do with the extent of articulatory contact. Cho and Ladefoged (1999, p. 211) state that contact with the tongue body and the soft palate is "more extended than that of bilabial and alveolar stops" and "similar differences in contact length between laminal and apical stops" are shown to contrast dental and alveolar stops.

While place of articulation, and its effect on VOT duration, has not been shown to be a linguistic universal, it may account for VOT duration differences in many languages. Similar trends have also been replicated in a number studies to be referenced in this dissertation showing that backedness correlates with longer VOT duration (Jones & Meakins, 2013 for Gurindji Kriol; Pasquale, 2005 for Quechua).

2.1.1.1 Voice onset time production in mixed languages

To date only one study relating to VOT appears in the mixed language literature. In this study Jones and Meakins (2013) look at VOT in stops in Gurindji-Kriol, a mixed language spoken in the Northern Territory, Australia. Similar to Quichua, Gurindji does not have a voicing contrast in the language's stop series. Like Spanish and Media Lengua, word borrowings from Kriol (an English-based creole) have also added voicing contrasts to the language (Jones & Meakins, 2013, p. 198).

One of their findings, specifically relating to this study, describes VOT variation in Kriol-derived words produced by adult speakers of Gurindji-Kriol. Here, they test whether the values systematically relate to those in English cognates and how they compare to those in

Gurindji-Kriol. Based on data gathered from a picture naming task, their results show that there is no effect of source-voicing among English voiced, English voiceless, and Gurindji-Kriol (non-contrastive) stops in word-initial position. Based on this finding, they conclude that Gurindji-Kriol stops, regardless of their source-voicing category, are produced with short lag VOT (with the exception of code-switching data in English).

These findings raise the question: How is VOT production realized in Media Lengua regarding source-voicing? Do Media Lengua speakers assimilate VOT values in Spanish-derived words to Quichua-like VOT values? Alternatively, is it possible that the extreme quantity of lexical borrowings added a voiced stop series into Media Lengua and/or caused voiceless VOT stop values to trend towards Spanish-like production? Based on the differences in formation between these two mixed languages (code-switching vs. relexification) and the type of splits (nominal/verbal split in Gurindji-Kriol vs. lexical/grammatical split in Media Lengua), I still predict the 90% lexical replacement in Media Lengua is enough to cause the VOT values in Media Lengua to have a subtle, yet significant trend towards Spanish values and away from Quichua.

2.1.1.2 Voice onset time production in contact languages

While many studies look at how bilingualism influences VOT values compared to those of monolinguals, comparative analyses of VOT production in word-borrowings in monolingual speech are lacking (Delano, 2012 for Spanish-Creole English; Flege, 1991 for Spanish-English; Kehoe, Lleó, & Rakow, 2004 for Spanish-German; MacLeod & Stoel-Gammon, 2005 for French-English; Pasquale, 2005 for Quechua-Spanish ; inter alia). Regarding findings in the literature on bilingualism, Pasquale (2005) reported that Quechua-dominant bilinguals produced overall shorter VOT values than Quechua monolinguals— values which trended towards Spanish-like production. Spanish-dominant bilinguals, on the other hand, showed no noticeable shift toward Quechua-like VOT production. MacLeod & Stoel-Gammon (2005)'s findings for simultaneous French-English bilinguals VOT production show that speakers' French values were monolingual-like, but English values were produced with lead voicing while monolinguals are not. Flege's (1991) study on VOT production in Spanish-English bilinguals shows that late L2 learners of English produced /t/ values at an intermediate stage between Spanish short-lag values and English long-lag values. At the same time, early L2 learners of English had VOT values which did not differ from those of English monolinguals. These findings suggest that simultaneous and early bilinguals often produce both L1 and L2 VOT values with little interference from the opposing language, while late bilinguals typically do not achieve native-like VOT production in their L2.

While analyses of VOT production of borrowed stops in monolingual speech are lacking, findings from Gurindji-Kriol (Section 2.1.1.1) suggest that even with a complete lexical category borrowed from a different language, VOT values do not seem to be affected. Based on this finding, I predict that Spanish borrowings in Quichua will also assimilate to VOT values of Quichua.

2.1.1.3 Spanish voice onset time production

As mentioned in at the beginning of this chapter, the phonemic inventory of Spanish contains voicing contrasts among bilabial, dental, and velar stop pairs (/p/-/b/, /t̪/-/d̪/, /k/-/g/). The primary duration correlate for contrast among these pairs involves long negative VOT (or long pre-voicing) for the voiced series and short-lag VOT for the voiceless series. Spanish dialects however, have been shown to have variation regarding to VOT duration. Table 12 details average Spanish VOT durations in five dialects. This data suggests that pre-velar voiceless stops in Puerto Rican and Guatemalan Spanish have shorter durations compared to other dialects while both Peruvian and Castilian appear to have shorter pre-voicing durations in the voiced series of stops.

	/p/	/t̪/	/k/	/b/	/d̪/	/g/	Source
Puerto Rico	4	9	29	-138	-110	-108	(Lisker & Abramson, 1964)
Guatemalan	9	10	26	-120	-109	-101	(Williams, 1977)
Venezuela	14	20	33	-95	-79	-64	(Williams, 1977)
Peruvian	15	16	30	-102	-110	-98	(Williams, 1977)
Castilian	13	14	27	-92	-92	-74	(Rosner et al., 2000)
Average	11	14	29	-109	-100	-89	

Table 12: Average Spanish VOT values across five Spanish dialects.

As part of this study, I also document the intra-group VOT duration values from all the language varieties under investigation.

2.1.1.4 Quechua voice onset time production

As mentioned in the previous section, the phonemic inventory of Quichua contains a similar stop series to that of Spanish, but with non-contrastive voicing (with the exception of Spanish borrowings) (/p/, /t/, /k/). Unlike the many studies which analyse Spanish voice onset time, only one investigation to date has looked at VOT in a Quechuan language. Pasquale (2005), analyzes VOT from Cuzco Quechua spoken in Urubamba, Peru, and VOT from Spanish speakers from the same region. Average durations are found in Table 13.

	/p/	/ t/	/k/	Source
Cuzco Q.	19	24	42	(Pasquale, 2005)

Table 13: Average monolingual Cuzco Quechua VOT values from four speakers.

	/p/	/ t/	/k/	Source
Cuzco Sp.	15	19	33	(Pasquale, 2005)

Table 14: Average monolingual Cuzco Spanish VOT values from three speakers.

Pasquale's analysis reveals significant differences between Cuzco Spanish and Cuzco Quechua VOT durations in both alveolar and velar stops but not in the bilabial pairs, though they trend in the right direction. These findings suggest Cuzco Quechua has an overall longer lag time than that of Spanish.

It should also be noted that the Cuzco dialect and Bolivian dialects of Quechua contain a three-way contrast between unaspirated, aspirated, and ejective voiceless stops (A. Lewis, 2001). This division however, is purportedly either a conservative feature of proto-Quechua or borrowed from Aymara (Jaqi) since only the southern dialects contain this split (Adelaar & Muysken, 2004; Mannheim, 1991). A. Lewis (2001) also notes that some varieties of Ecuadorian Quechua contain aspirates. This observation was later confirmed in Colantoni and Marinescu (2010)'s work on stops and afficates in central highland Quichua from the province of Cotopaxi. Kohlberger (2010)'s results not only demonstrate that phonetic aspiration is present in Cotopaxi, but speakers also show phonemic contrasts between aspirated and unaspirated stops. In earlier work on Ecuadorian Quichua, Stark and Muysken (1977) also make an entry in their dictionary for aspirated words found in the community of Ilumán, Imbabura e.g., *c'aca* 'scrub' vs. Spanish-derived *caca* 'poo'. Of their word-initial aspirated entries in the dictionary only two are found under *c'* [kʰ] and zero appear under *'t'*. The vast majority of the aspirated entries appear under *'p'* in words, which I interpret as /ɸ/ e.g., *piña* 'angry' [ˈpʰiɲa] vs. [ˈɸiɲa] and *panka*"leaf' [ˈpʰanga] vs. [ˈɸanga] (See Figure 8). In passing, I check the data for anomalies in the voiceless stops e.g., binominal distributions or skewed portions of the data, which may indicate the presence of an aspirated-unaspirated contrast.

2.2 VOT production analysis

2.2.1 Method

This chapter looks at VOT production data in each language variety and across the language varieties in this study. The aim of this experiment is to describe within-group voiced VOT integration and across-group VOT variation of borrowed stops from Spanish into Media Lengua and Quichua. I also seek out any Quichua VOT influences in the Rural and L2 Spanish data. The data under analysis in this experiment is analyzed via acoustic measurements.

2.2.1.1 Materials

Voice onset time data was gathered from two sources making up a total of 7859 tokens. The first source comes via my 2010-2012 corpus of elicited Media Lengua and Quichua data. This data makes up 35% (2716 tokens) of the total dataset and 70% and 57% of the Media Lengua and Quichua datasets respectively.

The data was elicitated from two lists comprised of Spanish sentences: The first contained roughly 2000 sentences covering all phrasal positions (initial, medial, and final), all six stops (/p/, /t̪/, /k/, /b/, /d̪/, /g/), in combination with all five vowels (/a/, /e/, /i/, /o/, /u/). This list was elicited from three Media Lengua speaking consultants: 43, 50, and 51, and three Quichua speaking consultants: 68, 72, and 73 (see Section 2.2.1.2). The second list consisted of a subset of the previous list made up of 100 Spanish sentences. It was developed for quick Media Lengua and Quichua elicitations from multiple speakers. While its primary purpose was to gather vowel data, after careful analysis, it was shown that the data was also adequate for both Media Lengua and Quichua VOT analysis. All six stops were present in utterance-initial, medial, and final positions in combination with all five vowels, with the exception of [gi] and [ge] in Media Lengua. The Quichua elicitations also rendered data with all three native Quichua stops (/p/, /t̪/, /k/) in utterance-initial, media, and final positions in combination with all three native Quichua vowels (/a/, /i/, /u/). In addition, this list also covered Spanish borrowings containing the syllables: /pe/, /te/, /ke/, /ko/, /be/, /bi/, /bo/, /bu/, /da/, /di/, and /du/.

During these elicitation sessions, participants were asked to give their best oral translation of a sentence into Media Lengua or Quichua (depending on the group of speakers partaking in the session). The same sentence list was used for both Media Lengua and Quichua elicitations in order to maintain similar data gathering conditions. The participants' oral translations were recorded on a TASCAM DR-1 portable digital recorder using TASCAM's compatible TM-ST1 MS stereo microphone set to 90˚ stereo width. Elicitations were recorded in 16-bit Waveform Audio File Format (WAV) with a sample rate of 44.4 kHz.

The second source of data came via a wordlist specifically used to elicit stops without interference from a second party i.e., myself or the native Spanish speaker who assisted me with the sentence list elicitations. This data makes up 65% (5143 tokens) of the total data from all five language variety datasets. This includes 30% of the Media Lengua dataset, 43% of the Quichua dataset, and 100% of the Spanish language datasets. Participants from each language variety group were asked to read words or sentences in their native language from a computer screen. Each sentence began with an utterance-initial stop that was the target of my analysis. For the Spanish participants single words were used instead of sentences to avoid sentence-initial articles which would shift the target to an utterance-medial position. Media Lengua and Quichua on the other hand required sentences to prime the target language e.g., seeing the word *caña* 'cane/ stick' instead of *cañawanmi* 'cane-INST-VAL' might cause a more Spanish-like pronunciation since Media Lengua and Quichua speakers are bilingual. To create a homogenous word sample for cross-language variety comparisons, Spanish words which were borrowed by both Media Lengua and Quichua speakers were chosen as the utterance-initial word.

Spanish	*Caña*
Media Lengua	*Cañawanmi pegawarka.*
Quichua	*Cañawanmi makawarka.*
Gloss	'He hit me with a stick.'

Table 15: Cross-language wordlist examples from Spanish, Media Lengua, and Quichua

The Quichua wordlist contained 66 sentences while both the Spanish and Media Lengua lists contained 100. If a participant could not read, (two cases in both Media Lengua and Quichua) I (twice, once for each language) or a native speaker (twice, once for each language) of the language under elicitation would read the sentence and ask the participant to repeat twice and use the second utterance for analysis. If a participant struggled with reading, I would ask them to repeat the sentence after they finished saying it allowing for a more naturalistic sample.

The participants were recorded on a TASCAM DR-1 portable digital recorder using a NEXXTECH unidirectional dynamic microphone (50-13000 Hz response). The wordlist was recorded in 16-bit Waveform Audio File Format (WAV) with a sample rate of 44.4 kHz. Because of the differences in data sources and microphones, *'recording type'* is added to all statistical models in take into account this effect.

2.2.1.2 Participants

Table 16 though Table 18 provide information pertaining to the participants who took part in the production portion of this study. The data includes: speaker code, age at the time of recording, gender, demographic descriptors including, education, level of Spanish, Quichua, Media Lengua, and place of residence.

For Media Lengua, 19 trilingual speakers (Quichua, Media Lengua, and Spanish) participated in this study. This group consisted of twelve women and seven men. All participants were from the community of Pijal Bajo and acquired Quichua and Media Lengua simultaneously from birth and began learning Spanish upon entering primary school, typically at 6-7 years of age, with the exception of two, whose L1 were Spanish but passively acquired Media Lengua and Quichua from birth. Elicitation data was gathered from eight participants, wordlist data gathered from 9 participants, and both elicitation and wordlist data was gathered from two participants. It should be noted that the use of Media Lengua is variable, some individuals may go days at a time without using it, while others use it constantly. Stewart (2011) even notes that some of the speakers claim to have not used the language in years.

Twenty Quichua speaking participants also participated in this study and all were bilinguals (Quichua and L2 Spanish) ranging from low to high proficiency. This group consisted of twelve women and eight men. Four women had a rudimentary level of Spanish, one man and one woman were a simultaneous bilinguals, and one man acquired Spanish at the age of 18, while the rest acquired Spanish upon entering primary school, typically at 6-7 years of age. Elicitation data was gathered from 11 participants, wordlist data was gathered from eight participants, and both elicitation and wordlist data was gathered from one participant. Participants were born, raised, and lived in the neighbouring communities of Chirihuasi and Cashaloma at the time of recording. These slightly more distant communities were chosen to gather Quichua data over Pijal and neighbouring communities to avoid any influence from Media Lengua on Quichua speech of these consultants. Future studies however, may want to focus on the trilingual speech of Pijal. Similar to Media Lengua, the use of Quichua is variable, but not to the same extent, some individuals may go days at a time without using it, while others use it constantly. It should be noted however, that the speakers in this study pretty much use Quichua on a daily basis.

From the Spanish groups 30 participants took part in this study, 10 from each variety. From each group, six participants were women (18 total from all three groups) while four were men (12 total from all three groups). Both the Urban and Rural Spanish groups consisted of monolinguals with little or no knowledge of Quichua. From the Urban Spanish group, all speakers had graduated college and were born, raised, and lived in Quito at the time of recording. From the Rural Spanish group, speakers had mixed educational backgrounds ranging from primary to secondary school. Nine participants were born, raised, and lived in the neighbouring communities of La Cadena and La Esperanza at the time of recording. One participant was from the community of San José near Otavalo but conducted business in the abovementioned communities. These communities where chosen due to the proximity to Chirihuasi; from where the L2 data originates. It was thought that any variation in the L1 and L2 Spanish may be related to a conscious or subconscious effort to distinguish themselves from each other. The L2 group consisted of the same 10 participants from the Quichua group who were asked to read the Quichua wordlist followed by the Spanish list.

Media Lengua Speaker Code	Age	Gender	Formal Education	Spanish Level	ML/ Q Level	ML Usage	Recording Type	Place of residence
041	59/62	M	Primary	High	Native	Intermittently	Elici./WL	Pijal Bajo
042	47	F	None	High	Native	Daily	Elicitation	Pijal Bajo
043	39/42	F	Secondary	High	Native	Daily	Elici./WL	Pijal Bajo
044	44	F	Primary	High	Native	Intermittently	Elicitation	Pijal Bajo
048	43	F	Primary	High	Native	Intermittently	Elicitation	Pijal Bajo
049	42	F	Primary	High	Native	Intermittently	Elicitation	Pijal Bajo
050	42	F	Secondary	Mid	Native	Intermittently	Elicitation	Pijal Bajo
051	60	F	None	Mid	Native	Infrequently	Elicitation	Pijal Bajo
052	40	M	Primary	High	Native	Infrequently	Elicitation	Pijal Bajo
053	58	M	Primary	High	Native	Intermittently	Elicitation	Pijal Bajo
054	59	M	Primary	High	Native	Intermittently	Elicitation	Pijal Bajo
055	46	F	Primary	Mid/High	Native	Intermittently	Wordlist	Pijal Bajo
056	64	F	None	Mid	Native	Intermittently	Wordlist	Pijal Bajo
057	63	F	None	Mid	Native	Intermittently	Wordlist	Pijal Bajo
058	33	M	University	Native	Native	Infrequently	Wordlist	Pijal Bajo
059	38	M	University	Native	Native	Infrequently	Wordlist	Pijal Bajo
060	24	F	Secondary	Native	Passive	Rarely	Wordlist	Pijal Bajo
061	24	F	University	Native	Passive	Rarely	Wordlist	Pijal Bajo
062	54	M	Primary	High	Native	Intermittently	Wordlist	Pijal Bajo
Average:	46							

Table 16: This table provides demographic information of the Media Lengua group including: age at the time of recording, gender, level of formal education, level of Spanish, Media Lengua, and Quichua, frequency of Media Lengua usage, recording type, and place of residency. It also includes the type of recording used to gather the data.

Q Speaker Code	Age	Gender	Formal Education	Spanish Level	Quichua Level	Quichua usage	Recording Type	Place of residence
063	66/68	M	Primary	Mid/High	Native	Daily	Elici./ WL	Chirihuasi
064	62	F	None	Low	Native	Daily	Elicitation	Chirihuasi
065	45	F	None	Low	Native	Daily	Elicitation	Chirihuasi
068	62	F	None	Low	Native	Daily	Elicitation	Cashaloma
069	29	F	None	Low	Native	Daily	Elicitation	Cashaloma
070	21	F	None	Low	Native	Daily	Elicitation	Cashaloma
072	42	M	NA	Mid/High	Native	Daily	Elicitation	Chirihuasi
073	70	M	University	Mid/High	Native	Daily	Elicitation	Chirihuasi
074	28	M	Secondary	High	Native	Daily	Elicitation	Chirihuasi
075	52	M	Secondary	Native	Native	Daily	Elicitation	Chirihuasi
076	55	F	NA	Mid/High	Native	Daily	Elicitation	Chirihuasi
077	49	M	Secondary	High	Native	Daily	Elicitation	Chirihuasi
078	30	M	University	High	Native	Daily	Wordlist	Chirihuasi
079	32	F	Primary	High	Native	Daily	Wordlist	Chirihuasi
080	43	F	NA	Mid	Native	Daily	Wordlist	Chirihuasi
081	53	M	Primary	Mid	Native	Daily	Wordlist	Chirihuasi
082	34	M	Secondary	High	Native	Daily	Wordlist	Chirihuasi
083	48	F	NA	Mid	Native	Daily	Wordlist	Chirihuasi
084	26	F	Secondary	Native	Native	Daily	Wordlist	Chirihuasi
085	38	F	Primary	High	Native	Daily	Wordlist	Chirihuasi
086	48	F	NA	Mid	Native	Daily	Wordlist	Chirihuasi
Average	44							

Table 17: This table provides demographic information of the Quichua and L2 Spanish speaking groups including: age at the time of recording, gender, level of formal education, level of Spanish and Quichua, recording type, frequency of Quichua usage, and place of residency. It also includes the type of recording used to gather the data.

Rural Spanish Speaker Code	Age	Gender	Formal Education	Spanish Level	Quichua Lengua Level	Recording Type	Place of residence
087	34	F	Primary	Native	None	Wordlist	La Cadena
088	38	M	Primary	Native	None	Wordlist	San José
089	22	F	Secondary	Native	None	Wordlist	La Cadena
090	27	F	Secondary	Native	None	Wordlist	La Cadena
091	28	F	Secondary	Native	None	Wordlist	La Cadena
092	34	M	Secondary	Native	None	Wordlist	La Cadena
093	56	M	Primary	Native	None	Wordlist	La Cadena
094	48	F	Primary	Native	None	Wordlist	La Cadena
095	48	M	Secondary	Native	None	Wordlist	La Esperanza
096	60	F	Primary	Native	None	Wordlist	La Cadena
Average	40						
Urban Sp. Speaker Code	Age	Gender	Formal Education	Spanish Level	Quichua Lengua Level	Recording Type	Place of residence
097	22	F	University	Native	None	Wordlist	Quito
098	35	F	University	Native	None	Wordlist	Quito
100	38	M	University	Native	None	Wordlist	Quito
101	33	M	University	Native	None	Wordlist	Quito
102	35	M	University	Native	None	Wordlist	Quito

Urban Sp. Speaker Code	Age	Gender	Formal Education	Spanish Level	Quichua Lengua Level	Recording Type	Place of residence
103	57	M	University	Native	None	Wordlist	Quito
104	34	F	University	Native	None	Wordlist	Quito
105	30	F	University	Native	None	Wordlist	Quito
106	24	F	University	Native	None	Wordlist	Quito

Table 18: This table provides demographic information of the L1 urban and rural Spanish speaking groups including: age at the time of recording, gender, level of formal education, level of Spanish and Quichua and place of residency. It also includes the type of recording used to gather the data.

2.2.1.3 Procedures

For the elicitation sessions, a native Spanish speaker or I explained the task and received voluntary written consent before each session began. Prior to beginning the task, demographic information was also gathered from the participants. Consultants were compensated monetarily for their time. My assistant or I read each sentence aloud in Spanish from a printout of either the 2000 sentence-list or the 100 sentence-list for the Media Lengua participants. My assistant (a native Spanish speaker) and I also read elicited the same 2000 and 100 sentence-list in Spanish for the Quichua participants and a native Quichua speaker from Chirihuasi interpreted if confusion arose. The 100 sentences were the same for all the participants and elicitation conditions did not vary.[4] The participants were asked to give their best oral interpretation of each sentence and wait at least five seconds before producing the utterance. We encouraged participants to consult with others if any doubts arose. We also asked participants to speak at a normal conversational speed and to repeat if needed. Consultations with other participants and the five second waiting period made it more likely that speakers

[4] It should be noted that since a native speaker of Media Lengua or Quichua did not elicit the sentences, there may be an increased chance of accommodation or hyper-correction. To reduce these factors, we held elicitation sessions with three or more participants at a time in their homes and asked them to speak in their language when consulting amongst themselves. Even if accommodation was a factor, we would expect an equivalent distribution in both Media Lengua and Quichua since the elicitation conditions did not change. Since we are also looking at within-speaker variation within individual words, it is difficult to imagine a scenario where a speaker might only accommodate only one portion of a word and not the rest. To tease out any accommodation effect, the statistical tests in section 2.2.2 include *'recording type'* which take into account the differences in the elicitations and wordlist data.

were accessing their long-term memory and reducing mimicry (Guion, 2003). It should be noted this method of data elicitation often produces idealized specimens compared to the realities of spontaneous speech. This method was preferred however, in order to limit the degree of variation due to the number of language varieties under analysis (5). While this may not provide a complete analysis of all speech types, it provides a relatively consistent baseline for future research.

For the wordlist data, participants were explained the task in Spanish and voluntary written consent was received before each session began. Prior to beginning the task demographic data was gathered. Consultants were compensated monetarily for their time. Each participant read aloud each sentence off of a Power Point presentation on a PC laptop.

Seven thousand eight hundred and fifty nine (7859) VOT durations were analyzed from both the elicitation sessions (2716) and wordlist (5143) reading task for this portion of the study. Table 19 provides the breakdown of the entire VOT dataset by language. The voiceless velar [k] was the most common stop (26%) in the dataset while the voiced velar [g] was the least (6%) common. The majority of tokens were Media Lengua in origin (37%) while rural Spanish and L2 Spanish provided 13% each.

Language/ Phoneme	/p/	/t/	/k/	/b/	/d/	/g/	Other	Total	Percentage
Urban Spanish	209	179	239	236	122	122	17	1167	15%
Rural Spanish	182	148	200	196	128	87	119	1060	13%
L2 Spanish	182	148	193	164	127	74	133	1021	13%
Media Lengua	481	378	881	339	273	135	383	2870	37%
Quichua	383	284	544	136	152	63	179	1741	22%
Total	1437	1137	2057	1071	802	481	831	7859	100%
Percentage	18%	15%	26%	14%	10%	6%	11%	100%	

Table 19: Voice onset time database breakdown.

Using Praat version 5.3.47 (Boersma & Weenink, 2013), I measured VOT duration from all five language varieties. To avoid weakening, only word-initial stops were measured. Positive VOT was measured from the initial burst of the voiceless stops to the onset of voicing

(Figure 10). Negative VOT was measured from the first instance of voicing to the initial burst (Figure 11). Utterance-medial, word-initial voiced stops rarely showed signs of closure due to co-articulatory effects from previous word's final segment. I still considered these segments as stops versus fricatives if they, of course, showed a noticeable release (Figure 12). Under these circumstances, I measured the beginning of the VOT from the beginning of the steady state of either the wave form or based on Praat's formant tract, if the wave form is not consistent.

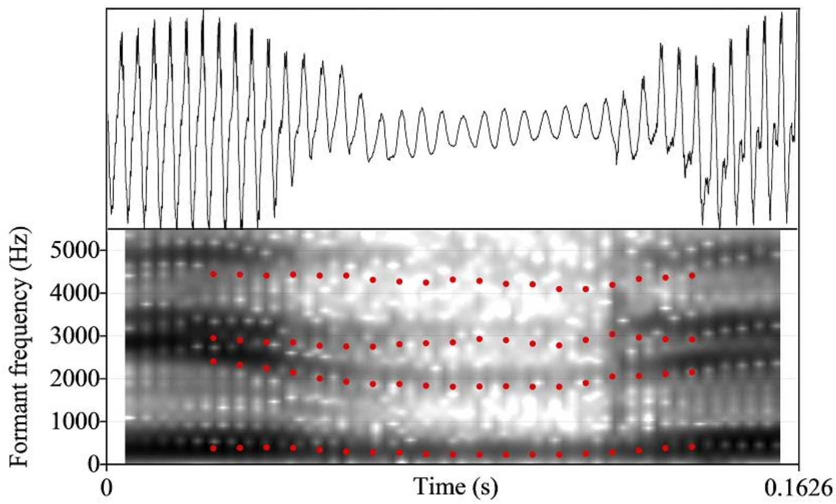


Figure 12: Utterance-medial, word-initial voiced stop steady-state. Voiced dental /d/ from Media Lengua *chaki dedota* 'toe'.

All VOT were demarcated on the first tier of a Praat TextGrid followed by the post-stop segment on the second tier. A third tier also contained the word from which the VOT was taken.

I wrote a Praat script to extract the temporal length between the two intervals on the first tier i.e., the VOT duration. The script also changes the ceiling of the formant search range to 5000 Hz for men and 5500 Hz to women as suggested in the Praat manual (Boersma & Weenink, 1996). This is due to the proportionately shorter vocal tracts of women speakers. The script also provides the following output: gender, the phoneme under analysis, the word from which the phoneme is analyzed, the post-stop vowel, and speaker code. Age, demographic factors, place of residency, stress/ pitch accent position, language of origin of the stop, language group, position of the stop in the utterance (initial, medial, or final), recording type (elicitation vs. wordlist), level of Spanish, Quichua, and Media Lengua were entered into the dataset manually.

Spanish-derived vowels were organized based on their original Spanish pronunciation, i.e., the [i] in *di̱biris* 'homework', would be considered /e/ and not /i/, since its pre-lexified production was that of /e/ in Spanish *deberes* /deˈberes/ 'homework'. To avoid false readings in the formant analysis, F1 values above 900 Hz were reviewed for consistency. If it appeared that the formant was in fact the F2 value, the original F1 value shifted to the F2 and subsequently the F2 value was shifted to the F3 value. The original F1 and F3 data were deleted from the dataset.

2.2.2 Results

The results of this study are presented in two subsections (2.2.2.1 and 2.2.2.2). The first section (2.2.2.1) explores intra-group variation in VOT duration from all five language varieties based on place of articulation. For both the individual and cross-segment analyses, we should expect similar trends to those found in Table 12 with longer durations for posterior articulations in the voiceless series and shorter durations for posterior articulations in the voiced series of stops.

The second section (2.2.2.2) explores inter-group stop variation across all five language varieties. In this section, I use two mixed effects models. The first tests the voiceless series and the second the voiced series VOT durations. This data should provide a picture as to how the language varieties under analysis compare and interact with one another regarding the VOT of stops along the contact continuum in Figure 1.

Mixed effects models were created in R x64 3.1.0 with the *lmer* function from the *lme4* package (Kuznetsova, Brockhoff, & Bojesen, 2014) and 95% confidence intervals (CI_{95}) were estimated using the *confint* function of the *lmerTest* package (Kuznetsova et al., 2014). All models included *speaker* and *word* as random effects. Non-significant predictors were removed from the models one-by-one, based on the closest t-value to zero, until only significant predictors remained. The models reported here contain no non-significant predictors.

The following predictors were considered when building the models: *gender* (male/ female), *age* (22-70, 40 factors), *stress* (stressed/ non-stressed position), *language of origin* (Spanish/ Quichua), *post-stop segment* (vowels: front, back, low; liquids), *utterance position* (initial, medial, final) *education* (high/ low), *level of Spanish* (high/low), and *recording type* (elicitation/ wordlist).

Each section also includes a density plot showing the raw data under analysis. It should be noted that due to the high power of the statistical tests, significant differences are not always clear in the raw data. The following sections include the results from the *confint* and the model summary outputs of each mixed effects model. When a result is significant, we are most interested in the coefficient estimate (β), which is a conservative estimate of the average duration difference in milliseconds between the VOT segments in question. The intercept results of each model are also included. The intercept can be defined as our 'starting point' or the estimated value in milliseconds if all the predictors were not applicable i.e., it is a 'basic' or 'average' value of the subset of data where all the predictors are their zero/ baseline value.

2.2.2.1 Intra-group VOT results

The purpose of this section is to describe VOT production in all five language varieties which has yet to be documented in the linguistic literature. This will allow for further cross-comparisons of Spanish VOT with varieties outside of Ecuador, like those provided in Table 12. In addition, this section provides answers to whether the voiced series (the phonemic conflict site under investigation in this dissertation), has been integrated productively into Media Lengua and Quichua. Significant results based on *voicing* should suggest speakers are making the relevant adjustments in the appropriate areas, namely in word-initial voiced stops of Spanish origin. The following subsections include a density plot of the raw data under analysis, the statistical results of each model, and a brief summary of the findings. General trends based on the graphs in each section suggest the voiceless velar [k], is longer in duration as would be expected based on findings by Fischer-Jørgensen (1954) inter alia, as citied in the introduction to this chapter. In every instance the dental stop [t̪] appears to be close to [p] in duration but with a slightly longer release. Regarding the voiced series, all five language varieties show substantial overlap in VOT duration across all three places of articulation. Three binomial distributions appear in the data which are given additional attention in their respective model sections: L2 Spanish [k], Quichua [t], and rural Spanish [d].

2.2.2.1.1 Urban Spanish intra-group VOT analysis

This section details the statistical results of Urban Spanish VOT durations. The predictors analyzed in this section include: *gender, age, stress,* and the *post-stop segment. Language of origin, level of Spanish, recording type, utterance position,* and *education* were excluded since the predictors were constant.

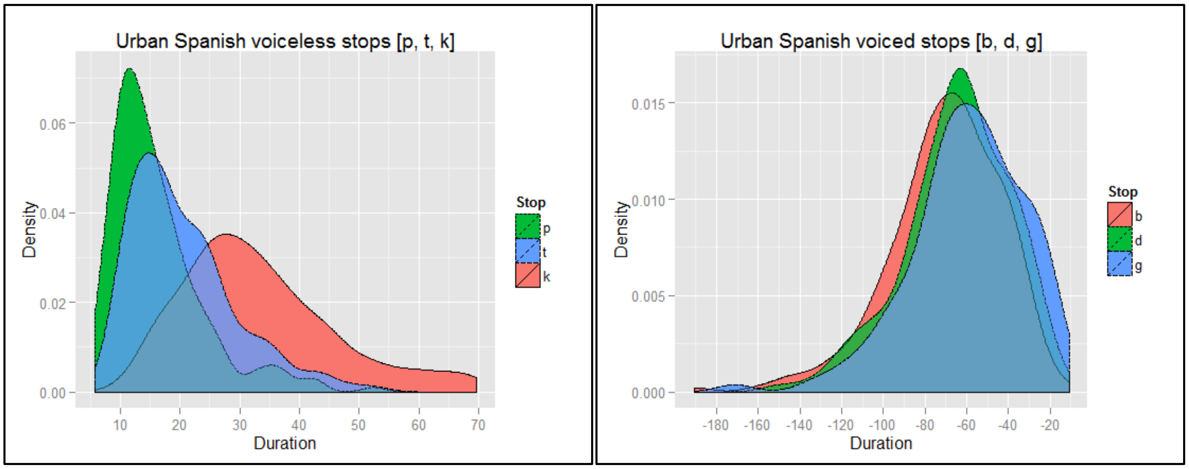


Figure 13: Two density plots with Urban Spanish voiceless stops VOT (left) and voiced stops VOT (right).

Table 20 details the statistical results of Urban Spanish VOT durations. Based on the model results, the intercept, with a 'base' value of 19 ms, contains the following baseline categories: the voiceless stop series, the front and back vowels, and both bilabial and coronal stops, which were non-significantly different in duration from each other. The following significant predictors can be added to the intercept to account for their effect on VOT. Voicing significantly affected the duration VOT by -92 ms, while stops produced in velar position significantly affected VOT by 14 ms (-59 for [g] (*Intercept + Velar + Voiced*) and 33 ms for [k] (*Intercept + Velar*)). Finally, there was an interaction between voicing and the VOT duration of stops in unstressed syllable positions which shortens the duration by 12 ms.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	18.6	2.1	14.6	22.6	8.8	2.50E-08
Velar	13.9	1.6	10.9	16.9	8.9	1.80E-14
Voiced	-92.1	1.8	-95.5	-88.6	-51.3	< 2e-16
Low vowel [a]	-5.4	1.7	-8.8	-2.1	-3.1	0.0022
Voiced*Unstressed	12.3	3.0	6.5	18.0	4.1	7.08E-05

Table 20: Statistical results from the VOT stop durations in Urban Spanish

Table 21 details the statistical results from Table 20 with the shortest and longest estimate VOT durations in milliseconds based on the significant predictors added to the intercept. This table also provides the mean duration and bare estimate of each VOT.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Short:long estimates in ms	13:45	13:45	27:59	-78:-47	-78:-47	-65:-33
Bare estimate	19	19	33	-73	-73	-59
Mean average	16	21	33	-70	-64	-59

Table 21: Duration range and mean VOT values in Urban Spanish based on estimate averages from Table 20.

2.2.2.1.2 Rural Spanish intra-group VOT analysis

This section details the statistical results of Rural Spanish VOT durations. The predictors analyzed in this section include: *gender, age, stress, education,* and the *post-stop segment. Language of origin, level of Spanish, recording type,* and *utterance position*, were excluded since the predictors were constant.

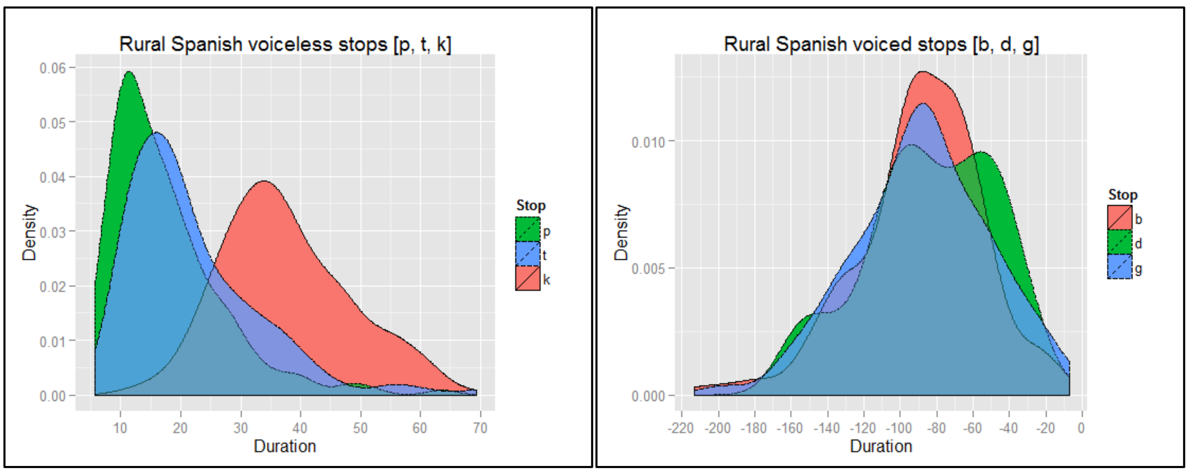


Figure 14: Contains two density plots with Rural Spanish voiceless stops VOT (left) and voiced stops VOT (right)

In the voiced stop series, the VOT duration of [d̪] is a bit of a conundrum as revealed in the distinct binomial distribution in Figure 14 (right). While *level of education* appears to account for some of the VOT variation in [d̪], upon closer analysis, it was found that eight of the ten participants make use of the long and short negative VOT distinction (>-75 ms, <-75 ms) before a back vowel (only [o] in this case as no instances of [d̪+u] were gathered) in what appears to be *free variation*[5]. The lexical items do not appear to be play a role as there was an even split between long and short durations (16 long and 16 short VOTs) and same words were

[5] I use this term with reservation since the sample size was small.

produced with varying VOT durations in each category e.g., the word-initial [d̪] *dolor* [d̪oˈloɾ] 'pain' was produced with a VOT of -44 ms by consultant 100, and with a VOT of -115 ms by consultant 104. It should be noted that with this particular word, these two speakers show opposing trends in *level of education* as reported by the model in Table 22 (education: #89: high, #93: low). Since only three words (uttered by each consultant) with an initial [d̪+o], were found in the dataset, this section requires further investigation before any concrete conclusions can be drawn.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	-68.6	8.3	-84.4	-52.3	-8.3	1.31e-5
Education: Low	-26.6	11	-48	-5.2	-2.4	0.042

Table 22: Statistical results from the VOT duration of Rural Spanish [d̪]

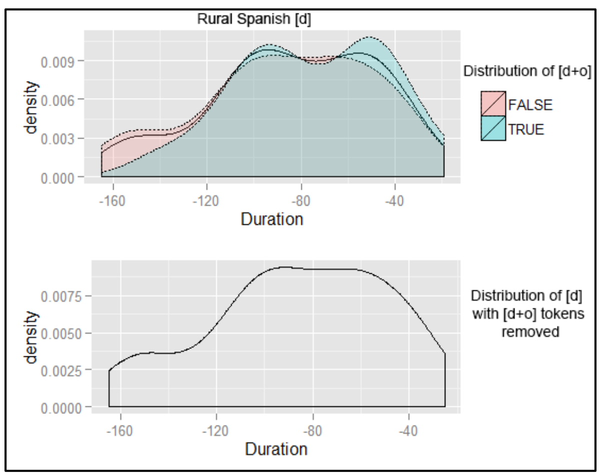


Figure 15: The top figure illustrates the distribution of [d̪+o] (light blue – binomial curve) compared to all other predictors (pink – plateau curve) while the bottom image removes the [d̪+o] predictor, which accounts for some of the variation in the original distribution.

Table 23 details the statistical results of Rural Spanish VOT stop durations. Based on the model results, the intercept, with a 'base' value of 21 ms, contains the following baseline categories: the voiceless stop series, the front and back vowels, liquids, and both bilabial and coronal stops, which were non-significantly different in duration from each other. The following significant predictors can be added to the intercept to account for their effect on VOT. Voicing significantly affected the duration VOT by -110 ms, while producing a stop in velar position significantly affected VOT by 19 ms. There was however, an interaction between voicing and stops in the velar position which significantly affected VOT duration by -17 ms. Therefore, the average duration for [g] based on this model is -87 ms (*intercept + velar + voiced + voiced*velar*) and 40 ms for [k] (*intercept + velar*)). There was an additional interaction between voicing and the VOT of stops in the unstressed position (non-penultimate) which significantly affected VOT duration by 14 ms. Finally, this model reveals that the VOT of stop consonants produced before a low vowel ([a]), were significantly different by -8 ms.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	20.8	2.9	15.1	26.5	7.2	3.18E-06
Velar	19.4	2.2	15.1	23.6	8.8	8.76E-13
Voiced	-110.6	2.3	-114.9	-106.2	-49.1	< 2e-16
Low vowel [a]	-8.1	1.9	-11.8	-4.5	-4.3	4.83E-05
Voiced*Unstressed	13.6	3.4	7.0	20.0	4.0	0.00013
Voiced*Velar	-17.5	3.7	-24.6	-10.5	-4.8	6.15E-06

Table 23: Statistical results from the VOT stop durations in Rural Spanish

Table 24 details the statistical results from Table 23 with the shortest and longest average VOT durations in milliseconds based on the significant predictors added to the intercept. This table also provides the mean duration and bare estimate values of each VOT.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Short:long estimates in ms	13:34	13:34	15:54	-98:-76	-98:-76	-96:-56
Bare estimate	21	21	40	-89	-89	-88
Mean average	17	22	38	-89	-83	-86

Table 24: Duration range and mean VOT values in Rural Spanish based on estimate averages from Table 23.

2.2.2.1.3 L2 Spanish intra-group VOT analysis

This section details the statistical results of L2 Spanish VOT duration. The predictors analyzed in this section include: *gender, age, stress, education, level of Spanish,* and the *post-stop segment. Language of origin, recording type,* and *utterance position* were excluded since the predictors were constant.

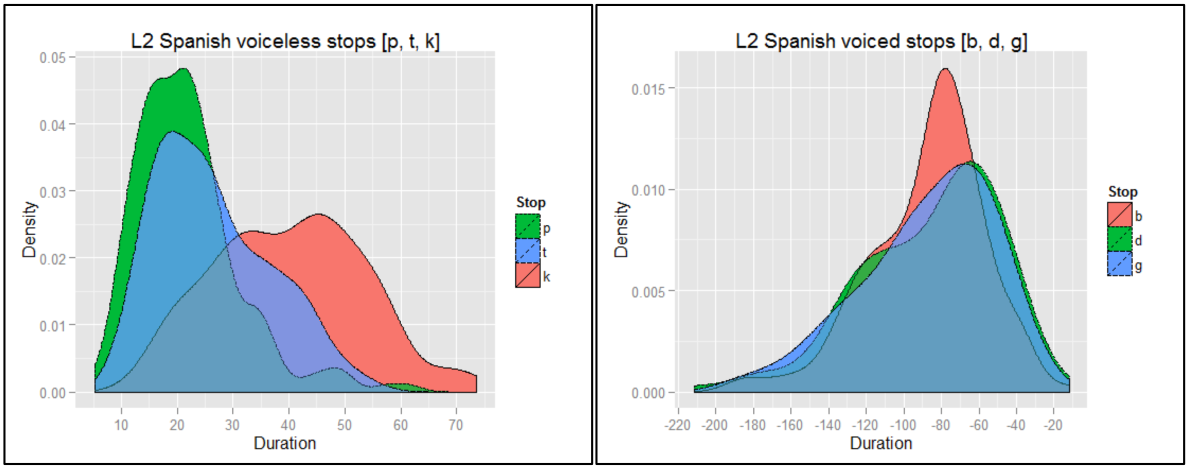


Figure 16: Contains two density plots with L2 Spanish voiceless stop VOT (left) duration and voiced stop VOT duration (right).

Figure 16 reveals a binomial distribution in the VOT of [k] which prompted further investigation. Additional analysis revealed the *back vowel* predictor was responsible for this discrepancy. The fact that back vowels follow into the high vowel category which affects VOT differently than low vowels, may suggest an aerodynamic explanation for this distribution. It is suggested by Mortensen and Tøndering (2013) that narrower vocal tract constriction in high vowels affects VOT duration since it takes longer to expel the air behind the stop occlusion taking longer for the adequate pressure to be achieved for voicing, thus resulting in a longer VOT. This phenomenon is further explained in Section 2.2.3. The fact that there were more instances of [k] than any other consonant is probably what makes the binomial distribution is more apparent in Figure 16. This effect was also shown to be significant in the model reported in Table 25, where stops preceding the low vowel [a], were significantly shorter than their high vowel counterparts. The top image of Figure 17 illustrates the split between back vowels (solid blue) and non-back vowels (solid pink) shown with a dashed blue line along with the overall distribution of [k] with a solid black line. In the bottom image of Figure 17, the back vowels have been removed revealing the degree of influence the back vowels have on the distribution, which was accounted for in the model. The rightward gradual slop is influenced by the front vowel duration (not pictured)—an effect of the same aerodynamic phenomenon explained above.

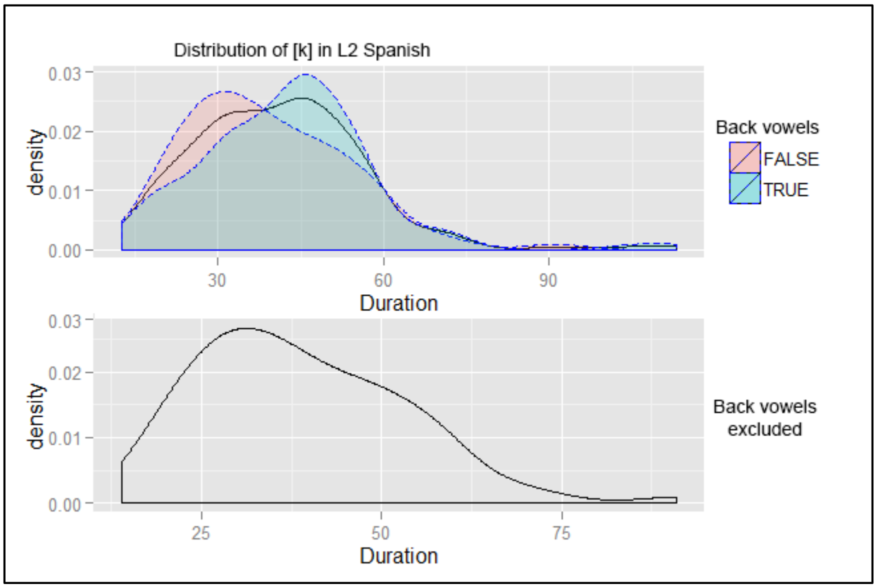


Figure 17: Back vowel distribution superimposed over the overall distribution of [k] in L2 Spanish (top) and the overall distribution of [k] in L2 Spanish with the back vowels removed.

Table 25 details the statistical results of L2 Spanish VOT stop durations. Based on the model results, the intercept, with a 'base' value of 25 ms, contains the following baseline categories: the voiceless stop series, the front and back vowels, liquids, and both bilabial and coronal stops, which were non-significantly different in duration from each other. The following significant predictors can be added to the intercept to account for their effect on VOT. Voicing significantly affected the duration VOT by -116 ms, while producing a stop in velar position significantly affected VOT by 17 ms. There was however, and interaction between voicing and the velar position which significantly affected VOT duration by -16 ms. Therefore, the average duration for [g] based on this model is -91 ms (*intercept + velar + voiced + voiced*velar*) and 42 ms for [k] (*intercept + velar*)). There was an additional interaction between voicing and the VOT of stops in the unstressed position (non-penultimate) which significantly affected VOT duration by 15 ms. Finally, this model reveals that the VOT of stop consonants produced before a low vowel ([a]), were significantly different by -6 ms.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	24.6	2.8	19.2	30.0	8.9	5.29E-08
Velar	16.9	2.4	12.3	21.5	7.1	8.42E-10
Voiced	-116.3	2.5	-121.2	-111.5	-46.2	< 2e-16
Low vowel [a]	-5.5	2.1	-9.5	-1.5	-2.6	0.01
Voiced*Unstressed	14.5	3.7	7.4	21.6	3.9	0.00018
Voiced*Velar	-16.6	4.0	-24.3	-8.7	-4.1	7.30E-05

Table 25: Statistical results from the VOT stop durations in L2 Spanish

Table 26 details the statistical results from Table 25 with the shortest and longest average VOT durations in milliseconds based on the significant predictors added to the intercept. This table also provides the mean duration and bare estimate values of each VOT.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Short:long estimates in ms	19:39	19:39	19:56	-97:-77	-97: -77	-97: -77
Bare estimate	19	19	42	-92	-92	-91
Mean average	22	25	40	-87	-86	-87

Table 26: Duration range and mean VOT values in L2 Spanish based on estimate averages from Table 25.

2.2.2.1.4 Media Lengua intra-group VOT analysis

I now turn to a language where the voiced VOT series may have entered the language as a phonemic conflict site. It is of interest to see whether speakers are producing pre-voicing in Spanish-derived words beginning with [b, d, g] or if they have adapted a different strategy for dealing with this conflict site. This section details the statistical results of Media Lengua VOT. The predictors analyzed in this section include: *gender, age, stress, post-stop segment*, *language of origin, level of Spanish, recording type, utterance position*, and *education.*

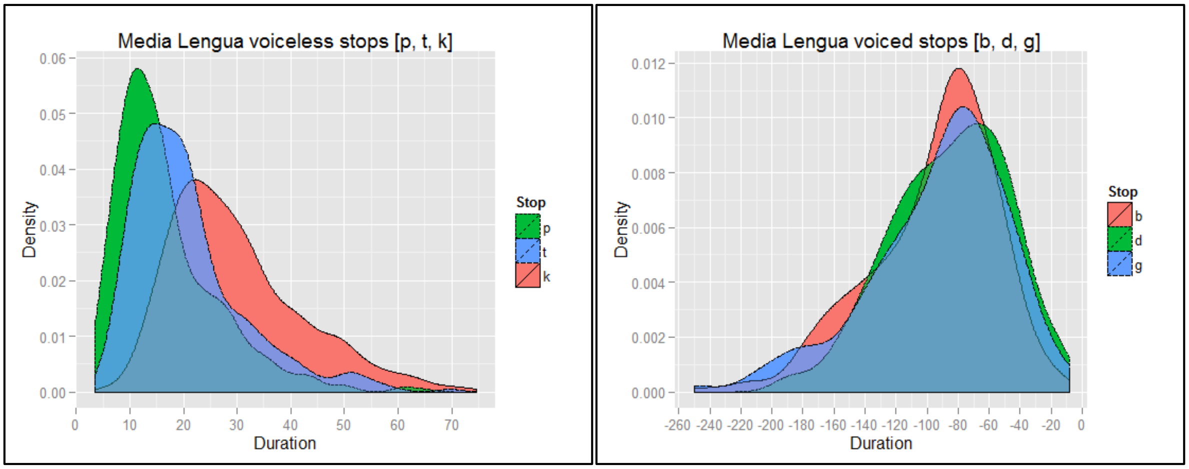


Figure 18: Contains two density plots with Urban Spanish voiceless stop VOT duration (left) and voiced stop VOT duration (right).

Table 27 details the statistical results of Media Lengua VOT stop durations. Based on the model results, the intercept, with a 'base' value of 19 ms, contains the following baseline categories: the voiceless stop series, the front and back vowels, the elicited sentences, and bilabial stops. The following significant predictors can be added to the intercept to account for their effect on VOT. Voicing significantly affected the duration VOT by -107 ms, while producing a stop in velar position significantly affected VOT by 13 ms. There was however, and interaction between voicing and the velar position which significantly affected VOT duration by -14 ms. Therefore, the average duration for [g] based on this model is -90 ms (*intercept + velar + voiced + voiced*velar*) and 32 ms for [k] (*intercept + velar*)). Stops produced with a coronal articulation significantly affected VOT duration by 5 ms. Velar stops were also significantly affected by taps [ɾ] by 20 ms. In addition, stops measured from wordlist readings were significantly different than those from the elicitation sessions by -4 ms. Finally, this model reveals that the VOT of stop consonants produced before a low vowel ([a]), were significantly different by -5 ms.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	18.9	1.7	15.5	22.3	10.9	< 2e-16
Velar	12.5	1.5	9.6	15.4	8.4	2.22E-16
Coronal	5.0	1.5	2.1	7.9	3.4	0.00078
Voiced	-107.1	1.5	-110.1	-104.2	-73.3	< 2e-16
Low vowel [a]	-5.7	1.3	-8.2	-3.2	-4.4	1.10E-05
Wordlist	-4.4	1.7	-7.8	-1.1	-2.7	0.0089
Voiced*Velar	-14.7	3.1	-20.7	-8.7	-4.8	2.55E-06
Velar*Tap	20.1	6.4	7.7	32.5	3.2	0.0017

Table 27: Statistical results from the VOT stop durations in Media Lengua

Table 28 details the statistical results from Table 27 with the shortest and longest average VOT durations in milliseconds based on the significant predictors added to the intercept. This table also provides the mean duration and the bare estimate of each VOT.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Short:long estimates in ms	9:19	24:14	52:21	-88:-92	-83:-93	-70:-100
Bare estimate	19	24	31	-88	-83	-90
Mean average	14	19	30	-86	-81	-92

Table 28: Duration range and mean VOT values in Media Lengua based on estimate averages from Table 27.

2.2.2.1.5 Quichua intra-group VOT analysis

Quichua is the second language under analysis where the voiced VOT series may have entered the language as a phonemic conflict site. It is of interest to see whether speakers are producing pre-voicing in Spanish-derived words beginning with [b, d, g] or have adopted a different strategy for dealing with this conflict site. This section details the statistical results of Quichua VOT duration. The predictors analyzed in this section include: *gender, age, stress, post-stop segment*, *language of origin, level of Spanish, recording type, utterance position,* and *education.*

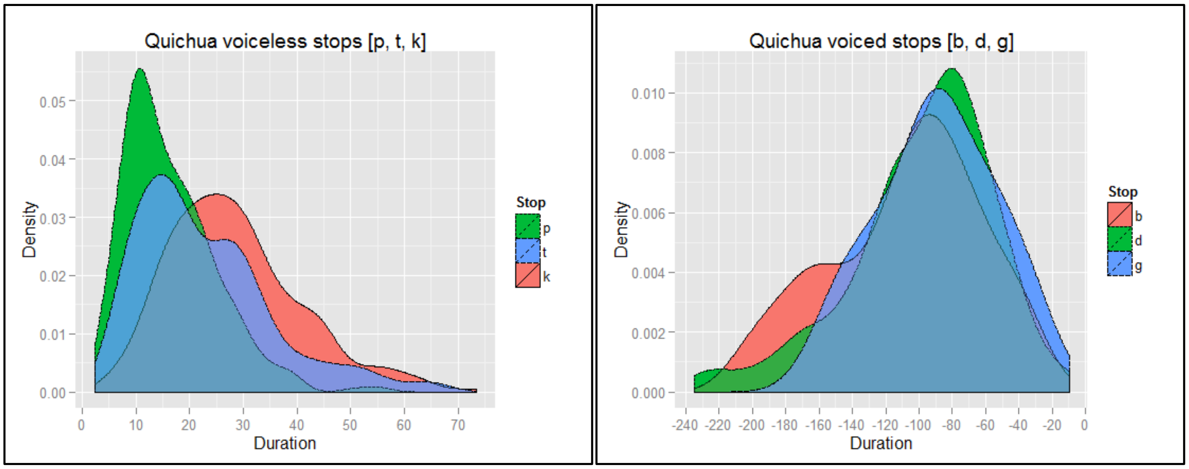


Figure 19: Contains two density plots with Quichua voiceless stop VOT duration (left) and voiced stop VOT duration (right).

Figure 19 revealed a prominent concentration of data just beyond the 22.5 ms mark in the VOT of [t] which prompted further investigation. Additional analysis revealed both the *front vowel* and *recording type* predictors were responsible for this distribution. The front vowel effect can be explained as a high vowel effect under the same aerodynamic reasoning described in Section 2.2.2.1.3, where the narrower vocal tract constriction requires more time to expel air in order to achieve adequate pressure levels to initiate voicing—resulting in longer VOT. See Section 2.2.2.1.3 and Section 2.2.3 for further information on this effect. For the *recording type* effect, it was found that utterances produced from the wordlist were longer than in those produced during elicitations. The former condition was more perceptible to careful speech, which in turn produces slower utterances, and slower speech rates according to Kessinger and Blumstein (1997) are known to increase the length of VOT. While the *front vowel* (high vowel) effect was shown to be significant in Table 29 via the shorter VOT durations found preceding the low vowel [a], the effect of *recording type* was non-significant and therefore excluded from the final model.

The top image of Figure 20 illustrates the split between front vowels (solid blue) and non-front vowels (solid pink) shown with a dashed blue line along with the overall distribution of [t] with a solid black line. In the bottom image of Figure 20, the front vowels have been removed revealing the degree of their influence on the distribution.

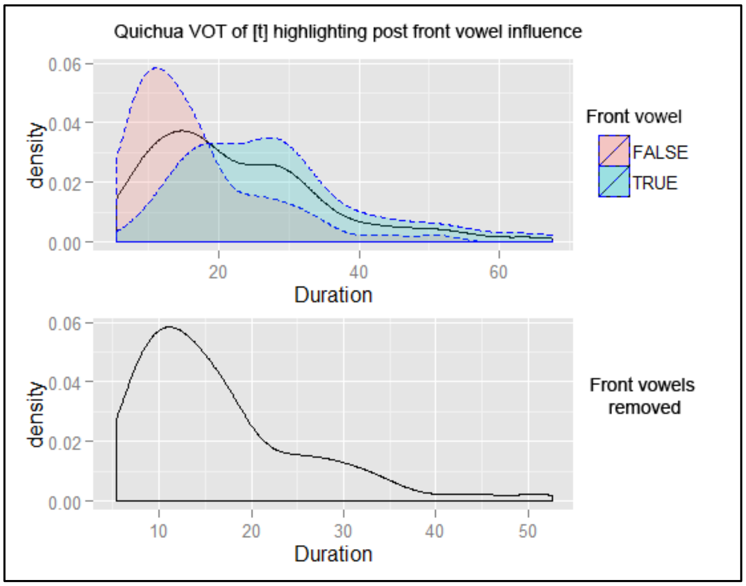


Figure 20: Front vowel distribution superimposed over the overall distribution of [t] in Quichua (top) and the overall distribution of [t] in Quichua with the front vowels removed.

Figure 21 reveals that *recording type* is also responsible for the second concentration in the data just beyond the 22.5 ms mark in Figure 19. The top image of Figure 21 illustrates the split between data gathered from the wordlist (solid blue) and data gathered during elicitation sessions (solid pink) shown with a dashed blue line along with the overall distribution of [t] with a solid black line. In the bottom image of Figure 20, wordlist data has been removed revealing the degree of influence this recording type has on the distribution.

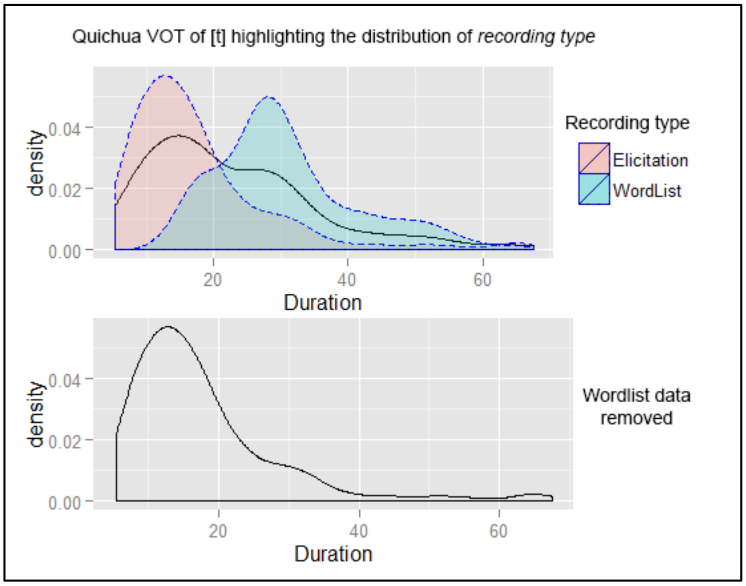


Figure 21: Recording type distribution superimposed over the overall distribution of [t] in Quichua (top) and the overall distribution of [t] in Quichua with data gathered from the wordlist removed.

Table 29 details the statistical results of Quichua VOT stop durations and their significant predictors. Based on the model results, the intercept, with a 'base' value of 18 ms, contains the following baseline categories: stops of Quichua origin, the voiceless stop series, stops in the stressed position, the front and back vowels, the elicited sentences, and bilabial stops. The following significant predictors can be added to the intercept to account for their effect on VOT. The VOT of stops of Spanish origin are on average 5 ms longer than those of native Quichua stops. Voicing significantly affected the duration VOT by -139 ms, while producing a stop in velar position significantly affected VOT by 15 ms: -106 ms (*intercept + velar + voiced*) and 32 ms for [k] (*intercept + velar*)). Stops produced with a coronal articulation significantly affected VOT duration by 5 ms. There was also an interaction between voicing and the VOT of stops in the unstressed position (non-penultimate) which significantly affected VOT duration by 14 ms. Finally, this model reveals that the VOT of stop consonants produced before a low vowel ([a]), were significantly different by -6 ms.

<table>
<tr><th></th><th>Estimate</th><th>Std. Error</th><th>2.5%</th><th>97.5%</th><th>t-value</th><th>Pr(>|t|)</th></tr>
<tr><td>(Intercept)</td><td>17.7</td><td>2.4</td><td>13.0</td><td>22.4</td><td>7.4</td><td>3.91E-11</td></tr>
<tr><td>Language of origin: Spanish</td><td>4.5</td><td>1.6</td><td>1.4</td><td>7.8</td><td>2.8</td><td>0.0049</td></tr>
<tr><td>Velar</td><td>15.0</td><td>1.4</td><td>12.3</td><td>17.6</td><td>10.9</td><td>< 2e-16</td></tr>
<tr><td>Coronal</td><td>5.4</td><td>1.5</td><td>2.5</td><td>8.3</td><td>3.6</td><td>0.00038</td></tr>
<tr><td>Voiced</td><td>-139.5</td><td>4.9</td><td>-149.1</td><td>-129.9</td><td>-28.3</td><td>< 2e-16</td></tr>
<tr><td>Low vowel [a]</td><td>-6.1</td><td>1.3</td><td>-8.6</td><td>-3.5</td><td>-4.7</td><td>4.23E-06</td></tr>
<tr><td>Voiced*Unstressed</td><td>14.1</td><td>5.1</td><td>4.2</td><td>24.0</td><td>2.8</td><td>0.005415</td></tr>
</table>

Table 29: Statistical results from the VOT stop durations in Quichua

Table 30 details the statistical results from Table 29 with the shortest and longest average VOT durations in milliseconds based on the significant predictors added to the intercept. This table also provides the mean duration and bare estimates of each VOT.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Short:long estimates in ms	11:22	17:28	27:37	-103:-127	-106:-122	-98:-112
Bare estimate	17	23	32	-121	-116	-106
Mean average	16	23	28	-100	-97	-89

Table 30: Duration range and mean VOT values in Quichua based on estimate averages from Table 29.

2.2.2.2 Inter-group variation based on place of articulation

The questions asked in this section are: How do the results from Section 2.2.2.1 compare across the five language varieties under investigation? And having shown evidence that the voiced series phonemic conflict site has been integrated in to Quichua and Spanish, how do their pre-voicing results compare to those of the Spanish varieties? This section provides statistical results for inter-group stop variation across all five language varieties. In this section, I use of mixed effects models to test the following predictors: *Language variety* (Urban Spanish, Rural Spanish, L2 Spanish, Media Lengua, and Quichua)*, place of articulation* (bilabial, coronal, and velar), *post-stop segment* (front, back, and low vowels and liquids)*, age,* and *stress* (penultimate syllable, non-penultimate syllable) while random effects include *speaker* and *word.* In order to offset some of the variation for the inter-group analysis, only data from the wordlist is analyzed in this section. Separate models are run based on voicing for manageability—a model for the voiced series and a separate model for the voiceless series. *Level of Spanish, education,* *utterance position,* and *language of origin* are excluded from the models due to homogeneity of the predictors in one or more language variety.

These results should provide a picture as to how the language varieties under analysis compare and interact with one another regarding stop VOT duration along the contact continuum in Figure 1. The two following sections (2.2.2.2.1-2.2.2.2.2) test VOT durations based on voicing quality across each language variety and contain boxplots illustrating the differences and similarities presented therein. Density graphs are not used as the high overlap makes the graphs difficult to dissect.

In the statistical models, Media Lengua is initially used as the baseline intercept. I chose Media Lengua since one of main objectives of this dissertation is to identify for any significant difference in VOT production between Media Lengua and Quichua, which would be revealed with Media Lengua as the baseline. This also allows for comparison with the Spanish varieties, which may reveal whether Media Lengua is or is not shifting towards Spanish-like VOT production values. If there is a non-significant difference between Media Lengua and any other language variety, those languages will also be added to the intercept and form part of the baseline.

2.2.2.2.1 Inter-group VOT analysis of the voiceless stop series

While the voiceless stop series is not considered a phonemic conflict site, due to the similar VOT durations revealed in section 2.2.2.1 and same places of articulation, it is still of interest as to how the series differs across the language varieties. Figure 21 shows L2 Spanish VOT values in all three places of articulation appear longer than in the other language varieties, while Rural Spanish [k] also appears to be longer than Urban Spanish, Media Lengua, and Quichua.

This section details the statistical results of the VOT duration of the voiceless stop series across all five language varieties. The primary factor of interest in this model is *language variety*, *place of articulation,* and interactions between both predictors since these variables should reveal any cross-group variation.

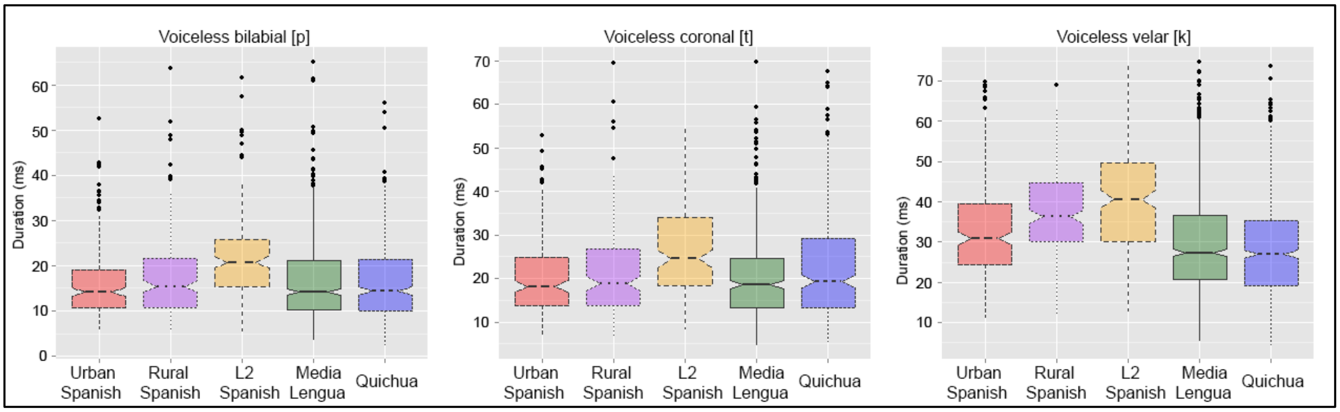


Figure 22: VOT duration distribution of the voiceless stop series across all five language varieties under analysis.

Table 31 details the statistical results for VOT duration with an inter-group analysis of the voiceless stop series taking into account all five language varieties. The baseline intercept of this model, with a value of 14 ms, contains all five language varieties since the VOT durations across Urban Spanish, Rural Spanish, L2 Spanish, Media Lengua, and Quichua were non-significantly different from each other. The baseline intercept also includes the bilabial stop series and the following post-stop segments: front vowels, back vowels, and liquids.

While no one language variety was exclusively significantly different another, interactions between predictors suggest velars of Spanish varieties were shown to be significantly longer in duration than their Media Lengua and Quichua counterparts: Urban Spanish 3 ms, Rural Spanish 7 ms, and L2 Spanish 5 ms. Across all five language varieties, the coronal stop [t] was shown to be significantly longer than bilabial [p] by just 2 ms, while velar [k] was significantly longer than [b] by 12 ms. Age of a speaker appears to affect voiceless VOT where lengthening increases the older a speaker is by 0.13 ms per age bracket (40 in total). This means that statistically, a oldest participant (68 years) should have VOT that is 5 ms (*age* *40) longer than the youngest speaker (22 years). As shown in Figure 23, Urban Spanish, Rural Spanish, and Media Lengua speakers show the strongest trend in *age* and lengthening while there is little effect on Quichua and L2 Spanish speakers.

The VOT of stops preceding the low vowel [a] were shortened by 5 ms. Finally, it should be noted that the non-significant language predictors (Rural, Urban, and L2 Spanish) are included in the model summary because of their significant interactions with the velar stop, which by default, includes the independent predictors by default.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	13.8	2.4	9.2	18.4	5.8	7.23E-08
Coronal	1.6	0.6	0.5	2.8	2.8	0.0055
Velar	12.4	0.5	11.5	13.4	25.2	< 2e-16
Rural Spanish *ns*	-0.2	2.1	-4.2	3.9	-0.08	0.94
Urban Spanish *ns*	-1.2	2.1	-5.3	2.9	-0.6	0.58
L2 Spanish *ns*	-1.3	0.9	-3.1	0.5	-1.4	0.15
Age	0.13	0.05	0.04	0.2	2.8	0.0063
Low vowel [a]	-5.7	0.5	-6.6	-4.8	-12.5	< 2e-16
Velar*Rural Spanish	7.0	1.3	4.5	9.4	5.5	3.71E-08
Velar*Urban Spanish	3.1	1.2	0.7	5.5	2.6	0.011
Velar*L2 Spanish	4.5	1.3	2.1	7.0	3.6	0.00031

Table 31: Statistical results for the inter-group VOT analysis of the voiceless stop series

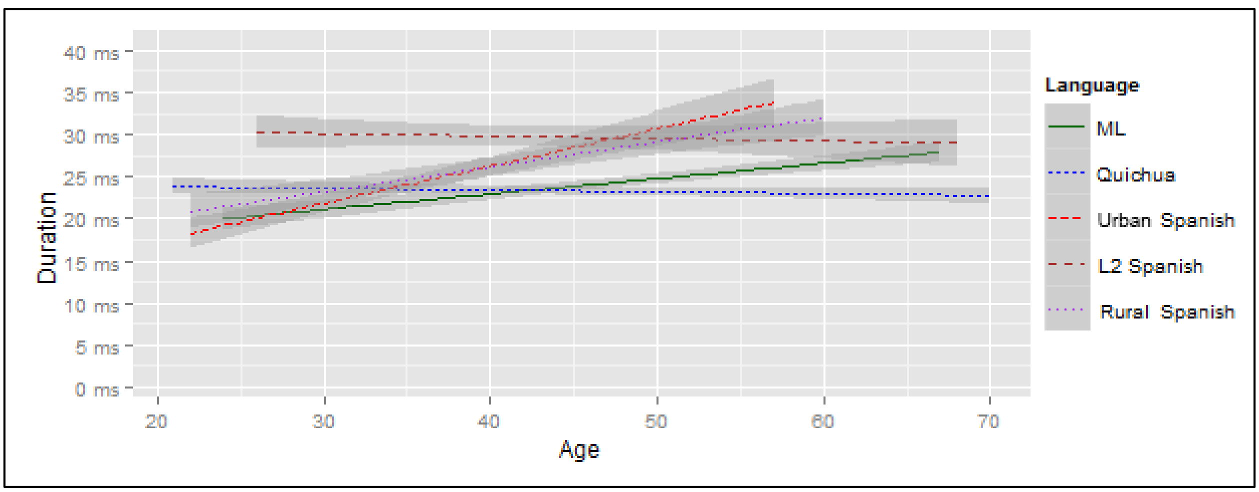


Figure 23: Correlation between *age* and VOT lengthening

2.2.2.2.2 Inter-group VOT analysis of the voiced stop series

Turing to the voiced stop series, the main question of interest in this section is how the VOT values of this phonemic conflict site compare to those of the Spanish varieties. This section details the statistical results of the VOT duration of the voiced stop series across all five language varieties. The primary factor of interest in this model is *language variety*, *place of articulation,* and interactions between both predictors since these variables should reveal any cross-group variation.

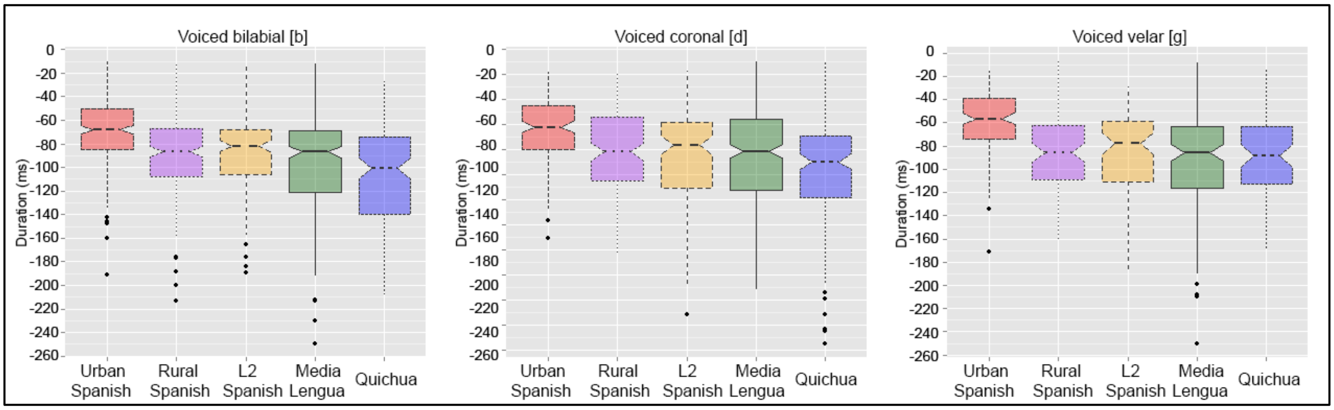


Figure 24: VOT duration distribution of the voiced stop series across all five language varieties under analysis.

Table 32 details the statistical results for VOT duration with an inter-group analysis of the voiced stop series across all five language varieties. The baseline intercept of this model contains Rural Spanish, L2 Spanish, and Media Lengua since non-significant differences in voiced VOT were computed in across these language varieties. The baseline intercept also includes front vowels, back vowels, and liquids in addition to stops found in stressed syllables.

Quichua speakers produced overall longer negative VOTs than the baseline languages (Rural Spanish, L2 Spanish, and Media Lengua) by 19 ms. Urban Spanish speakers on the other hand, produced overall shorter negative VOT than the baseline languages by 22 ms. Stops proceeding the low vowel [a] were lengthened 8 ms compared to segments in the baseline intercept (front vowels, back vowels, and liquids). The VOT of stops found in unstressed positions were significantly shorter than those found in stressed positions by 11 ms.

Interactions between predictors suggest velars in Quichua are significantly shorter in duration by 12 ms than other Quichua voiced stops—making them closer in duration to the baseline language varieties (L2 Spanish, Media Lengua, and Quichua). In addition, velars found before a tap e.g., [gɾ] configurations as in *grande* [gɾande] 'big', shortened the VOT by 33 ms across all five language varieties.

	Estimate	Std. Error	2.5%	97.5%	t-value	Pr(>|t|)
(Intercept)	-92.8	3.4	-99.3	-86.1	-27.4	< 2e-16
Quichua	-19.2	2.9	-24.9	-13.6	-6.7	4.74E-11
Urban Spanish	22.4	6.2	10.2	34.5	3.6	0.00069
Low vowel [a]	-8.3	2.8	-13.7	-2.9	-3.0	0.0036
Unstressed position	11.0	2.4	6.2	15.6	4.5	1.26E-05
Quichua*Velar	11.5	4.5	2.7	20.3	2.5	0.0113
Velar*Tap	33.4	13.6	7.1	59.7	2.5	0.014

Table 32: Statistical results for the inter-group VOT analysis of the voiced stop series

2.2.3 Chapter 2 summary

The results from this experiment are best summed up in two parts: The first (Section 2.2.3.1) provides a description of VOT duration in all five language varieties while the second (Section 2.2.3.2) details the overlapping VOT duration across the contact continuum described in Figure 1. Because of the high degree of overlap along the continuum, I look at the data using multidimensional scaling based on standard deviation overlap. Here, it is hoped that approaching this phonemic conflict site (the voiced VOT series) in the Media Lengua and Quichua data from a different angle will help further support the statistical results from section 2.2.2.2.2.—results suggesting Media Lengua conforms to more Rural and L2 Spanish-like Spanish values, while Quichua is significantly different from this group.

2.2.3.1 VOT descriptions

The first section of this experiment (Section 2.2.2.1), describing intra-group variation, explored VOT production in each language variety. The second section (Section 2.2.2.2), describing inter-group variation, compared VOT results across each language variety. Based on the intra-group analysis, Table 33 provides the results of the 'bare estimates' (the intercept value in addition to any essential values for each stop e.g., voicing for the voiced series) in each language variety.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Urban Spanish	19	19	33	-73	-73	-59
Rural Spanish	21	21	40	-89	-89	-88
L2 Spanish	19	19	42	-92	-92	-91
Media Lengua	19	24	31	-88	-83	-90
Quichua	17	23	32	-121	-116	-106

Table 33: Bare estimate summary of the intra-language VOT analyses from each language variety

The intra-group results in Table 33, show the voiceless series in all five languages makes use of unaspirated VOT values, and long pre-voicing values for the voiced series. Cross-language results suggest there are non-significant differences across all five language varieties regarding VOT duration of the voiceless series with the exception of velar production in the Spanish varieties. Here, [k] was produced with a significantly longer VOT value (Urban Spanish 3 ms, Rural Spanish 7 ms, and L2 Spanish 5 ms) than that of Quichua and Media Lengua. Across all language varieties the VOT of voiceless coronal [t] was 1.7 ms longer than bilabial [p] while velar [k] was 13 ms longer than bilabial [p]. These findings are supported by research from Fischer-Jørgensen (1954), Lisker and Abramson (1964), Peterson and Lehiste (1960), and Zue (1976) showing that greater tongue retraction equates to longer VOT duration. For the intra-language results, only Media Lengua and Quichua showed significant differences in VOT duration across all three places of articulation. While the Spanish varieties trended in the same direction, they did not reach significance. This is probably due to the fact that the Media

Lengua and Quichua datasets were much larger since they contained data from both the elicitation sessions and wordlist readings.

Turning to the voiced series of stops, results from the inter-language analysis suggest that VOT is not a strong correlate for differentiating stops based on place of articulation. Overall tendencies regarding language reveal however, that Quichua and Spanish pre-voicing VOT durations were significantly different from L2 Spanish, Rural Spanish, and Media Lengua pre-voiced VOT durations (which were non-significantly different from each other). These results show that Urban Spanish speakers have significantly shorter pre-voicing VOT values (by 22 ms) from the other languages under analysis, while Quichua speakers have significantly longer pre-voicing vowels (by 19 ms). There was however, a significant interaction between Quichua VOT production and voiced stops in velar position. This result shows that for [g], Quichua speakers only maintain pre-voicing 7 ms longer than the other language varieties, rather than 19 ms.

In the voiced series, taps ([ɾ]) following velar [g] decreased the pre-voicing duration of the VOT by 33 ms. I have found no mention of this effect in the literature but I hypothesize this may be an co-articulation effect which cuts short lead voicing in anticipation of the initial tap closure. This can be seen in the lack of post-[g] frication (Section 5.6), which makes up part of [g] in all instances preceding a vowel. From an aerodynamic stand point, I attribute post-[g] frication to the retracted tongue body position which requires a moment for pressure to equalize following the release before voicing can initiate. In the voiced velar+tap sequence however, the tongue appears to interrupt this process while the additional built up pressure behind the release may be driving the flap instead of creating frication noise. Further analysis is required to pin point the exact nature of the shortened VOT of [g] in [gɾ] clusters.

The VOT of stops found in unstressed positions were also shorter by 11 ms. This is not surprising given the added emphasis put on stressed syllables. It has been reported that stressed syllables or syllables containing pitch accent can cause VOT lengthening, especially in word-initial position (Abramson & Lisker, 1967; Cooper, 1991; Pierrehumbert & Talkin, 1992).

It is also interesting to note, that Media Lengua aligns with Rural and L2 Spanish values rather than with Quichua, suggesting a preferential shift towards Spanish-like VOT production. I hypothesize this is due to the relexified Spanish vocabulary. If during the genesis of Media Lengua, contact with Spanish was more intense and bilingualism was at a higher level than in other groups of Quichua speakers, it would make sense that they adopted more Spanish-like VOT values as part of the new voiced series via the new lexicon.

On that same note, the intra-language results from Quichua provide another interesting finding involving the significant difference in voiceless VOT duration based on *language of origin*. Here, Quichua speakers are producing the word-initial VOT of Spanish-derived words 5 ms longer than that of native Quichua voiceless stops. Table 34 provides the bare estimate results including *language of origin* and L2 Spanish for comparison.

	[p]	[t̪]	[k]	[b]	[d̪]	[g]
Quichua – Native	17	23	32	-121	-116	-106
Quichua – Spanish derived	22	28	37	-116	-110	-100
L2 Spanish	19	19	42	-92	-92	-91

Table 34: Bare estimate values for Quichua VOT including language of origin

This tendency may suggest Quichua speakers are overshooting Spanish-derived voiceless VOT values of [p] and [t], and undershooting [k] and voiced VOT values, probably as an effort to emphasize the Spanish-like quality of the word. This division based on *language of origin* however, may also be linked with code-switching. It is often assumed that, unlike lexical borrowings which typically conform to the phonology of the language they have entered, code-switching utterances are often thought to preserve a higher degree of phonological characteristics of the source language. Therefore this might account for the statistical difference in voiceless VOT production based on significant difference in *language of origin* in the Quichua intra-language results. Moreover, the fact that *language of origin* was non-significant in the Media Lengua intra-language analysis and voiceless VOTs in Media Lengua were also non-significantly different from Quichua in the inter-language analysis, might suggest the Media Lengua speakers have converged the Spanish system with that of Quichua and therefore, do not rely on their knowledge of Spanish when producing voiceless VOT values of Spanish origin. In other words, Spanish borrowings in Media Lengua make up the lexical basis for the language whereas in Quichua, they do not. Therefore, Quichua speakers are aware when they are using Spanish and they adjust their phonology accordingly—similar to that of their L2 production values (especially for velar [k]).

It should be noted that the voiceless series is not a phonemic conflict site since both languages have very similar VOT duration values and the places of articulation are the same. This is in contrast to say, the voiced stop series or mid-vowels which are not found in the native Quichua phonological system outside of borrowings. Therefore, approaching the dual voiceless stop system may be best analyzed through assimilation models like PAM (Best et al., 2003). Here, the voiceless series from Spanish should assimilate to that of Quichua since both series are nearly identical in VOT duration and place of articulation. Because of this, it is not surprising that Media Lengua speakers do not differentiate VOT values based on *language of origin.* For the Quichua speakers on the other hand, in order to have created the *language of origin* division within such a small range of durations, there is probably an external motive e.g., an effort to emphasize the Spanish-like quality of the utterance resulting in the overshot VOT values of [p] and [t] shown in Table 34.

The results from both the intra- and inter-language analysis for the VOT stop analysis also show that the low vowel [a] in the post stop position lengthened the overall negative VOT duration in each language while at the same time shortened the overall duration of the positive VOT in each language. Shorter VOT durations in careful speech has been attested throughout the literature when a stop precedes a low vowel (Berry & Moyle, 2011 inter alia; Bijankhan & Nourbakhsh, 2009; Esposito, 2002; Fischer-Jørgensen, 1980; Higgins, Netsell, & Schulte, 1998). For the voiceless series, Mortensen and Tøndering (2013) suggest this outcome is a physiological consequence vocal tract constriction. Instead of referencing vowel height as the distance between the palate to the tongue, they describe vowel height as the degree of constriction at the narrowest point in the vocal tract. Once the vocal tract occlusion, created by the stop consonant, is released, the supraglottal pressure takes a moment to return to adequate levels before voicing can commence. The degree constriction dictates how quickly air can escape after the release. If the passage through the mouth is wide, as in [a], pressure levels were taper off quickly, whereas if the passage is narrower, as in [i/u] or [e/o], pressure levels will take longer to dissipate. This delay in airflow out of the mouth in higher vowels also delays the onset of voicing which increases VOT length. While this explains the voiceless VOT results, it runs counter to the voiced VOT findings which show that [a] in the post stop position actually lengthens negative VOT compared to the duration of VOTs preceding higher vowels. I hypothesize this effect may be both a physiological (velopharyngeal leakage in low vowels) and co-articulatory effect. Since nasal leakage is common in lower vowels than in higher ones (Thompson & Hixon, 1979), and voiced stops in Spanish show some degree of nasal leakage (Solé & Sprouse, 2011), it may be that the velum relaxes sooner in anticipation of [a] than it would in anticipation for a higher, purely oral vowels. This would allow negative voicing to begin sooner than in other vowels. At this point, this is only conjecture and requires further investigation.

Another result of interest is the effect of *age* found in the inter-language voiceless stop series and in the intra-language analysis of the Urban Spanish group. Here, the older group of speakers were shown to increase voiceless VOT duration by on average 14 ms in the Urban Spanish group and 4 ms in the cross-language results. In the latter analysis, there was no interaction with Urban Spanish, which suggests *age* affects other languages varieties similarly, but to a lesser extent. There was also no interaction in the Urban Spanish results with *voicing*, which suggests older speakers may shorten their negative VOTs as well. For the voiceless series, this is an interesting effect since it appears to run counter to studies which suggest younger speakers tend to produce longer voiceless VOTs than older speakers (Benjamin, 1982; Ryalls, Simon, & Thomason, 2004; Torre & Barlow, 2009) or studies that show no effect based on *age* (Neiman, Klich, & Shuey, 1983; Petrosino, Colcord, Kurcz, & Yonker, 1993). Contrary to these studies however, Flege and Eefting (1986) show the in a production and perception study of /t/ and /d/ in both English and Spanish that children tended to produce /t/ with shorter VOT values than adults. The difference between Spanish children (16.5 ms) and adults (22.4 ms) was 6 ms, while differences between English children (82.3 ms) and adults (88.6 ms) also averaged 6 ms. The problem here however, is that both the younger and older groups in this study are adults, not children. It has also been shown that VOT values vary as a function to speech rate (Kessinger & Blumstein, 1997; Wesimer, Ellis, & Chicouris, 1979) where older speakers typically have slower speech rates and therefore longer VOT values than the younger group. Based on these finding, I posit that this may be an epiphenomenon attributed to the slower speech rate of older speakers rather than changes to production rules of stop consonants, as suggested in Flege and Eefting (1986). The fact that the Urban Spanish speakers had such a large age based shift, while the older speakers of other varieties did not, may also suggest a diachronic change in VOT duration values. Both these hypotheses however, require further experimentation to confirm the speech rates of the older speakers have indeed decreased or that this shift is in fact a group disassociation phenomenon.

Further investigation is currently underway to map the first seven formant trajectories of both voiceless and voiced stops in all five language varieties along with the post-stop segment durations. With this research, I hope to explore other possible correlates used to differentiate stop consonants based on place of articulation.

2.2.3.2 Multidimensional scaling analysis

Focusing specifically on the voiced stop series (the phonemic conflict site under analysis in this chapter), results from Section 2.2.2.2.2 show highly overlapping VOT values across all five language varieties. To approach the data from a different angle, I opted to illustrate the relationship between each language variety using multidimensional scaling based the distance percentage of how many values fit within one standard deviation in each language variety. For example, the mean VOT average of Media Lengua [b] is -95 ms with a standard deviation of 41 ms, giving a standard deviation range from -136 ms to -54 ms (-95-41;-95+41) (Equation 1). Then the number of voiced bilabial [b]s from each language variety, which fall within this range, is extracted independently and divided by the total number of [b]s from the language under analysis. Next, this result is multiplied by 100 then subtracted by 100 (Equation 2). For example, there are 82 instances of Quichua voiced bilabial VOTs which fall within one standard deviation of Media Lengua voiced bilabial VOTs out of a total of 137 instances. These 82 instances are divided by the 137 total instances, resulting in 0.62. This value is then multiplied by 100, (62%) and then subtracted by 100, (38%). This provides the distance in percentage between Media Lengua and Quichua based on one standard deviation. This method is then repeated for each voiced stop and the resulting percentages from all three voiced stops is averaged, giving us the distance between the voiced stop phonemic conflict site series across all the language varieties.

$$a = \left(\frac{\sum x_i}{n}\right) - \left(\frac{\sqrt{\sum(x-\bar{x})^2}}{n-1}\right) \quad b = \left(\frac{\sum x_i}{n}\right) + \left(\frac{\sqrt{\sum(x-\bar{x})^2}}{n-1}\right)$$

Equation 1: This equation calculates the standard deviation range based on the mean average; *a* is the low range, while b is the high range.

$$Dinstance\ \% = 100 - \left(\left(\frac{n\ within\ a\ and\ b}{n}\right) * 100\right)$$

Equation 2: This equation calculates the distance in percentage based on the number of items within the range in Equation 1 divided by the total number of items.

The results from these calculations are shown in Table 35. Based on one standard deviation from the mean average, Media Lengua (the first row) differs from Quichua by 31.9%, L2 Spanish by 22.1%, Rural Spanish by 26.1%, and Urban Spanish by 32.1%. These results show Media Lengua and L2 Spanish are the most alike with the lowest number of voiced VOT values outside one standard deviation—the largest distance is between Quichua and Urban Spanish with 41% of Urban Spanish voiced VOT values falling outside one standard deviation of Quichua voiced VOT values.

	Media Lengua	Quichua	L2 Spanish	Rural Spanish	Urban Spanish
Media Lengua	0	31.9	22.1	26.1	32.1
Quichua	31.9	0	27.8	30.3	41
L2 Spanish	22.1	27.8	0	33	36.7
Rural Spanish	26.1	30.3	33	0	35.4
Urban Spanish	32.1	41	36.7	35.4	0

Table 35: Percentage of distance of voiced VOT values based on one standard deviation accounting for each language variety.

Using multidimensional scaling, Table 35 is represented graphically in Figure 25. Rather than showing the distance percentages, Figure 25 provides percentages of similarity i.e., the percentage of crossover of voiced VOT values within one standard deviation of each language variety. This image shows Media Lengua voiced VOT values are most similar to rural varieties of Spanish (Rural (73%) and L2 (78%)) and of equal distances between Quichua and Urban Spanish (68%). This suggests Media Lengua speakers have distanced themselves from Quichua-like voiced VOT production values and have aligned more with rural varieties of Spanish than Quichua—a result supported by the statistical results in Section 2.2.2.2.2. According to Figure 25, Media Lengua speakers may even be distancing themselves from L2 Spanish VOT values on their way to more Rural Spanish-like values as seen in the middle ground it occupies between both groups.

Rural varieties of Spanish however, have more voiced VOT overlap within one standard deviation with Quichua, than with Urban Spanish—Rural Spanish 70% compared to 65% and L2 Spanish 72% compared to 63%. Interestingly, Rural Spanish has more overlap in common with voiced VOT values in Media Lengua (73%) compared with L2 Spanish (67%), further suggesting Media Lengua voiced VOT values make up a middle ground between both groups. A result which again further suggests a possible shift in progress away from L2 Spanish voiced VOT values towards Rural Spanish-like voiced VOT values. Quichua and Urban Spanish were the most distant with only 59% overlap—a result also supported by the statistical results in Section 2.2.2.2.2. These data paint a dynamic picture, of how Media Lengua speakers have distanced themselves from Quichua-like voiced VOT values, while rural varieties of Spanish appear to have been influenced slightly more by Quichua voiced VOT values than Urban Spanish-like values—for Rural Spanish speakers, an effect probably brought on by prolonged contact with Quichua and L2 Spanish speakers. This effect is further discussed in Chapter 6.

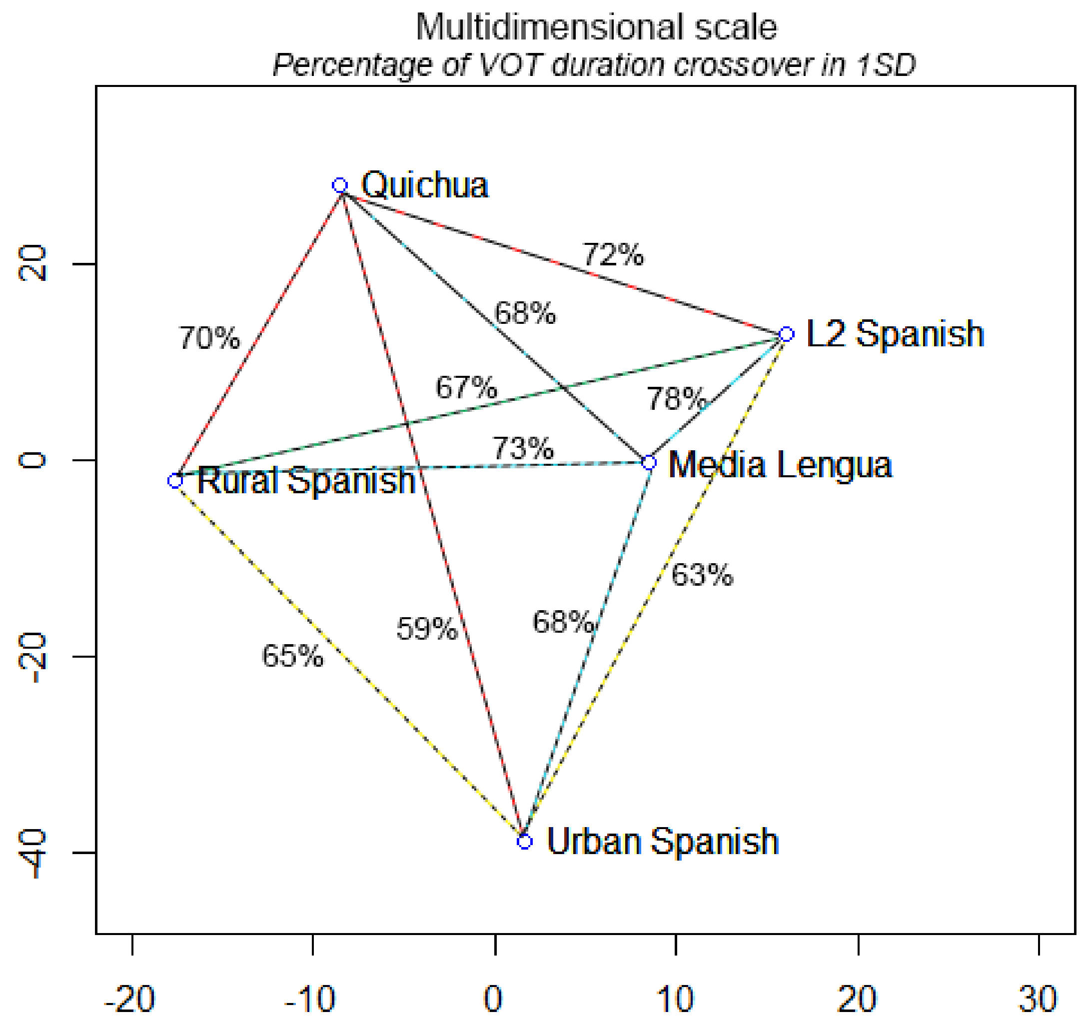


Figure 25: Multidimensional scale of the voiced VOT distances between each language variety based on one standard deviation.

This plot shows how VOT values are related across all five language varieties and reveals inter-language similarity and dissimilarity effects that did not reach significance the statistical model in Section 2.2.2.2.2 e.g., Rural Spanish showing greater overlap in voiced VOT values with Quichua, L2 Spanish, and Media Lengua than with Urban Spanish based on one standard deviation. This multidimensional scale provides an additional way of looking at a subset of the voiced VOT data, which happens to fall in line with the statistical results from the inter-language analysis in section 2.2.2.2.2. Having both methods in agreement reinforces the current reality of voiced VOT production from this dataset. Chapter 3 shifts to VOT perception using minimal pairs contrasting by voicing. The goal of this forthcoming chapter is to verify whether speakers are able to perceptually contrast stop voicing or whether Media Lengua and Quichua speakers are just assimilating Spanish-like production without perceptual recourse.

Chapter 3

Stop perception

3 Introduction

Having established significant differences in production among voiceless and voiced stops in Media Lengua and Quichua in Chapter 2, I now turn to perception of this phonemic conflict site. The question posted here centres on whether these production results are in fact contrastive or whether Media Lengua and Quichua speakers are just assimilating Spanish-like production without taking into account perceptual boundaries like those present in Spanish. I turn to a psycholinguistic word discrimination task to assess the stop voicing contrast.

Like VOT production, it is well known that the perception of stop contrasts is language specific (Abramson & Lisker, 1970, 1973). Word/syllable discrimination tasks and/or phonetic categorization tasks using synthetic VOT values are often used as a method to better understand how speakers label, categorize, and discriminate contrastive stops. These psychoacoustic experiments typically reveal that responses to stimuli along a synthetic voicing continuum e.g., /ba/ to /pa/, become more random the further away the VOT value is from a speaker's prototypical value. The opposite is also said to be true; speakers' categorical judgements become more accurate the closer the discrimination stimuli is to its prototypical form. For instance, Abramson & Lisker (1970) showed that the perceptual boundaries (50% point) between the phonemes /b/ and /p/ for English speakers appeared at the 25 ms mark, for /d/ and /t/ at 22 ms, and for /g/ and /k/ at 24 ms. For Thai speakers, with a three way contrast between /b/, /p/ and /p^h/, perceptual boundaries appeared at approximately -20 ms for /b/ and /p/, and approximately 40 ms for /p/ and /p^h/. Abramson & Lisker (1973) also showed that perceptual boundaries for Spanish[6] /b/ and /p/ appeared at 14 ms, /d/ and /t/ at 22 ms. and /g/ and /k/ at 24 ms.

Reaction time experiments using synthetic VOT continua provide evidence that listeners differentiate 'good' exemplars of stop consonants with quicker reaction times to stimuli compared to atypical exemplars. Results to these experiments also demonstrate that while reaction times are slower in the latter condition, listeners are still able to discriminate between acoustically different sounds stemming from within-categories. Using a same-different reaction time experiment with /ba/-/ba/, /pa/-/pa/ and /ba/-/pa/ syllable pairs, Pisoni and Tash (1974) showed that response times were faster for pairs containing acoustically identical stimuli compared to pairs that were acoustically different. For the data containing contrastive stimuli across phoneme pairs (/ba/-/pa/), they found that reaction time was faster for pairs with more acoustic distance compared to pairs those with smaller distances. Later evidence from fMRI investigations on VOT perception by Blumstein, Myers, and Rissman (2005) showed that different patterns of activation were distributed across distinct areas of the brain's neural network[7] which coincide with VOTs produced at the endpoint of a category, within a category, or at categorical boundaries. They suggest these distribution patterns reflect the functional roles of each area used in processing phonetic categories. They also show that activation in frontal areas of the neural network (specifically the inferior frontal gyrus and cingulate) show categorical membership to be gradient. Finally, they reveal that activation in temporo-parietal areas (middle temporal gyrus and the angular gyrus) correspond to the prototypical exemplar of a phonetic category. These results, produced along a Voicing

[6] According to Abramson & Lisker (1973), the twelve speakers were not from dialectally homogenous regions.
[7] "These areas include the [superior temporal gyrus] bilaterally, the left [inferior frontal gyrus], the left [middle temporal gyrus] extending to the [angular gyrus], the left [inferior parietal lobule], and the right and left cingulate" (Blumstein et al., 2005, p. 1361).

continuum with 10 ms intervals, also indicated that the neural system is sensitive VOT differences of this duration. The aforementioned reaction time experiments supervised by Pisoni and Tash (1974) also show evidence that prototypical exemplars, the mean average of specific trace details of a category, allow for quicker reaction time, while more atypical stimuli require greater response time.

In order to test categorical judgements of the participants in this study, I use a word discrimination task with semi-synthetic 10-step VOT continua. Both intra- and inter-group variation are investigated with Urban Spanish, Quichua, and Media Lengua. Rural Spanish speakers however, did not partake in this portion of this study due to unavoidable logistic issues, but since the goal here lays primarily in uncovering differences in perception based on age of acquisition between so called 'mixed' vs. 'contact' languages, I deemed this not to be an issue since the Spanish results are only used as a baseline to judge the overall 'goodness' of the experiment. In other words, if speakers with a known stop voicing contrast are unable to consistently contrast the two phonemes, the experiment needs to be revaluated; however, if they are able to consistently contrast the data, any variation in the Media Lengua and Quichua data can be considered a result of their perception instead of an experimental issue.

The primary goal of this experiment is to verify that the production results showing significant contrast between voiceless and voiced stops from Chapter 2 are in fact perceived as categorically distinct. If so, it is also of interest as to whether there are any significant differences between how Quichua and Media Lengua speakers perceive this phonemic conflict site. I hypothesize that since the age of acquisition of Spanish was roughly the same age for both Quichua and Media Lengua speakers (6-7 years of age) the greater exposure to Spanish-derived voiced stops in Media Lengua from birth, might render different perceptual patterns from Quichua speakers who acquired contrastive stops later in life. The data under analysis in this experiment is analyzed from a word discrimination task along a semi-synthetic voicing continuum.

3.1 Method

The method section for this experiment describes its design (Section 3.1) including how the Voicing continuum was created (Section 3.1.1), and how the data was then presented to the participants (Section 3.1.2). The remaining sections include demographic information on the participants who took part in this experiment (Section 3.1.3) and procedures for executing the experiment (Section 3.1.4).

3.1.1 Experiment design

3.1.1.1 Stimuli

To gather stop perception data, I designed a word discrimination task involving 7 minimal pairs with word-initial voicing contrasts e.g., *baño 'washroom'* and *paño* 'cloth'. The minimal pairs are derived from Spanish, relexified in Media Lengua, and known to be used, albeit infrequently, in Quichua. Table 36 includes the breakdown of the minimal pairs used in this experiment by place of articulation. The [p]-[b] and [k]-[g] series contains two pairs, while the [t]-[d] series contains three.

[p]-[b]	[t]-[d]	[k]-[g]
paño 'fabric'	*tos* 'cough'	*col* 'cabbage'
baño 'washroom'	*dos* 'two'	*gol* 'goal'
peso 'weight'	*tía* 'aunt/Ms.'	*casa* 'house'
beso 'kiss'	*día* 'day'	*gasa* 'gauze'
	té 'tea'	
	de 'D'	

Table 36: Minimal pair words for the discrimination tasks

Instead of using purely synthetic speech, I opted to create semi-synthetic tokens based on natural speech to minimize issues regarding segmental quality often attributed to synthetic speech (Vainio, Järvikivi, Werner, Volk, & Välikangas, 2002). To do so, I modified the specific portions of the original tokens under investigation synthetically, and then combined the remaining portion of the original token to create a more naturalistic sounding sample. The creation of the synthetic portion was accomplished by physically adding or removing VOT information in each step along the continuum and modifying formant transitions, pitch, and the post-stop vowel duration relative to the VOT durations. A native Urban Spanish speaker from Quito (consultant #107) was recorded reading each word from Table 36 on a TASCAM DR-1 portable digital recorder using a NEXXTECH unidirectional dynamic microphone (50-13000 Hz response). The words were recorded in 16-bit Waveform Audio File Format (WAV) with a sample rate of 44.4 kHz.

I opted to use a 10-step Voicing continuum to transition from one phonemic category to the next in order to cover a relatively large range of samples with shorter time intervals (ms) between each sample. As values drift further from their prototypical form along the continuum, it was hypothesized that responses to the stimuli would vary more frequently. Based on the Spanish perceptual boundaries from Abramson and Lisker (1973) (/b/ and /p/ 14 ms, /d/ and /t/ 22 ms, and /g/ and /k/ 24 ms), I opted to expand the temporal differences of the first 4 steps at the beginning the continuum, which contain negative VOT durations, while shorter transitions of 10 ms were used for last 5 steps. These shorter transitions should allow for better identification of distributional laps between categories. The first four steps were calculated based on the remaining duration after the 10 ms steps were taken into account. Equation 3 calculates the VOT duration of the first four steps of the continuum.

$$y\ ms = \frac{(-a\ ms + b\ ms) - (c * 10\ ms)}{4}$$

Equation 3: This equation calculates the VOT duration of the first 4 steps of the continuum.

Where *y* is the duration of each of the first four steps in the continuum in milliseconds; *a* is the duration of the negative VOT in milliseconds; *b* is the duration positive VOT on the opposite side of the continuum in milliseconds; *c* is the number of steps 10 ms in length, in this case 5; and *4* is the number of steps needing to be calculated at the beginning of the continuum.

It should be noted that it is often the norm to measure negative VOT from the first instance of voicing until the release burst. In order to preserve more natural like transitions into the vowels however, VOT was measured from voicing onset all the way up to the vowel. This was important due to post-frication, which often accompanies voiced velars in the Spanish, Media Lengua, and Quichua data[8].

To adjust the VOT along the continuum, the original voiced token was loaded into Audition Creative Suite, version 6, ("Adobe Audition," 2013) where the duration from the initial moment of voicing to *y* ms inward was removed. This was repeated for the first four steps based on the results from Equation 3. For the last five steps, 10 ms was removed at a time. At the moment of the switch between the negative and positive VOT, the remaining negative duration was removed and the positive VOT from the original voiceless token was added. The remaining duration needed to complete the step was then calculated and the extra time was removed from the moment of the vowel onset leftward towards the release. The rest of the steps with a positive VOT were adjusted in the same fashion. Figure 26 provides an example of the VOT durations along a continuum with a negative VOT of -104 ms on the left and positive VOT of 37 ms on the right. The last 5 steps are spaced by 10 ms and the first four steps are spaced by 23 ms as calculated using Equation 3.

[8] In Chapter 5, Section 6, I argue this is an aerodynamic rather than linguistic phenomenon since the retracted position of [g], creates a smaller space behind the occlusion causing a greater build-up of pressure which requires longer equalization time after the release than more fronted occlusions.

-104	-81	-59	-36	-13	-3	7	17	27	37	VOT (ms)
1	2	3	4	5	6	7	8	9	10	Step

Figure 26: Example of a hypothetical Voicing continuum for /g/ to /k/.

Before editing the physical VOT however, pitch, vowel duration, and the initial 10 formant points were adjusted along the continuum relative to VOT duration calculations of each token.

Because pitch depression after voiced stops has been identified as a correlate of voicing (Haggard et al., 1970), it was important to shift the pitch relative to the VOT durations to achieve more naturalistic tokens for the continuum. To do so, the pitch throughout the stop was flattened based on the average frequency (Hz) of the post-stop vowel. To calculate the average frequency, the original tokens were opened in Praat (Boersma & Weenink, 2013), and converted into a *Manipulation* file with the following settings: time step 0.01, min pitch (Hz) 75, max pitch (Hz) 600. This file was then opened in the *View & Edit* window and the *Stylize Pitch* function was set to 1.0, thus reducing the number of pitch points. The pitch points within the stop and post-stop vowel were then adjusted based on the average pitch of the vowel. This file was then saved as step 1. It was also important to modify the original tokens at each end of the continuum as well to maintain similar synthetic modifications throughout the continuum. To calculate the subsequent steps along the continuum relative to the VOT duration, the following calculations were used:

$$y = \left(\frac{(a-b)/9}{-c+d}\right)5$$

Equation 4: This equation calculates pitch values for the last 5 steps of the continuum relative to the VOT duration of each step.

$$z = \frac{(a-b)-y}{4}$$

Equation 5: This equation calculates the pitch values for the first 4 steps of the continuum relative to the VOT duration of each step. Value y is calculated in Equation 4.

Where *a* in both equations is the average frequency of the post-stop vowel from the original voiced stop token; *b* in both equations is the average frequency of the post-stop vowel from the original voiceless stop token; 9 is the number steps in the continuum (the first step does not require calculation); c is the duration of the negative VOT; *d* is the duration of the positive VOT; 5 is the number of steps at the end of the continuum requiring calculation; *y* in both equations is the pitch frequency step for the last 5 steps of the continuum; 4 is the number of steps at the beginning of the continuum requiring calculation; and *z* is the frequency step for the first 4 steps of the continuum. Figure 27 provides an example of the resulting VOT and pitch steps along a 10 step continuum.

212	213	215	216	217	218	218	219	219	220	Pitch (Hz)
-104	-81	-59	-36	-13	-3	7	17	27	37	VOT (ms)
1	2	3	4	5	6	7	8	9	10	Step

Figure 27: Example of a hypothetical pitch continuum for /g/ to /k/.

As I modified the pitch in each in each step, I saved each one as a new token; 10 in total. These files were then opened in Praat to modify the duration of each post-stop vowel. Because of Allen and Miller (1999) and Metz et al. (2006)'s findings that vowels immediately following a voiced stop are inherently longer than those following a voiceless stop, it was also important to modify the duration of the post-stop vowel relative to the VOT duration to maintain a more naturalistic sounding token.

Equation 4 and Equation 5 were once again used to modify the duration of each token relative to the VOT but with *a* being the duration of the post-stop vowel of the original voiced token and *b* being the duration of the post-stop vowel of the original voiceless token.

To modify the duration, each token along the continuum was individually opened in Praat and converted to *Manipulation* file with the following settings: time step 0.01, min pitch (Hz) 75, max pitch (Hz) 600. This file was then opened in the *View & Edit* window and three duration points were added; the first at the beginning of the vowel, the second at the end of the vowel, and the third to the middle of the vowel. The duration was then modified by dragging the mid-point up (slower) or down (faster) based on scaled values of the calculated durations. The scaled values were calculated by dividing each step by the first. Figure 28 provides an example of the resulting duration and scaled duration steps along a 10 step continuum.

165	161	158	154	151	149	148	147	145	144	Vowel duration (s)
1.00	0.98	0.96	0.94	0.91	0.91	0.90	0.89	0.88	0.87	Scaled duration
212	213	215	216	217	218	218	219	219	220	Pitch (Hz)
-104	-81	-59	-36	-13	-3	7	17	27	37	VOT (ms)
1	2	3	4	5	6	7	8	9	10	Step

Figure 28: Example of a hypothetical vowel duration continuum between [ga] and [ka].

The last step in modifying the tokens along the continuum involved adjusting the formant trajectories relative to the VOT duration in each step. While the F1 cutback was not apparent in any of the original minimal pair tokens, the formant tracks did show different trajectories. The F1 frequencies of the voiced stop-to-vowel trajectories were lower (higher tongue-body position) than those of the voiceless stop-to-vowel trajectories, F2 frequencies of the voiced stop-to-vowel trajectories were more fronted (higher frequencies) than their voiceless counterparts, and F3 frequencies in the voiced stop-to-vowel trajectories were higher than those in the voiceless series. To alter the formant trajectories relative to the VOT durations, the original voiced and voiceless tokens were loaded into Praat and a synthetic source-filter was created as per the following steps: (1) the original sound files were resampled to 11000 Hz (the standard for female speakers) with a precision value of 50. (2) The resampled files were then converted to linear predictive coding formant (LPC) (burg) with a prediction order of 10, a window-length of 25 ms, a time step of 5 ms, and a pre-emphasis frequency of 50 Hz. (3) The LPC and the resampled file were then passed through an inverse filter. This process created the source-filter based on the resampled values and the formant information from the

LPC file. This filter was later used to reconstruct the wave file once I altered the formant values.

To modify the formant values relative to the VOT duration steps, the resampled token was converted to a *Formant (burg)* file containing 5 formants with a maximum possible formant value of 5500 Hz (the standard for female speakers), a window length 25 ms, and a pre-emphasis frequency of 50 Hz. This formant file was then converted to a *FormantGrid* for editing. The frequency of the first 10 formant points from the first, second, and third formants in the stop-to-vowel trajectory were then gathered. This process was repeated for both the unaltered voice and voiceless tokens.

Using Equation 5, the formant value of each step was calculated, except with *a* being the frequency of the first formant point of the original voiced stop and *b* being the frequency of the first formant point of the original voiceless stop. This process was repeated for each point of each formant under analysis (F1, F2, and F3). After the values were calculated, the formant points could be altered accordingly. After each step was modified, the FormantGrid and the inverse filter were both selected and the *Filter (no scale)* function in Praat was applied producing a wave file with the modified formant values. Table 37 provides an example of the resulting formant values along a 10 step continuum. The columns represent each step along the continuum and the rows, the adjusted formant frequency of the first 10 formant points of the following vowel segment.

527	518	508	499	490	486	483	479	476	472	F1 step 1 (Hz)
488	477	466	455	444	440	435	431	427	423	F1 step 2 (Hz)
484	485	486	488	489	489	490	490	491	491	F1 step 3 (Hz)
537	537	536	536	536	536	535	535	535	535	F1 step 4 (Hz)
572	558	545	531	518	512	507	502	497	492	F1 step 5 (Hz)
580	560	541	521	502	494	487	480	472	465	F1 step 6 (Hz)
583	568	554	539	524	519	513	508	502	497	F1 step 7 (Hz)
581	568	555	542	529	524	520	515	510	505	F1 step 8 (Hz)

582	568	554	540	526	521	516	510	505	500	F1 step 9 (Hz)
588	573	557	542	527	521	515	509	504	498	F1 step 10 (Hz)
1838	1844	1850	1856	1862	1864	1866	1869	1871	1873	F2 step 1 (Hz)
1920	1910	1900	1889	1879	1875	1871	1868	1864	1860	F2 step 2 (Hz)
2307	2251	2195	2139	2083	2062	2041	2020	1999	1978	F2 step 3 (Hz)
2417	2323	2229	2136	2042	2007	1972	1936	1901	1866	F2 step 4 (Hz)
2470	2372	2274	2176	2079	2042	2005	1968	1932	1895	F2 step 5 (Hz)
2519	2416	2312	2209	2105	2066	2027	1989	1950	1911	F2 step 6 (Hz)
2525	2451	2377	2302	2228	2200	2172	2145	2117	2089	F2 step 7 (Hz)
2534	2475	2416	2357	2298	2276	2253	2231	2209	2187	F2 step 8 (Hz)
2560	2498	2436	2374	2311	2288	2265	2242	2218	2195	F2 step 9 (Hz)
2580	2515	2451	2386	2322	2298	2274	2249	2225	2201	F2 step 10 (Hz)
2934	2891	2848	2805	2762	2746	2729	2713	2697	2681	F3 step 1 (Hz)
2960	2907	2854	2801	2748	2728	2708	2688	2668	2648	F3 step 2 (Hz)
3027	3082	3137	3191	3246	3267	3287	3308	3328	3349	F3 step 3 (Hz)
3107	3102	3097	3092	3087	3085	3084	3082	3080	3078	F3 step 4 (Hz)
3318	3275	3232	3188	3145	3129	3113	3096	3080	3064	F3 step 5 (Hz)
3330	3283	3235	3188	3140	3122	3104	3087	3069	3051	F3 step 6 (Hz)
3313	3256	3199	3142	3086	3064	3043	3022	3000	2979	F3 step 7 (Hz)
3298	3243	3187	3132	3077	3056	3035	3014	2994	2973	F3 step 8 (Hz)
3287	3245	3204	3162	3121	3105	3090	3074	3059	3043	F3 step 9 (Hz)
3309	3269	3229	3188	3148	3133	3118	3103	3088	3073	F3 step 10 (Hz)
165	161	158	154	151	149	148	147	145	144	Vowel duration (ms)
1.00	0.98	0.96	0.94	0.91	0.91	0.90	0.89	0.88	0.87	Scaled duration
212	213	215	216	217	218	218	219	219	220	Pitch (Hz)
-104	-81	-59	-36	-13	-3	7	17	27	37	VOT (ms)
1	2	3	4	5	6	7	8	9	10	Step

Table 37: Example of the formant values along a hypothetical [ga] to [ka] continuum. Columns represent each step along the continuum and the rows, the adjusted frequencies of the first 10 formant points of the following segment.

Table 38 details the VOT durations from each minimal pair along the continuum.

Voiced	Continuum values for [b]-[p] in ms										Voiceless
	1	2	3	4	5	6	7	8	9	10	
Baño 'washroom'	-111	-94	-77	-60	-43	-33	-23	-13	-3	7	*Paño* 'fabric'
beso 'kiss'	-151	-124	-96	-69	-41	-31	-21	-11	-1	9	*Peso* 'weight'
	Continuum values for [d]-[t] in ms										
Dos 'two'	-106	-89	-71	-54	-36	-26	-16	-6	4	14	*tos* 'cough'
día 'day'	-154	-125	-96	-67	-38	-28	-18	-8	2	12	*tía* 'aunt/Ms.'
de 'D'	-174	-141	-109	-76	-43	-33	-23	-13	-3	7	*Té* 'tea'

	Continuum values for [g]-[k] in ms										
gol 'goal'	-133	-103	-74	-44	-14	-4	6	16	26	36	*col* 'cabbage'
gasa 'gauze'	-101	-82	-64	-45	-26	-16	-6	4	14	24	*casa* 'house'

Table 38: VOT durations of each minimal pairs analyzed in this study.

Once the pitch, vowel duration, formant trajectories, and VOT were modified along the continuum, the unaltered portion of each token was removed and replaced with the same section from the original voiced phoneme resampled to 11000 Hz. This provided a more naturalistic sound token. Figure 29 provides individual LPC spectrograms of each step along the continuum.

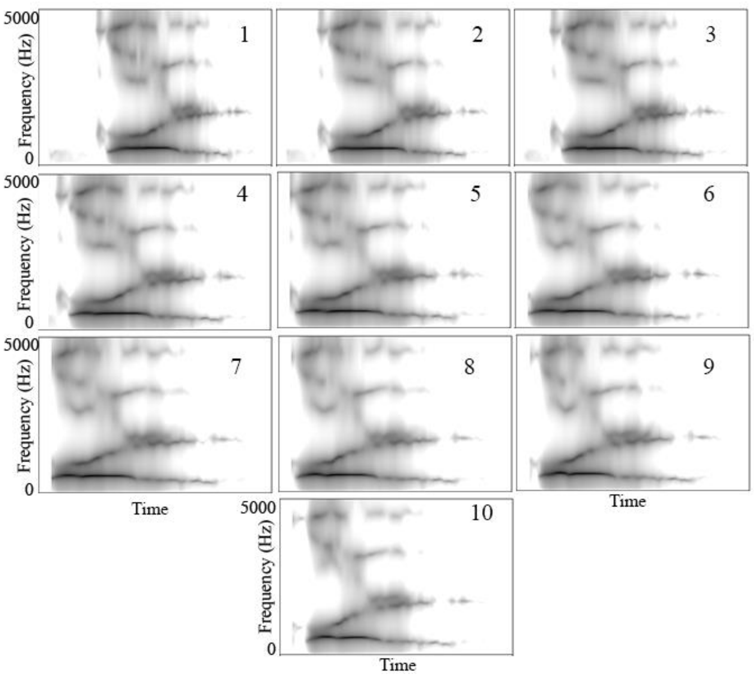


Figure 29: LPC spectrograms of each 10 step along the continuum between *gol* 'goal' and *col* 'cabbage'.

3.1.2 Presentation

This section describes the user interface used to present the experiment to the participants. For presentation, the 10 tokens described between each minimal pair in Section 3.1.1 were in integrated into a Power Point presentation for the experimental task. Images corresponding to each token were loaded into the presentation with one minimal pair on each slide (Figure 30).

Figure 30: Three slides from the word discrimination task. The top left slide contains the minimal pairs *paño* 'cloth' and *baño* 'washroom'. The middle slide contains minimal pairs *tos* 'cough' and *dos* 'two'. The bottom right slide contains minimal pairs *col* 'cabbage' and *gol* 'goal'.

In order to achieve more precise results, the presentation was designed to contain more repeats of stimuli at the end of the continuum to Abramson and Lisker (1973)'s perceptual boundaries (/b/ and /p/ 14 ms, /d/ and /t/ 22 ms, and /g/ and /k/ 24 ms). Therefore, tokens containing negative VOTs were presented less frequently than those in the positive range since they approach the hypothesized perceptual boundary. It was decided that the tokens nearest to Abramson and Lisker (1973)'s perceptual VOT boundaries would be repeated four times; those to the left and right of these values were repeated 3 times, those to the left and right of those were repeated twice, finally any remaining tokens were repeated once. In this case of this experiment, perceptual boundaries were hypothesized to take place around steps 8 and 9 on my continuum, therefore these tokens were repeated four times, steps 10 and 7 three times, step 6 twice, and steps 1-5 once. Consequently, the participants listened to same minimal pair series along the continuum 21 times; 147 VOT tokens across the seven minimal pairs. Table 39 provides the number of repeated tokens along the continuum.

-104	-81	-59	-36	-13	-3	7	17	27	37	VOT (ms)
1	1	1	1	1	2	3	4	4	3	# of token repeats
1	2	3	4	5	6	7	8	9	10	Step

Table 39: Example of the repeated steps along a /g/ to /k/ continuum.

The Power Point presentation was configured to play one sound 50 ms after each slide appeared on the screen. Participants had the option to repeat the token by clicking on speaker icon at the bottom of the screen if they so desired. The presentation was configured to use 'Kiosk' mode, which only allowed the participants to move on to the following slide by clicking on either of the two images. Each image was programmed using the Visual Basic for Applications (VBA) add-on in Power Point to record the participant's response. The slides were randomized using a macro (Reilly, 2011) and then further adjusted making sure no two contained the same images one after the other. After randomization, one slide containing a token from step 10 was inserted at the beginning of the presentation to provide the participants with a canonical form to get their bearings before being presented with non-canonical forms at random. The experiment was interspersed with other conditions (vowel and liquid minimal pairs) which I plan to analyze outside of this dissertation. At the beginning of the presentation, fields were added to gather the participants name, age, and gender. At the end of the experiment a text file was outputted with all the participant's responses. This output file contained: name, age, gender, response, and the name of the corresponding audio file.

3.1.3 Participants

Table 40 through Table 42 provide information pertaining to the participants who took part in the word discrimination task. These data include: speaker code, age at the time of the experiment, gender, demographic descriptors including, education, level of Spanish, Quichua, Media Lengua, and place of residence.

Eleven Media Lengua speakers participated in this experiment and all were trilingual (Quichua, Media Lengua, and L2 Spanish). This group consisted of seven women and four men. All participants were from the community of Pijal Bajo and acquired Quichua and Media Lengua simultaneously from birth and began learning Spanish upon entering primary school, typically at 6-7 years of age with the exception of two, whose L1 were Spanish but passively acquired Media Lengua and Quichua from birth. It should once again be noted that the use of Media Lengua is variable, some individuals may go days at a time without using it, while others use it constantly. Stewart (2011) even notes that some of the speakers claim to have not used the language in years.

Ten Quichua speaking participants also participated in this study and all were bilinguals (Quichua and L2 Spanish) ranging from low to high proficiency. This group consisted of six women and four men. Two women had a rudimentary level of Spanish, while the rest acquired Spanish upon entering primary school, typically at 6-7 years of age. Participants were born, raised, and currently lived in the neighbouring communities of Chirihuasi and Cashaloma. Similar to Media Lengua, the use of Quichua is variable, but not to the same extent, some individuals may go days at a time without using it, while others use it constantly. It should be noted however, that the speakers in this study pretty much use Quichua on a daily basis.

Of the three Spanish dialects under analysis in this dissertation, only Urban Spanish speakers took part in the perception portion of the study to create a baseline for Media Lengua and Quichua stop judgements. From the Urban Spanish group from Quito 18 participants took part in this experiment, twelve women and six men. This group consisted of Spanish monolinguals with little or no knowledge of Quichua. All participants were primary school teachers, except for one law student and one orthodontist. All were born, raised, and currently lived in Quito except one born in the city of Tulcán (Carchi).

Media Lengua Speaker Code	Age	Gender	Formal Education	Spanish Level	ML/ Quichua Level	ML usage	Place of residence
041	62	M	Primary	High	Native	Intermittently	Pijal Bajo
043	42	F	Secondary	High	Native	Daily	Pijal Bajo
055	46	F	Primary	Mid/High	Native	Intermittently	Pijal Bajo
056	64	F	None	Mid	Native	Intermittently	Pijal Bajo
057	63	F	None	Mid	Native	Intermittently	Pijal Bajo
058	33	M	University	Native	Native	Infrequently	Pijal Bajo
059	38	M	University	Native	Native	Infrequently	Pijal Bajo
060	24	F	Secondary	Native	Passive	Rarely	Pijal Bajo
061	24	F	University	Native	Passive	Rarely	Pijal Bajo
062	54	M	Primary	High	Native	Intermittently	Pijal Bajo
Average:	45						

Table 40: This table provides information of the Media Lengua group including: age at the time of the experiment, gender, level of formal education, level of Spanish, Media Lengua, and Quichua, frequency of ML usage, and place of residency.

Quichua Speaker Code	Age	Gender	Formal Education	Spanish Level	Quichua Lengua Level	Quichua usage	Place of residence
063	68	M	Primary	Mid/High	Native	Daily-home	Chirihuasi
078	30	M	University	High	Native	Daily-home	Chirihuasi
079	32	F	Primary	High	Native	Daily-home	Chirihuasi
080	43	F	NA	Mid	Native	Daily-home	Chirihuasi
081	53	M	Primary	Mid	Native	Daily-home	Chirihuasi
082	34	M	Secondary	High	Native	Daily-home	Chirihuasi
083	48	F	NA	Mid	Native	Daily-home	Chirihuasi
084	26	F	University	Native	Native	Daily-home	Chirihuasi
085	38	F	Primary	High	Native	Daily-home	Chirihuasi
086	48	F	NA	Mid	Native	Daily-home	Chirihuasi
Average	42						

Table 41: This table provides information of the Quichua and L2 Spanish speaking groups including: age at the time of recording, gender, level of formal education, level of Spanish and Quichua, frequency of Quichua usage, and place of residency.

Urban Sp. Speaker Code	Age	Gender	Formal Education	Profession	Place of birth/ Residence
97	22	F	University	Student	Quito
112	51	F	Teaching cert.	Teacher	Quito
114	55	M	Medical degree	Orthodontist	Tulcán/Quito
115	58	M	University	Teacher	Quito
116	41	F	University	Teacher	Quito
117	47	M	Teaching cert.	Teacher	Quito
118	40	M	University	Teacher	Quito
119	28	F	University	Teacher	Quito
120	58	M	University	Teacher	Quito
121	57	F	Teaching cert.	Teacher	Quito
122	41	F	Teaching cert.	Teacher	Quito
123	45	F	University	Teacher	Quito

Urban Sp. Speaker Code	Age	Gender	Formal Education	Profession	Place of birth/ Residence
124	31	F	University	Teacher	Quito
125	40	F	Teaching cert.	Teacher	Quito
126	65	M	Teaching cert.	Teacher	Quito
127	31	F	University	Teacher	Quito
129	38	F	University	Teacher	Quito
132	37	M	Teaching cert.	Teacher	Quito
Average	44				

Table 42: This table provides demographic information of the L1 urban Spanish speaking group from Quito including: age at the time of recording, gender, level of formal education, profession, and place of birth/ residency.

3.1.4 Procedure

For the experiment, participants were explained that they would hear a variety of words and their task was to click on the picture that corresponded to the word they heard. It was also mentioned that if they would like to hear the token again, they could click on the speaker icon at the bottom of the screen. They were urged however, to go with their first instinct. The participants were told the words would be repeated many times and that some of them might be harder than others to perceive but to try their best. Before beginning the task, I also reviewed the minimal pairs with the participants with a printout of the picture pairs to avoid any confusion during the task. Before receiving written consent, the participants were told the entire task lasted about 15 minutes and there were no right or wrong answers. Participants were monetarily compensated for their time.

The participants were provided with a PC laptop and noise cancelling headphones for the experiment. For participants who did not feel comfortable using laptop mouse to click on the pictures, we asked them to point at the picture they heard in the audio sample and my assistant or I would click the image for them. After the experiment, if the participant was interested in seeing the results, the outputted response data was loaded into Excel and automatically graphed to show their results. I would explain to the participants whether or not they could make out differences in the minimal pairs based on this task and if so, at what point they identified one over the other.

3.2 Perception Results

To reiterate, the goal of this experiment is to test whether Quichua and Media Lengua speakers perceptually contrast voiceless stops from their voiced counterparts. Furthermore, is there a difference between how Media Lengua and Quichua speakers perceive the categorical boundaries? Urban Spanish is used as a baseline for comparison in this analysis to test whether perceptual results from the Quichua and Media Lengua data match those of native Urban Spanish speakers. Using Spanish also tests the accuracy of the experiment with a group of participants that have a known voicing contrast. Based on production results from the previous chapter, I hypothesize that both Media Lengua and Quichua speakers will have a perceptual voicing contrast between stops pairs in all places of articulation. However, because Media Lengua speakers have a greater need for contrastive stops, to avoid ambiguities in the relexified Spanish vocabulary, I posit there may be greater number of consistent responses from the Media Lengua participants than for Quichua participants, who acquired the contrast later in life.

For the statistical model, I built a generalized (logistic) linear mixed effects model fitted by the Laplace approximation to test the results from the perceptual experiment described in section 3.1.1. Logistic regressions help answer two basic questions: (1) is there a difference among the languages at the intercept, in this case by subtracting 1 from each continuum step 0 so that the model treats step 1 as the intercept[9], and (2) do the slopes of the curves differ across the continuum by language? To answer the latter question, the model contains interactions

[9] All the graphs will continue to show the original continuum numbers.

between *continuum* and *language.* This model was created in R 3.1.2 with the *glmer* function of the *lme4* package (Bates, 2012). Ninety-five percent confidence intervals (CI_{95}) were computed using the Wald test. The random effects *speaker* and *word* were taken into account in the model. I considered the following predictors (fixed effects): *language group* (Urban Spanish, Quichua, and Media Lengua), *age*, *education* (low (none, primary), high (secondary, university)), and *level of Spanish* (low (zero, low, mid), high (high, native)). Non-significant predictors were removed from the model one-by-one, based on the closest z-value to zero, until only significant predictors remained. The model reported here contains no non-significant predictors except those used in interactions.

We are most interested in the coefficient estimate (β), which is a conservative estimate of the average difference in log-odds (a measurement of probability) responses between the predictors in question. For example, a negative log-odd result for *continuum* means the likelihood of a participant choosing a voiced token decreases *x* amount per step. Because the continuum has voiced stops on the left and voiceless stops on the right, this number should not be positive. A positive log-result for *language* simply means a given group of language speakers chose the voiced series more frequently than the language included in the intercept (Media Lengua). The intercept can be defined as our 'starting point' or 'base value' in log-odds, if none of the predictors were not applicable i.e., it is a 'basic' or 'average' value of the subset of data where all the predictors are their zero/ baseline value.

Once again, the goal of this analysis is to look at whether Quichua and Media Lengua speakers perceptually contrast voiceless stops from their voiced counterparts. If there is a difference in perception, what are the categorical boundaries? Figure 31, Figure 32 and Figure 33 contain line plots, for each place of articulation—[b-p], [d-t], and [g-k]. Each plot illustrates the averaged trajectories of the responses from each language along the continuum— Quichua (dotted, blue), Media Lengua (solid, dark green), and Urban Spanish (dashed, red). Figure 35 provides a breakdown of the experimental results by age and language.

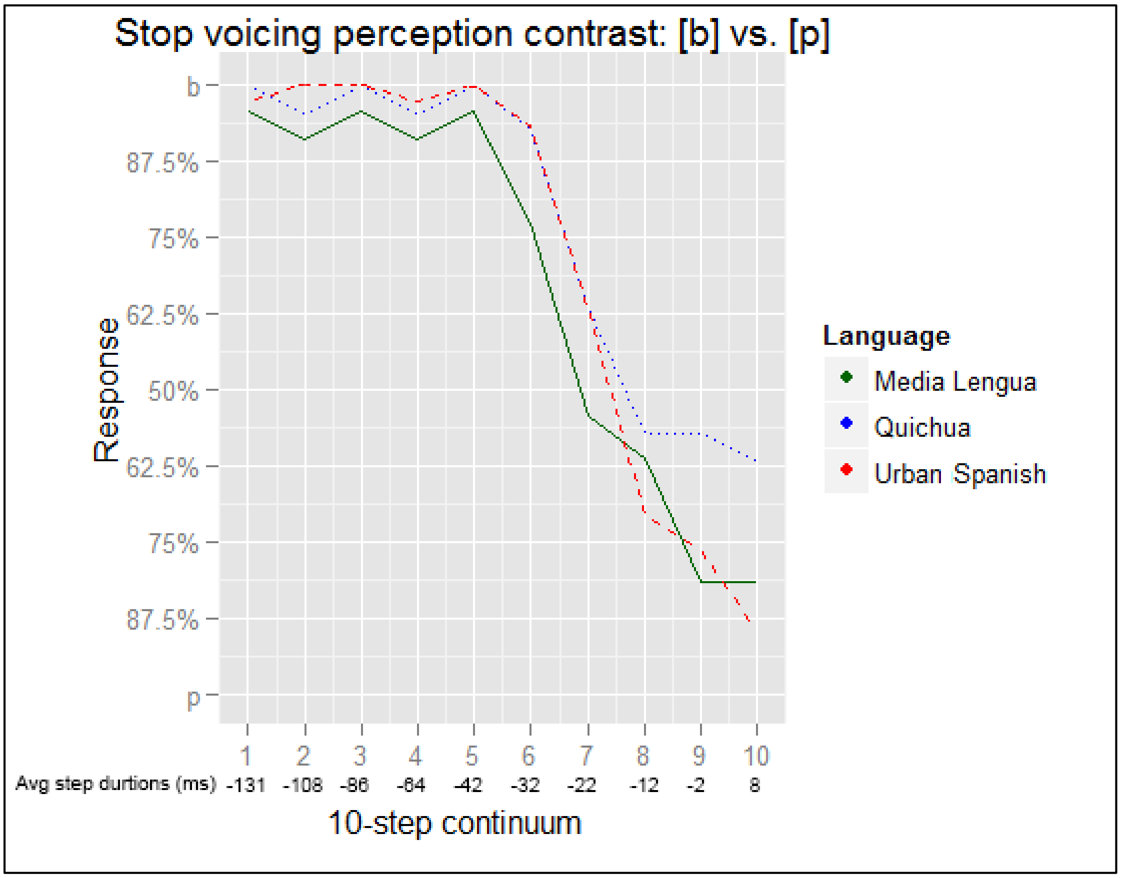


Figure 31: Bilabial stop voicing perception from Urban Spanish (dashed), Media Lengua (solid), and Quichua (dotted).

These trends from Figure 31 suggest speakers from all three language varieties clearly recognize voiced [b] tokens as such all the way up to step 5. One discrepancy however, is visible in the perception of [p] at the end of the continuum. Here, Quichua speakers show varied responses reaching just below the 50% mark, while Media Lengua and Spanish speakers appear to show consistent responses which average 85%. This difference is probably caused by the short VOTs for the [p] tokens (7 ms for *paño* 'fabric' and 9 ms for *peso* 'weight') at the end of the continuum. The values used for [p] were based on the original token produced by the native Spanish speaker which was, unfortunately shorter than those proven to be the statistical duration in Chapter 2. It appears this shortcoming may have left off some of the more prototypical VOT values for Quichua participants. The categorical boundary however, still appears in the image between steps 7 and 8. More details will be provided in Section 3.2.2 with a description of intra-group variation by speaker.

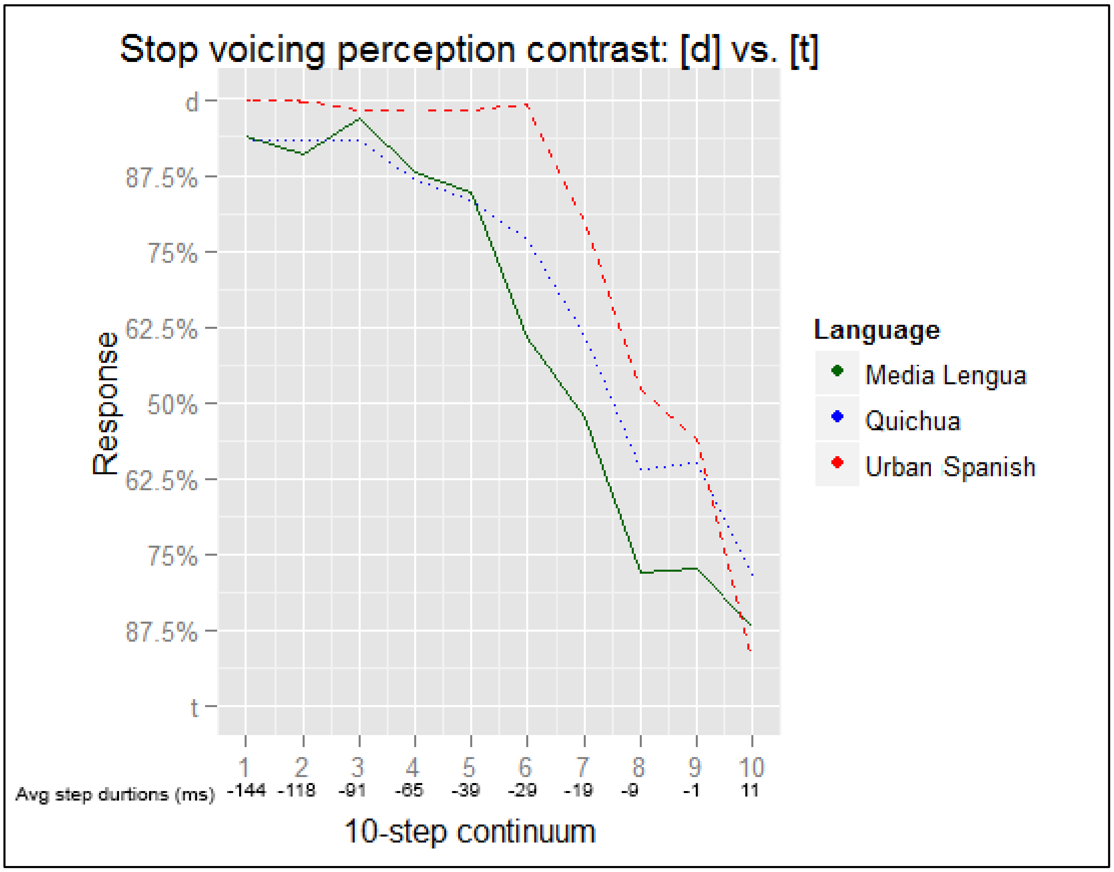


Figure 32: Coronal stop voicing perception from Urban Spanish (dashed), Media Lengua (solid), and Quichua (dotted).

The trends in Figure 32 suggest speakers from all three language varieties clearly recognize voiced [d] tokens as such. Urban Spanish speakers maintained a high level of consistent responses for [d] up to step 6 while Quichua and Media Lengua speakers began to vary their responses at around step 4. All 3 groups show consistent responses of at least 80% by step 10 for [t].

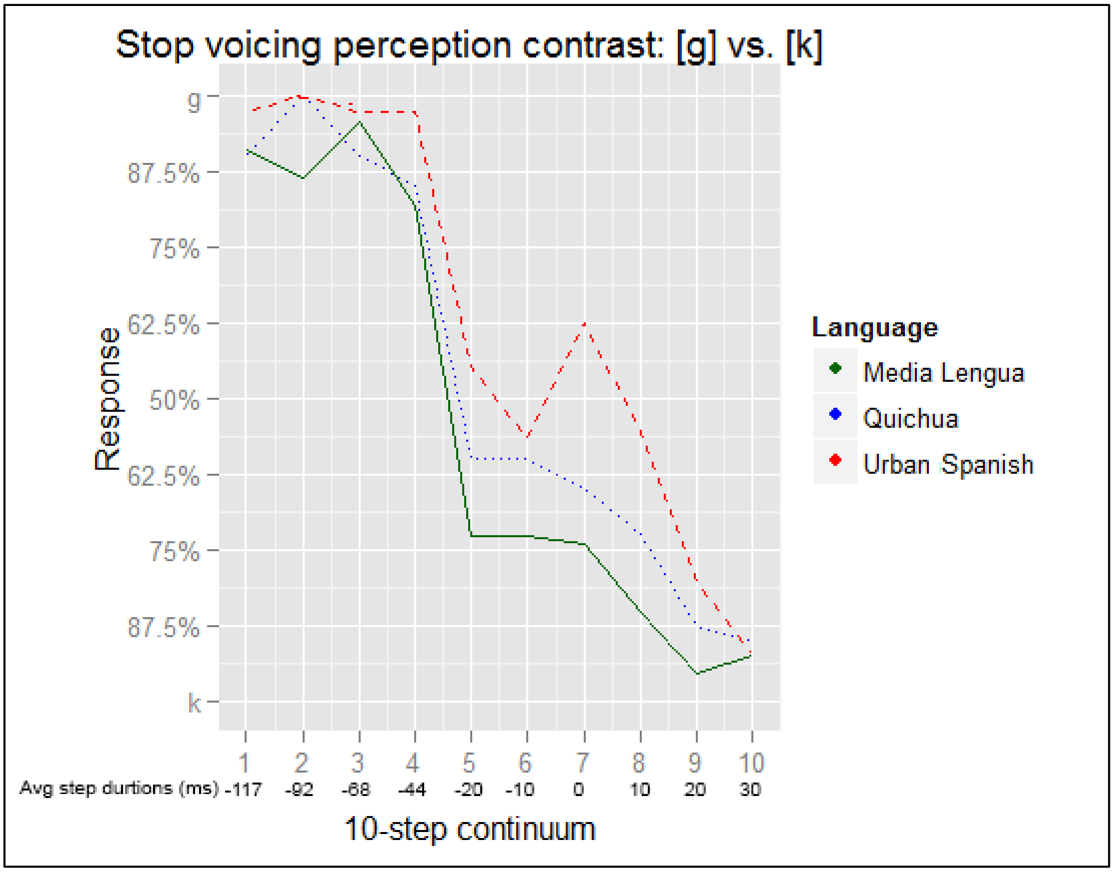


Figure 33: Velar stop voicing perception from Urban Spanish (dashed), Media Lengua (solid), and Quichua (dotted).

The trends in Figure 33 suggest speakers from all three language varieties clearly recognize voiced [g] tokens as such up to step 4. One discrepancy however, is visible in the perception of [k] between steps 6 and 8 in Urban Spanish, which shows a sharp spike towards [g] before returning back to [k]-like perception. It was pointed out by a large number of participants that some of the tokens neither sounded like [k] or [g] but more like [t]. These tokens happened to fall between the abovementioned steps. The phenomenon has to do with how the continuum was constructed and a special feature of [g] involving post-frication following release. Post-[g] frication will be discussed more in-depth in Chapter 5, Section 6, but as the name suggests it basically involves a moment of voiceless frication following the stop. When creating the continuum, this area was taken into account as part of the stop since the continuum was designed to extend from the most negative portion of the VOT all the way up to voicing of the post-stop vowel before the positive VOT was added. This caused the later steps (6-8) to pass through this region of frication towards the end of the continuum which was often perceived as [t]. As seen in Figure 33, this region also affected Media Lengua and Quichua participants, but to a lesser degree as indicated by the abrupt levelling of the trend line. Based on this phenomenon, I suspect Urban Spanish velar stop perception will appear as significantly different from Quichua and Media Lengua Quichua speakers. Based on the trend lines in Figure 33 however, both before and after this area of frication, little cross-language variation is noticeable.

Table 43 contains the results from the generalized linear mixed effects model using *response* as the dependant variable. Based on the model results, the intercept contains the following baseline categories: the Media Lengua speaker responses, responses to the bilabial, and coronal stimuli (which were non-significantly different from each other), and the interaction between *Media Lengua* and the *continuum*.

The intercept, with a 'base' value of 4.3 log-odds, suggests the probability that Media Lengua participants selected a voiced stop over a voiceless stop at the beginning of the continuum was 99% (74:1 odds). The probability of selecting a voiced stop ([b, d, g]) decreased by, on average, -0.71 log-odds per step along the continuum as indicated by the slope of the curve (Figure 34). For the Urban Spanish and Quichua groups, there were significant interactions with *continuum*. The results for the Urban Spanish group suggests that participants have a steeper slope than Media Lengua and Quichua speakers, which based on the model output, correlates to a greater number of responses to the voiced series of stops (*Spanish intercept* = 6.7 (*intercept + Spanish + continuum-1&Spanish*); *Spanish continuum* = -0.97 (*continuum-1 + continuum-1&Spanish*)). For the Quichua group, results suggest that participants have the shallowest slope of the three languages under analysis, which based on the model output, correlates to a greater number of varied responses across the continuum (*Quichua intercept* = 4.4 (*intercept + continuum-1&Quichua*); *Quichua continuum* = -0.61 (*continuum-1 + continuum-1&Quichua*)). Taking into account the intercept and the overall distance between each step along the continuum results based on *language* suggest the categorical boundaries for the Urban Spanish group are found later on in the continuum than those of the Quichua and Media Lengua participants.

For place of articulation, responses to velar [g] were less common than for [b] or [d], suggesting an earlier switch from [g] to [k]. The log odds value of the result for *velar* was -1.28 log-odds. There was however, an interaction between the Urban Spanish participants and the responses to the velar stop pairs. Here, the results shift to -0.87 from -1.28—suggesting the same trend for but with lesser variation in responses to the velar stimuli compared to velar responses from the Quichua and Media Lengua participants.

Finally, and interaction between the Quichua participants and *age* just reached significance. This result means the older a Quichua participant is, the more the intercept increased. In this case there was an increase of 0.03 log-odds per year (9 in total). This increase in the intercept, which did not significantly affect the overall slope i.e., there was a non-significant interaction with *continuum*, suggests the older group has a slight perceptual difference across voiced and voiceless stop pairs than those of the younger group. For example, oldest speaker, aged 68, has a difference of 0.29 log-odds (*age**9) compared to the youngest participant (26 years of age).

	Estimate	Std. Error	2.5%	97.5%	z-value	Pr(>|z|)
(Intercept)	4.3	0.53	3.3	5.4	8.2	3.45E-16
Continuum-1	-0.71	0.04	-0.78	-0.64	-19.9	<2.00E-16
Quichua *ns*	-1.3	0.80	-2.9	0.27	-1.6	0.10
Spanish	2.7	0.41	1.9	3.5	6.6	5.75E-11
Velar	-1.28	0.49	-2.2	-0.32	-2.6	0.0093
Age *ns*	-0.003	0.01	-0.019	0.013	-0.34	0.74
Continuum-1*Quichua	0.10	0.05	0.007	0.20	2.1	0.036
Continuum-1*Spanish	-0.26	0.05	-0.36	-0.16	-4.9	7.62E-07
Velar*Spanish	0.41	0.16	0.094	0.72	2.5	0.011
Quichua*Age	0.032	0.02	0.00014	0.064	2.0	0.049

Table 43: Generalized linear mixed effects model results for stop perception.

According to the *intercept* (made of up Media Lengua speaker responses, bilabials and coronal responses, and the Media Lengua and continuum interaction) and *continuum* results, for every step along the continuum, the chances of selecting a voiced stop deceases by 0.71 log-odds from an initial base value of 4.3 log-odds. This means by the last step of the continuum, there is a -2.7 log-odds (*intercept* + (*continuum**9)) or a 6% chance that a participant will hear the voiced stimuli. Table 44 and Figure 34, detail these results along the continuum. In both Table 44 and Figure 34, the categorical boundary (the 50% point) is highlighted, which falls near step 6.

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	4.3	3.6	2.9	2.2	1.5	0.8	0.0	-0.7	-1.4	-2.1
Odds	73.7	36.2	17.8	8.8	4.3	2.1	1.0	0.5	0.3	0.1
Probability	0.99	0.97	0.95	0.90	0.81	0.68	0.51	0.34	0.20	0.11
Duration at step (ms)	-138	-113	-89	-65	-41	-31	-21	-11	-1	10

Table 44: Log-odds, odds, and probability model results along the 10-step continuum according to the intercept (4.3 log-odds) and continuum result (-0.71 log-odds) per step.

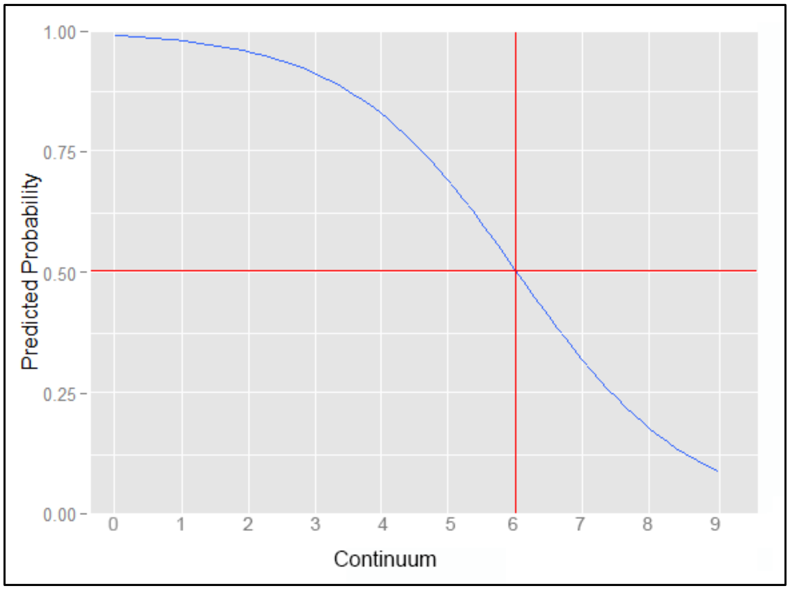


Figure 34: Log-odd results along the 10-step continuum highlighting the perceptual boundary from the intercept (Media Lengua) near step 6.

For the Spanish and Quichua groups, which both had significantly different values from that of the intercept language (Media Lengua) when interacting with the *continuum* predictor, the baseline results (not including the *velar* and *age* predictors) are presented in Table 45 (Quichua) and Table 46 (Urban Spanish). Here, the categorical boundary for both groups shifts to the right (towards 0):

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	4.4	3.8	3.2	2.6	2.0	1.4	0.7	0.1	-0.5	-1.1
Odds	81.5	44.3	24.0	13.1	7.1	3.9	2.1	1.1	0.6	0.3
Probability	0.99	0.98	0.96	0.93	0.88	0.79	0.68	0.53	0.38	0.25
Duration at step (ms)	-138	-113	-89	-65	-41	-31	-21	-11	-1	10

Table 45: Log-odds, odds, and probability model results along the 10-step continuum adjusted for the Quichua and continuum interactions per step.

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	6.7	5.8	4.8	3.8	2.9	1.9	0.9	0.0	-1.0	-2.0
Odds	845.6	320.5	121.5	46.1	17.5	6.6	2.5	1.0	0.4	0.1
Probability	1.00	1.00	0.99	0.98	0.95	0.87	0.72	0.49	0.27	0.12
Duration at step (ms)	-138	-113	-89	-65	-41	-31	-21	-11	-1	10

Table 46: Log-odds, odds, and probability model results along the 10-step continuum adjusted for the Urban Spanish and continuum interactions per step.

Expanding to other predictors, both the Quichua and Urban Spanish participants have steeper overall slopes than that of Media Lengua speakers, which based on Table 44 though Table 46, suggest the categorical boundary of the Media Lengua participants appears one step before that of the Urban Spanish and Quichua participants.

By taking into account the significant predictor *velar* results, which lower the intercept by 1.28 log-odds at step 0 for Quichua and Media Lengua, and by 0.87 for Urban Spanish (via the Spanish-velar interaction), the results from Table 47 through Table 49 suggest the categorical boundary for the velar switch takes place two steps before that of the bilabial and coronal boundaries, with the exception of Spanish, which shifted only one step due to the significant positive interaction with the *velar* predictor—a result caused by the aforementioned varied responses between steps 6-8. Here, the categorical boundary between [g] and [k] for Media Lengua Speakers takes place at step 4, for Quichua speakers at step 5, and for Urban Spanish speakers at step 6. These results are further supported in Figure 33, which shows Media Lengua participants crossing the 50% point between steps 4 and 5, Quichua participants at step 5, and Urban Spanish participants between steps 5 and 6.

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	3.0	2.3	1.6	0.9	0.2	-0.5	-1.2	-2.0	-2.7	-3.4
Odds	20.5	10.1	5.0	2.4	1.2	0.59	0.29	0.14	0.07	0.03
Probability	1.0	0.9	0.8	0.7	0.5	0.4	0.2	0.1	0.1	0.0
Duration at step (ms)	-117	-92	-68	-44	-20	-10	0	10	20	30

Table 47: Log-odds, odds, and probability results along the 10-step continuum according to the baseline intercept values including the velar place of articulation.

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	3.1	2.5	1.9	1.3	0.7	0.1	-0.5	-1.2	-1.8	-2.4
Odds	22.6	12.3	6.7	3.6	2.0	1.1	0.6	0.3	0.2	0.1
Probability	0.96	0.92	0.87	0.78	0.66	0.52	0.37	0.24	0.15	0.09
Duration at step (ms)	-117	-92	-68	-44	-20	-10	0	10	20	30

Table 48: Log-odds, odds, and probability results along the 10-step continuum adjusted for the Quichua and continuum interaction, and the velar place of articulation.

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	6.1	5.2	4.2	3.2	2.3	1.3	0.3	-0.7	-1.6	-2.6
Odds	459.4	174.2	66.0	25.0	9.5	3.60	1.36	0.52	0.20	0.07
Probability	1.0	1.0	1.0	0.96	0.90	0.78	0.58	0.34	0.16	0.07
Duration at step (ms)	-117	-92	-68	-44	-20	-10	0	10	20	30

Table 49: Log-odds, odds, and probability results along the 10-step continuum adjusted for the Urban Spanish and continuum interaction, the velar place of articulation, and the Urban Spanish and velar interaction.

Lastly, by taking into account the significant interaction between *Quichua* and *age*, the intercept is increased by 0.032 log-odds per year (9 in total) at step 0 for Quichua participants. The results from Table 45, including the youngest age range, compared with Table 50, including the oldest age category, suggest the categorical boundary for the oldest Quichua speakers shifts slightly to step 8 (43% being closer to 50% than 58%).

Continuum step	0	1	2	3	4	5	6	7	8	9
Log-odds	4.6	4.0	3.4	2.8	2.1	1.5	0.9	0.3	-0.3	-0.9
Odds	98.3	53.4	29.0	15.8	8.6	4.66	2.53	1.37	0.75	0.41
Probability	1.0	1.0	1.0	0.94	0.90	0.82	0.72	0.58	0.43	0.29
Duration at step (ms)	-138	-113	-89	-65	-41	-31	-21	-11	-1	10

Table 50: Log-odds, odds, and probability results along the 10-step continuum adjusted for the Quichua and age interaction based on the oldest participant in the group.

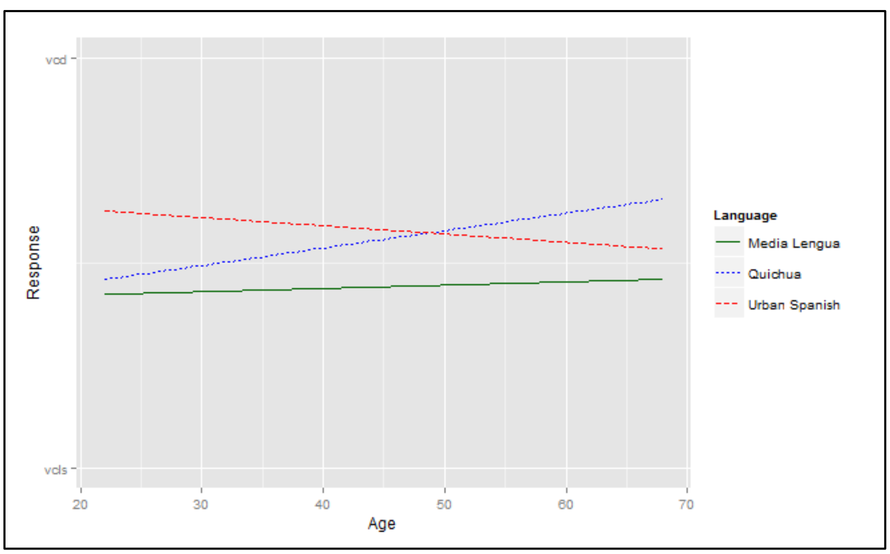


Figure 35: Responses to the test stimuli by age and language.

Figure 35, representing age on the x axis (with 31 categories) and voiced versus voiceless responses on the y axis, illustrates this age-based trend graphically. Here, Quichua speakers are shown to increase their number of responses to the voiced series of stops with *age*. This suggests either a shift of the categorical boundary or reduced perception is correlated with *age*. *Age* on the other hand, does not appear to affect Media Lengua speakers and a reverse trend is found for Urban Spanish speakers.

The main question proposed at the beginning of this chapter was whether the production results from Chapter 2 are in fact contrastive or if Media Lengua and Quichua speakers are just assimilating Spanish-like production without taking into account perceptual boundaries. According to the statistical model presented in Table 43, the breakdowns of the predictors along the continuum in Table 44 though Table 50, and the averages presented in Figure 31 through Figure 33, Media Lengua and younger Quichua speakers indeed contrast the stop pairs by voicing and across all places of articulation. In fact, younger Quichua speakers have the same categorical boundaries as Urban Spanish speakers for the bilabial and coronal stops (-11 ms), while the categorical boundary for the Media Lengua participants is found just one step before hand (-21 ms). Older Quichua speakers also show evidence of perceptual contrast though responses are more varied and the categorical boundary is shifted towards the end of the continuum (-1 ms).

One of the more interesting findings suggests that *age* affects perception of stops in the Quichua group. Based on this result, younger speakers are either shifting the perceptual boundary towards Spanish-like perception or older speakers have limited perceptual contrast. To better understand what is taking place in the Quichua group, Figure 36 looks at each speaker individually in hopes of identifying possible effects of *age* in the Quichua group. The Media Lengua group is also presented to use as a point of comparison.

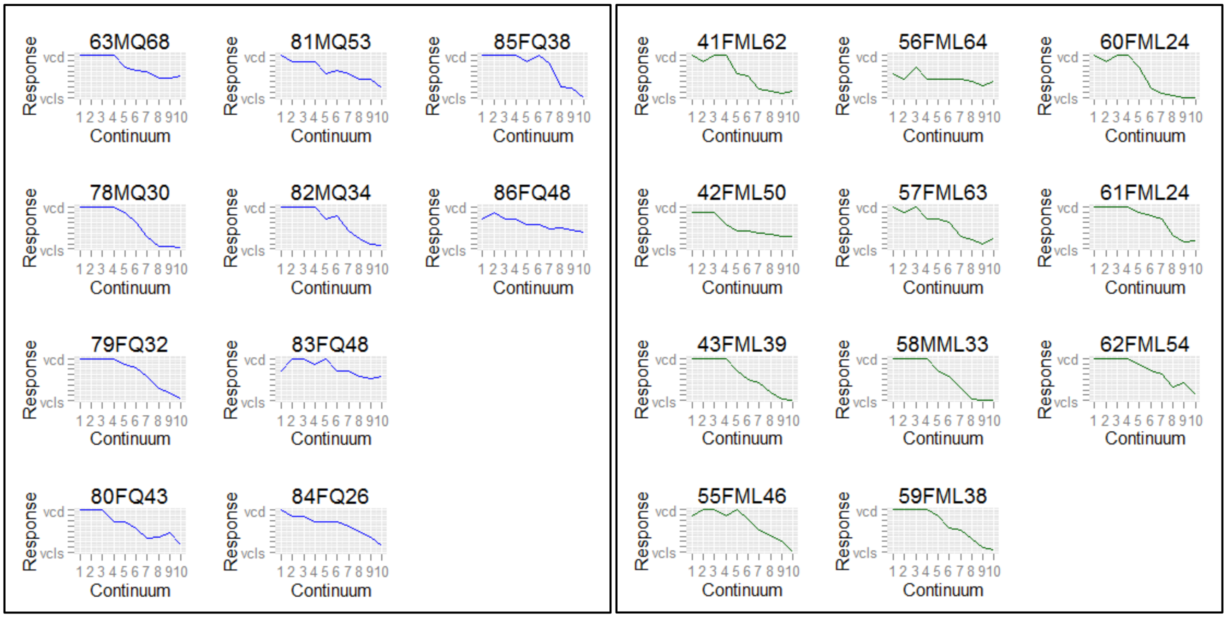


Figure 36: Quichua (left) and Media Lengua (right) voiced/voiceless stop perception by speaker

Results by Quichua participant, as shown in Figure 36 (left), reveal that half the participants (#63, #81, #83, and #86) do not show a strong perceptual contrast, though they appear to trend right direction. Those that did show a strong contrast (#78, #79, #82, #84 and #85) were all between the ages of 30 and 38, while those with more limited perceptual contrast were between the ages of 43 and 68. The data from Figure 36 and Table 50 suggest that in addition to shifting the perceptual boundary, older the Quichua participants also lack a strong perceptual contrast between voiced and voiceless stops as seen in the greater variation in responses to the stimuli. Section 3.3 provides a hypothesis to this phenomenon.

For the Media Lengua participants on the other hand, results from in Figure 36 (right) reveal all but two participants, #42 and #56, showed a strong perceptual contrast. While these participants fell into the older age category, 50 and 64 respectively, three other older participants also showed strong perceptual contrasts—#41, aged 62, #62, aged 54, and #57, aged 63.

3.3 Chapter 3 summary

The goal of this experiment was to explore inter-group VOT perception using minimal pairs with a stop voicing contrast in word-initial position in Urban Spanish, Media Lengua, and Quichua. The primary motive of this analysis was to test whether Quichua and Media Lengua speakers perceive a voicing contrast in Spanish lexical borrowings. Evidence of a strong perceptual contrast revealed through this experiment supports the production results from Chapter 2 which show speakers consistently make appropriate articulatory adjustments between voiced and voiceless stops. A secondary motive for this analysis was to add to the contact literature with the first perceptual study to take into account a mixed language and its source languages. While this study only made use of two to three minimal pairs per stop pair under analysis, the statistical results show participants in all three languages had a relatively high degree of perceptual contrast, with the exception of the older group of Quichua participants.

Perceptual discrimination tasks of this nature also provide quantitative results which can be used to hone in on a listener's categorical boundaries (50% crossing point). This is possible since a speaker's responses become more consistent the closer the discrimination stimuli are to their prototypical forms, thus in turn leaving the boundaries as the most distant point between two such forms. For instance, Abramson & Lisker (1973) also showed that perceptual boundaries for Spanish[10] /b/ and /p/ appeared at 14 ms, /d/ and /t/ at 22 ms and /g/ and /k/ at 24 ms. Results from this experiment however, paint a different picture of stop perception. Based on the calculations from the statistical model in Table 43 and the subsequent

[10] According to Abramson & Lisker (1973), the twelve speakers were not from dialectally homogenous regions.

breakdowns of the predictors in Table 44 though Table 50, results show all three languages have negative categorical boundaries as seen in Table 51.

	Urban Spanish	Quichua	Media Lengua
[b-p] [d-t]	-11 ms		-21 ms
[g-k]	0 ms	-10 ms	-20 ms

Table 51: Perceptual boundaries (50% crossing point) for all stop pairs and languages analyzed in this experiment

Unlike Abramson & Lisker (1973)'s results (14 ms for /b-p/, 22 ms for /d-t/, and 24 ms for /g-k/), the perceptual boundaries in Urban Spanish from Quito were and negative. Identical boundaries were found for Quichua, with the exception of [g] which took place before that of Urban Spanish, while all of Media Lengua's perceptual boundaries were shown to take place before those of Quichua and Urban Spanish at greater negative values. The discrepancy between these findings and those of Abramson & Lisker (1973), may suggest Abramson & Lisker (1973)'s results might need to be reconsidered. It seems peculiar that their 1964 study showed the average VOT durations of Puerto Rican Spanish (4 ms for [p], 9 for [t̪], and 29 ms for [k] see Table 12) fell short of their perceptual boundary results for both [p] and [t̪] while on the borderline average of [k] in their 1973 study. In fact, all of the varieties presented in Table 12 fell short of the perceptual boundary for [d] presented by Abramson & Lisker (1973) while only one variety (Peruvian Spanish) reached 15 ms as an average VOT duration. If this were indeed the case, speakers would be producing voiceless VOTs that were perceptually indiscriminate from their voiced counterparts. It may be their results were influenced to some degree by English or a cross-dialectal variation with long voiceless VOTs that I am unaware of from an unknown country as their participants were from Puerto Rico, and "some six nations from Central and South America", with at least one participant who appeared to be an English-Spanish bilingual and one had been on "mainland for close to fifteen months" Abramson & Lisker (1973, p. 2). In the latter case, it is possible that VOT influence from an aspirated language like English may influence a voicing language such as Spanish, which may have affected the outcome of their study (Simon, 2010).

Turing to the discrepancy between *age* in the Quichua participants. The results suggest younger speakers have the same degree of perception as Media Lengua speakers while older Quichua speakers have more limited perception in the stop voicing contrast comparatively. I hypothesize that since the age of acquisition of Spanish was roughly the same age for both Quichua and Media Lengua speakers (6-7 years of age) the greater exposure to Spanish-derived voiced stops in Media Lengua from birth, might have rendered different perceptual patterns from Quichua speakers who acquired contrastive stops later in life. This justification might also explain why the categorical boundaries for the Media Lengua participants were found before that of Quichua Speakers. It may be that acquiring the stop voicing contrast natively at birth, Media Lengua speakers were able to take advantage of the long negative VOT by shifting the categorical boundary further inward (more negative). This could have created more optimal conditions conducive to a better perception between stop pairs based on the native Quichua phonology—recall that Media Lengua phonology is fundamentally Quichua. The Quichua speakers on the other hand, who acquired the contrast later in life would not have had the ability to take advantage of the fine acoustic details needed to improve stop perception and instead rely on input from Spanish.

The question now shifts to why younger speakers of Quichua are able to better perceive the contrast than older participants since the age of Spanish acquisition for both groups was roughly the same? I believe the answer lies in the increased level of Spanish ability and the increased level of diffusion of Spanish over the last few generations. Not only do the younger generations tend to be more proficient in Spanish due to an increase in educational opportunities, but also the level of exposure to Spanish has increased dramatically throughout their society. Beyond increased educational opportunities, the younger generations have more constant communication with mainstream Spanish-speaking society, an increased tendency to use Spanish over Quichua among peers and siblings, and an increase usage of media access e.g., radio, TV, and internet. These shifts in language use in the younger generations are probably responsible for solidifying the stop voicing contrast. The older generations, of both Media Lengua and Quichua speakers on the other hand, grew up speaking primarily Quichua or Media Lengua and had less educational opportunities, less access to mainstream Spanish-speaking society, and Spanish media. These conditions would therefore be less favourable to the stop voicing contrast based on a solely lower degree of Spanish acquisition and Spanish borrowings. For the older Media Lengua speakers however, the use of the Spanish lexicon in their language was probably enough of a factor to create a high degree of perceptual contrast between voiced and voiceless stops in order to avoid ambiguities in the language.

Now that it has been established that the voiced stop series has entered both Quichua and Media Lengua productively and perceptually, I now turn to specific aspects of stop production in Chapters 4 and 5. These include phonetic pre-nasality (Chapter 4) and variations in word-initial stop production (Chapter 5).

Chapter 4

Stop Nasality

4 Introduction

Having established that both Media Lengua and Quichua have adopted the stop voicing contrast, both productively and perceptually, this chapter turns a specific production aspect of voiced stops—phonetic pre-nasalization. Since one of the main goals of this dissertation is an in-depth description of stops in Media Lengua, Quichua, and Spanish, the research objective of this chapter is to identify whether Spanish stops include any indication of pre-nasalization in the voiced stop series. If there is indeed evidence, does this phenomenon carry over into Media Lengua and Quichua via Spanish borrowings?

This chapter explores the possibility of pre-nasalization during word-initial voiced stop production in Quichua, Media Lengua, and Urban Spanish from Quito using a new technique, dubbed 'The Earbuds Method' (Stewart & Kohlberger, 2015). This method, presented here for the first time on field data, allows for comparative measurements and visualization of intensity from both the nasal and oral tracts during speech production using time-aligned audio of simultaneous recordings from each tract (see Section 4.1).

This method is shown to be a non-invasive and accurate technique used for analyzing levels of intensity during speech production every 6.25 ms interval throughout a recording. The method was designed as an alternative to the A1-P0 technique of measuring harmonic differences between the highest harmonic near the F1 (A1) and a low frequency harmonic (H1 or H2) which corresponds to a nasal resonant frequency from the nasal tract (Chen, 1996; Feng & Castelli, 1996; Styler, 2011). The A1-P0 method often requires large quantities of data and may hinder cross-speaker analysis due to irregularities in nasal cavity size. Another shortcoming of this method, as described in Price and Stewart (2013), is the fact that variation in vowel height and tongue position require different harmonics to be measured which affect cross-vowel comparisons. Chen (1996) describes A1-P1, where P1 is a second nasal resonance peak located near the 1,000 Hz range, as a better measurement for high front vowel nasality. Schwartz (1968) on the other hand, describes A1-P2, where P2 is yet another nasal resonance peak located between the second and third formants, as a better measurement of back vowel nasality. This method is also limited by its inability to measure degrees of orality and nasality in sound segments other than vowels. It should be noted however, that Styler (forthcoming) is currently working on improved methods for analyzing nasality acoustically.

The Earbuds Method on the other hand, allows for temporal analysis of nasal and oral speech production and provides a non-linear suprasegmental approach, independent of vowel and consonant features. Currently however, this method is limited to intensity (or LPC gain) calculated in Pascals (a unit of energy derived through pressure fluctuations). It should be noted that this method does not gage airflow and does not use a continuous variable similar to that of a nasal airflow mask. Instead, intensity is sampled into an evenly spaced number of *frames* where it is calculated at each interval.

Nasality is particularly of interest in Spanish stops because of recent findings by Solé and Sprouse (2011)[11] who reported nasal leakage in Spanish utterance-initial stops as a mechanism to achieve a difference in transglottal airflow pressure for voicing. Their study consisted of multiparametric aerodynamic and acoustic data which suggest a delay in nasal closure relative to oral closure. This delay is seen as a momentary nasal burst before phonation onset. They conclude that this additional velum manoeuvre facilities voicing

[11] I would like to thank Martin Kohlberger for pointing out this article to me.

since stops require a large enough subglottal and oral pressure difference, via air flow through the glottis, to induce voicing. They show that attaining this pressure difference is further complicated with post-pause stop e.g., utterance-initial stops, since vocal fold vibration must be initiated rather than sustained, while at the same time vocal folds must be adequately tensed for voicing. Their paper also reports that the difficulty in attaining sustained voicing can be seen cross-linguistically in the large number of languages with phonological voicing contrasts that do not require glottal vibration to produce so called 'voiced' stops.

Specifically regarding Spanish, their findings show pre-nasalization appears to be cross dialectal as this mechanism was identified in Spain (4 speakers), Mexico (1 speaker) and Uruguay (1 speaker). The following section (4.1) details the "Earbuds Method", which makes use time-aligned recordings from the nasal and oral tracks to analyze intensity differences, to see if this delayed velum gesture is carried over into Quichua, Media Lengua, and found in Urban Spanish from Quito. Because nasality appears to be at least partially responsible for the long negative VOT durations in the Spanish voiced stop series, and results from Chapter 2 also show long negative VOT for the voiced stop series in Quichua and Media Lengua, I suspect nasal leakage may have carried over into Quichua and Media Lengua as well. If this is indeed the case, I expect to find similar increased intensity readings in the negative VOT portion of the voiced stops under analysis.

4.1 Method

4.1.1 Experiment design

One female consultant from each of the three language groups under analysis (Quichua, Media Lengua, and Urban Spanish) was asked to re-read the list of 100 sentences (see

Chapter 2, Section 2.2.1.2), but this time holding a pair of generic Electra stereo earbud ear phones below each nostril. These low impedance earbuds (27 ohms) were directly connected to the recording jack on a PC laptop computer.[12] Once the recording session began, Praat was used to record a mono wave file with a sampling frequency of 44.1 kHz. At the same time, a unidirectional dynamic microphone was held near the speaker's mouth to capture oral speech production. The oral track was recorded independently of the nasal track on a TASCAM DR-1 with the same sampling rate of 44.1 kHz. The oral track was then converted from stereo to mono. Next both the nasal and oral tracks were time aligned in a stereo file using Audacity (Ash, Chinen, Dannenberg, Johnson, & Martyn, 2012) with the nasal track placed in the left (top) channel and the oral track placed in the right (bottom) channel.

The stereo file was then loaded into Praat. Next, each channel was extracted using the *Convert* → *Extract all channels* function. A textGrid was then created and each utterance-initial voiced stop was annotated using the oral track for reference due to the unintelligibility of the nasal track. Each was then converted to a formant file using the *Analyse spectrum* → *To formant (burg)* function with the following settings: the 'auto' time step value of 0.0, a maximum of 5 formants, a maximum Hertz frequency of 5500 Hz, a window length of 0.025, and pre-emphasis of 50 Hz. This step preforms a short-term spectral analysis and approximates the spectrum using frames based on the number of formants (Boersma & Weenink, 2013). Using the values above, frames were placed at 6.25 millisecond intervals for all three language varieties. During the creation of the formant file, the intensity of each frame was calculated in Pascals (Pa). In order to visualize the

[12] Recording through earbuds or standard earphones is possible since both work on the same basic principle as microphones— pressure fluctuations in sound waves are picked up and converted to electrical current.

intensity, the formant file was converted to a Linear Predictive Coding (LPC) file using the *Analyse* → *To LPC* function with a sampling frequency of 16,000 Hz. It should be noted that the LPC file uses the same Pa values as the intensity formant file, but labels them as 'gain'. LPC gain (intensity), can then be visualized by using the *Draw* → *Draw gain...* function with the following settings: a 'from time value' of 0.0, a 'to time' value of *all*, a minimum gain value of 0.0, and a maximum gain value 0.0, where default gain values of 0.0 represent the minimum and maximum Pa values in the dataset.

The LPC files were then exported from Praat where the gain values were separated using regular expressions[13]. Because the nasal and oral tracks were not calibrated during recording i.e., independent recording devices were used for both tracks, and airflow through the oral tract is intrinsically louder than through the nasal tract, the data required normalization. To do so, each track was independently mapped onto a 1 to 10 scale and converted using a 10-base logarithm as shown in the following equation:

$$x_{log10,i} = \frac{a + \left(log10(x) - A\right)\left(b - a\right)}{\left(B - A\right)}$$

Equation 6: This equation maps the data to a 1 to 10 scale and then converts it using a 10 base logarithm.

Where a is the first number of the adjusted scale, in this case 1; b is the last number of the adjusted scale, in this case 10; x is the original frame value in Pascals; A is the minimum value throughout the range; and B is the maximum number throughout the range.

By dividing the nasal values (N) by the oral values (O) from equal frames in the normalized data e.g., nasal frame 23 and oral frame 23, and multiplying the result by 100, the

[13] The regular expression /gain = \d.\d+(e-\d+|)/ was used in conjunction with EditPad Lite 7's (Goyvaerts, 2014) *Cut all matches* function.

resulting percentage can used as an indicator to the amount nasal vs. oral intensity/gain (I) in a given frame.

$$\left(N/O\right) * 100 = I\%$$

Equation 7: This equation calculates percentage based on the oral and nasal intensity values.

To add the phonological segments to the dataset for referencing which sounds are more or less nasal, the frame number of each value was added to the dataset. Because the tracks were time aligned, there were an equal number of frames which perfectly aligned temporally with both oral and nasal production. The Praat textGrid was then exported and the minimum and maximum time of each annotation interval was extracted using regular expressions[14]. The minimum and maximum values of each interval were then averaged in order to place the sound segment in the middle of the range. Next the interval average was converted to frames using the following equation:

$$Frame = \left(\left(\frac{min * \max}{2}\right)/Ts\right) + Ff$$

Equation 8: This equation averages the maximum and minimum values of each time interval then converts the result into frames.

Where *min* is the minimum time interval; *max* is the maximum time interval; *Ts* is the time step in this case 0.00625 s; and *Ff* is the time interval of the first frame.

A *for loop* was then used to align the frames containing the segments with the complete frame range in the dataset. Finally percentages greater than or equal to 101% were marked as 'nasal' while those less than or equal to 99% were marked as 'oral'. While a simple fluctuation in the intensity reading from the nasal tract is enough to indicate nasality under most conditions, it was thought best to provide a consistent benchmark which overwhelmingly shows nasal intensity was greater than oral intensity. I considered this important in case the

[14] The regular expressions /   xmin = (\d+\.\d+|\d)/, /   xmax = (\d+\.\d+|\d)/, and /*text = "(|.+)"*/ were used in conjunction with EditPad Lite 7's (Goyvaerts, 2014) *Cut all matches* function.

earbuds picked up any feedback from the oral tract which could have been misinterpreted as nasal intensity. Segments which aligned with a 'nasal' result were considered to be nasal because of their greater degree of intensity from the nasal tract compared to the oral. Figure 37 provides an example of the Earbud Method results in a line chart. It should be emphasized that we are not interested height of each peak but instead whether there is justifiable fluctuation in either of the tracts. In this case, I am interested in which tract is more prominent during a specific frame or segment of analysis. To clarify why we are not interested in the overall amplitude of each peak, it helps to look at the oral track. For example, if we compare the second 'o' in *documentoka* 'document' with the first 'a' in the utterance it does not make sense to claim the 'a' is more oral, than the 'o'. This is also true for nasal track.

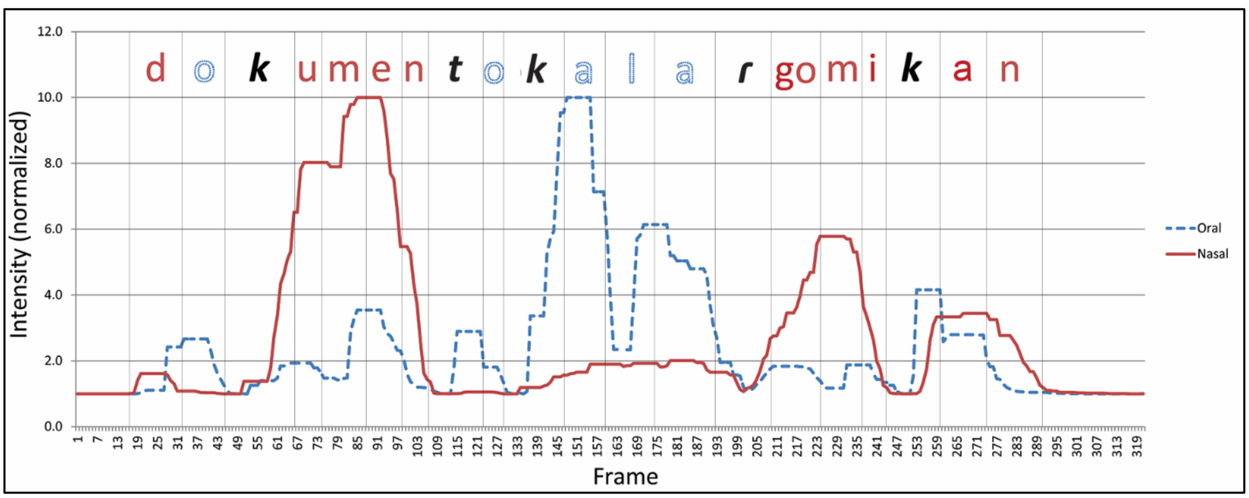


Figure 37: Superimposed nasal (red/solid) and oral (blue/dashed) intensity tracks of the Media Lengua sentence *Documentoka largomi kan.* 'The document is long.' This figure shows pre-nasalization of the utterance-initial stop /d/ located near frame 19. It also demonstrates that both pre- and post-nasalization stem from inherent nasal consonants up to a syllable away in the '*gomi'* cluster beginning near frame 205. Velum lowering is also noticeable in the middle of the last /a/ segment as seen in the transition between oral to nasal prominence. Finally, it is apparent that voiceless stops, approximants, and taps are indeed obstructing the flow of air through both tracks as intensity falls to near zero.

While it is beyond the scope of this study, it is worth noting a few features of Figure 37 which may also benefit future research into nasalization. The first, involves complete cut off of amplitude for obstruents [k, t, ɾ] followed by an increase in intensity after the release. On that same note, a similar pattern is shown with the approximant [l] — decreased intensity during the partial closure phase followed by an increase upon release. Taking into account the characteristics of these segment classes, studies looking at nasal harmony should have a better picture of how nasality interacts across such segments. The second point of interest involves pre- and post-nasalization which is clearly illustrated in the *kumen, gomi*, and *an* clusters. The nasal track (red/solid) for the *kumen* cluster clearly shows pre-nasalization appearing during the release phase of 'k' while the velum remains open for 'u' and 'e' between the nasal consonants 'm' and 'n'. Since this cluster is surrounded by stops, no post-nasalization in apparent after 'n'. The *gomi* cluster on the other hand, demonstrates how intensity begins to build as air escapes the velum opening two segments before the inherently nasal 'm' consonant. Post-nasalization is seen on 'i' but the intensity quickly fades in preparation for the following stop. In this example, it is also clear that nasalization on the word-initial stop appears at the beginning of the negative VOT and is maintained until about the halfway mark, at which point the velum closes and the segment becomes oral for its remaining duration.

4.1.2 Participants

Table 1 provides information pertaining to the participants who took part in the nasality experiment. The data includes: speaker code, age at the time of recording, gender, demographic descriptors including, education, level of Spanish, Quichua, Media Lengua, and place of residence.

One speaker from the Urban Spanish, Media Lengua, and Quichua groups participated in this experiment. The Urban Spanish speaker was a Spanish monolingual from Quito, the Quichua speaker was a simultaneous bilingual in both Spanish and Quichua from Chirihuasi, and the Media Lengua speaker was a trilingual in Media Lengua, Quichua, Spanish from Pijal—L1 in Media Lengua and Quichua and began acquiring Urban Spanish upon entering primary school. All three participants had secondary or university level education and all three were women.

Speaker Code	Age	Gender	Formal Education	Spanish Level	Media Lengua Level	Quichua Level	Place of residence
096	34	F	University	Native	None	None	Quito
043	42	F	Secondary	High	Native	Native	Pijal Bajo
084	26	F	University	Native	None	Native	Chirihuasi
Average:	45						

Table 52: This table provides information on the Urban Spanish, Media Lengua, and Quichua speakers who participated in the nasality experiment. Information includes: age at the time of the experiment, gender, level of formal education, level of Spanish, Media Lengua, and Quichua, and place of residency.

4.1.3 Procedures

The elicitation sessions for this experiment followed that of the word-list procedure in Chapter 2, Section 2.2.1.3. After the initial word-list was recorded, one participant from the Quichua, Media Lengua, and Urban Spanish groups was asked if they would like to participant in the nasality experiment. It was explained that they would be asked to reread the word-list described in Chapter 2, Section 2.2.1.3, but this time holding one earbud under each nostril. Those who participated in the nasality reading were monetarily compensated for the additional session.

Using Praat version 5.3.47 (Boersma & Weenink, 2013) three elements were extracted using the same script described in Section 2.2.1.3: (1) VOT duration, (2) the following segment, and (3) the word containing the word-initial stop under analysis.

4.2 Results

The results of this experiment are presented in two main sections. Section 4.2.1 looks at the number of word-initial voiced stops that registered some degree of nasality across all three languages. This section also looks to see if any specific voiced stop ([b-d-g]) undergoes nasalization more frequently than another. Finally, Section 4.2.3 investigates the degree of nasality in each word-initial voiced stop i.e., the proportional difference between the nasal and oral frames in each stop. This section also looks for durational differences in the VOT of stops containing nasality versus those that do not.

Statistical analyses using mixed effects models were not run since only three speakers participated in this portion of the study and each participant produced the same native/Spanish-derived words. The goal of this analysis is only to offer general observations in each language and to speculate on trends found in the data.

4.2.1 Frequency of nasalized stops to oral stops

This section looks at the number of word-initial voiced stops that registered some degree of nasality across all three languages. Figure 38 represents the number of voiced stops grouped by place of articulation (x-axis). Each stop is divided by those containing some degree of nasalization (green) and those that are completely oral (orange). The Urban Spanish data, consisting of 32 tokens, shows stops, with some degree of nasal leakage, largely outweigh those which are completely oral while [d] showed no instances of purely oral tokens. Similarly, Media Lengua, containing 48 tokens, shows stops containing nasality are considerably more common than those that are purely oral. On the other hand, Quichua, containing 37 tokens, shows the opposite trend with oral stops outweighing those containing nasality (with the exception of [g])— [b] only slightly and [d] by nearly 50%. Nasal stops for [g] in Quichua were only slightly more common than purely oral ones.

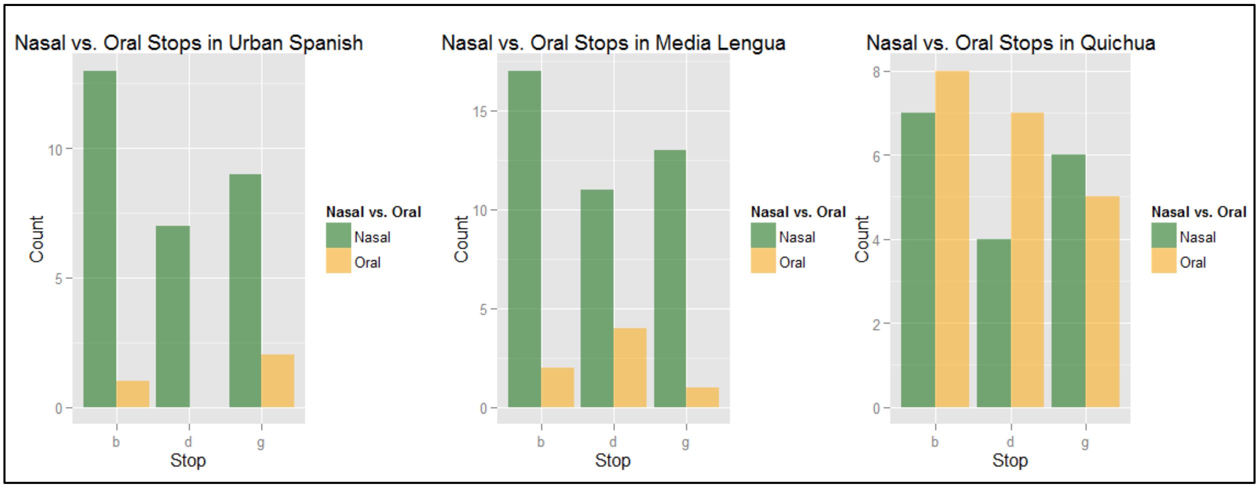


Figure 38: The graphs in this figure represent the number of stops containing some degree of nasality compared to purely oral stops. The graph on the left contains stops from Urban Spanish, the middle graph from Media Lengua, and the right graph from Quichua.

The results from this graph suggest nasality is in fact a common characteristic in all three languages with the Spanish and Media Lengua speakers showing an overwhelming tendency to nasalize stops. Since only one speaker took part in this experiment, it difficult to make any cross language comparisons even though it appears Quichua and Media Lengua appear to differ greatly. Table 53 details each stop under analysis by the percentage of nasal to oral stops across each language. The results suggest there is no obvious place of articulation that undergoes nasalization more often than another.

Percentage of nasal stops			
	Urban Spanish	Media Lengua	Quichua
[b]	93%	89%	47%
[d]	100%	73%	36%
[g]	82%	93%	55%

Table 53: Percentage of stop containing nasality by place of articulation and language

4.2.2 Proportional analysis of oral and nasal intensity per stop

This section looks at the degree of nasality in each word-initial voiced stop by frame. This analysis allows us to evaluate where nasality is produced during each stop e.g., is nasalization only found at the beginning of the negative VOT as reported by Solé and Sprouse (2011)? Does it appear middle? End? Or does it cross the entire stop? This section also looks for durational differences in stops containing nasality versus those that do not. Might nasalization play a role in lengthening the negative VOT of a voiced stop?

Figure 39 represents the proportional differences in nasal vs. oral information based on the number of frames with a higher intensity reading from the nasal track compared to that of the oral track. The Urban Spanish speaker showed a considerable amount of variation ranging from 100% nasal to 6% nasal (mean 49%; median 47%). Both the Media Lengua and Quichua participants on the other hand, showed less variation in the amount of nasality present in the voiced stops. Media Lengua [min. 20%, max. 100%, mean 61%, median 63%] and Quichua [min. 6%, max. 70%, mean 48%, median 48%]. At the same time, these averages suggest the Quichua participant produced less nasalization, comparatively, than the Media Lengua participant.

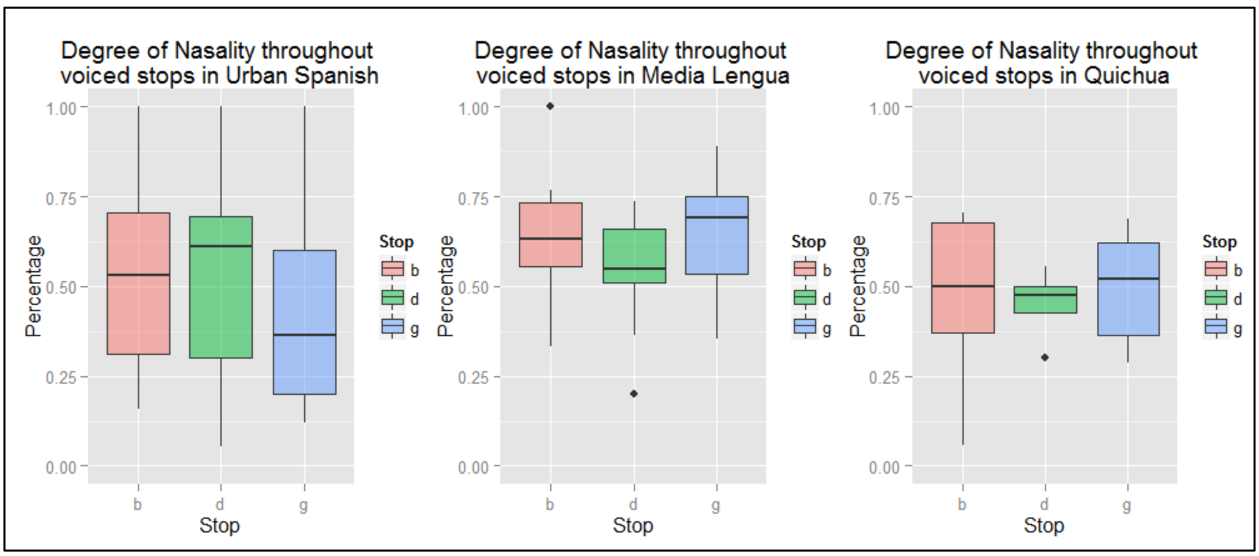


Figure 39: The graphs in this figure represent the proportional difference in nasal to oral information based on the number of frames containing a higher nasal to oral intensity compared to those with greater oral intensity throughout the negative VOT of the voiced stop. The graph on the left contains data from Urban Spanish, the middle graph from Media Lengua, and the right graph from Quichua.

Figure 40 represents the durational differences between stops containing some degree of nasality and those which are purely oral. First, it should be mentioned that due to the small number purely oral tokens in Urban Spanish and Media Lengua, there is little variation in the oral boxplots. In spite of the low number of oral tokens however, it is clear from all three graphs, that those containing some degree of nasality are substantially longer than those that do not. This suggests that nasality may be in part responsible for the long negative VOT durations found in all three languages.

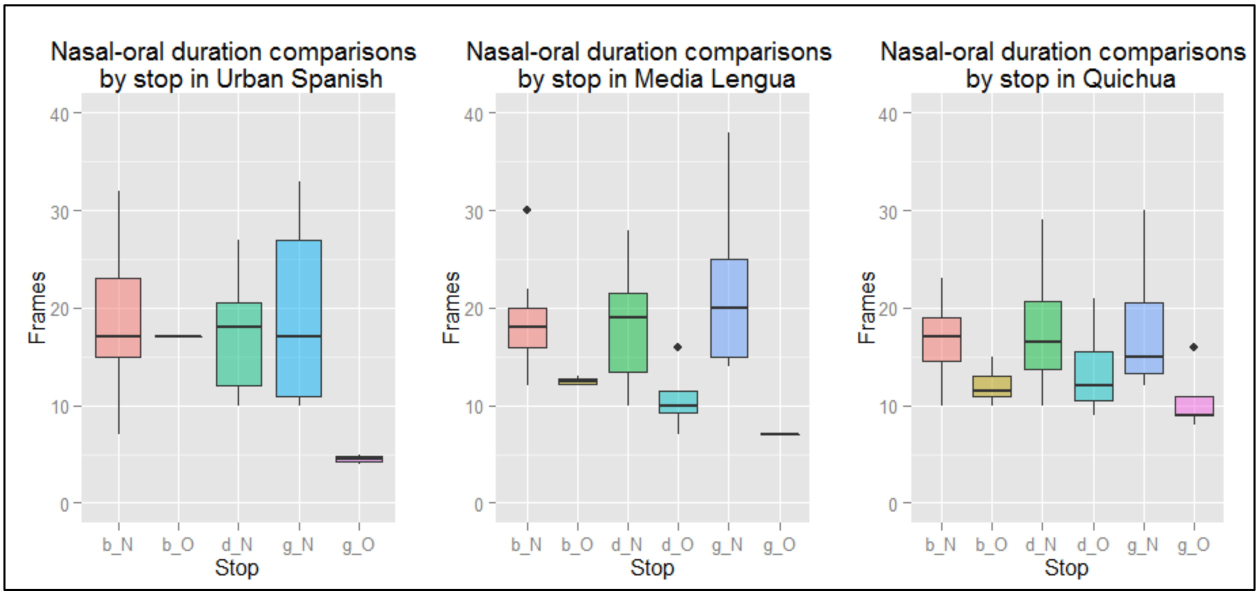


Figure 40: The graphs in this figure represent durational differences between stops containing some degree of nasality and purely stops. The graph on the left contains data from Urban Spanish, the middle graph from Media Lengua, and the right graph from Quichua.

Figure 41 provides data on where the nasal portion is located in the stop. The data was divided by: 'beginning' meaning the frames containing the nasal information initiated the stop followed by purely oral frames thereafter; 'middle' meaning the frames containing the nasal information were found in the centre of the segment and surrounded by oral frames on each side; 'end' meaning the nasal information lead into the next syllable; and 'entire segment' meaning each frame from the beginning of the negative VOT until the release contained nasal information.

As illustrated in the graphs, the overwhelming majority of stops contained nasal information at the beginning of the segment. For Urban Spanish, the second most common position for nasal frames was in segment-medial position. Media Lengua on the other hand, showed only four tokens that did not contain segment-initial nasalization and they were equally dispersed across the stops. Quichua only showed two positions, segment-initial and two tokens that remained nasalized for the entire length of the segment.

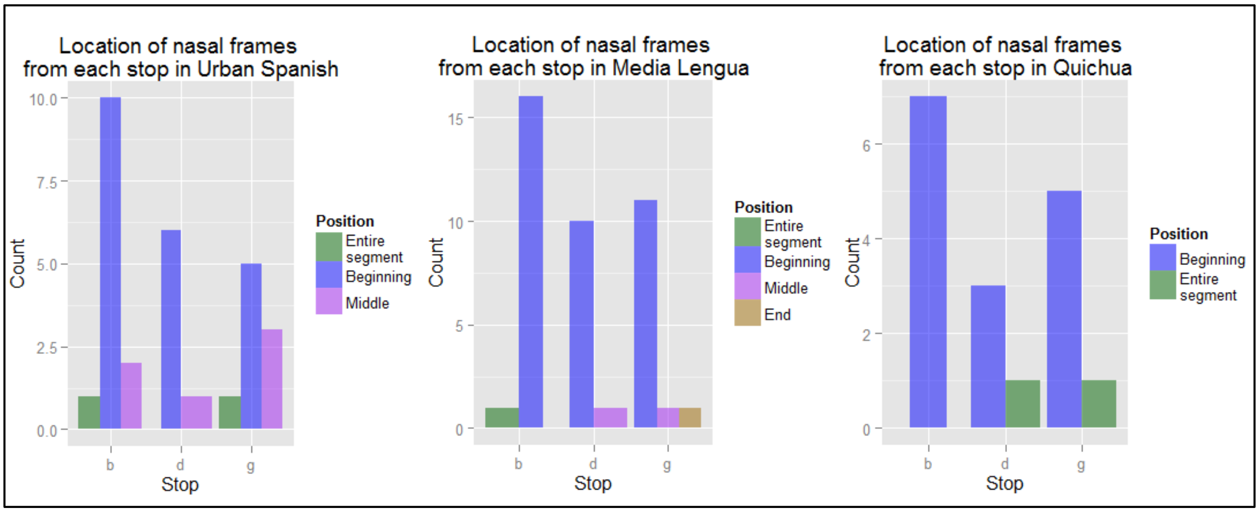


Figure 41: The graphs in this figure illustrate the location of the nasal frames in the stop—beginning (blue), middle (purple), end (brown), and the entire segment (green). The graph on the left contains data from Urban Spanish, the middle graph from Media Lengua, and the right graph from Quichua.

4.3 Chapter 4 summary

The goal of this experiment was twofold. The first was to test whether pre-nasalization was indeed an aspect of voiced stops in Urban Spanish, and if so, does this aspect carry over to Media Lengua and Quichua via Spanish borrowings. Since only one participant from each language took part in this experiment, these results are only meant provide general observations and trends in the data. The second was to implement the 'Earbuds' method and understand how its results can be used to gain a clearer picture of nasality.

Based the results, it is clear that nasality is a component of word-initial voiced stops in all three languages— in the vast majority of tokens in Spanish and Media Lengua and in roughly half of those in Quichua (see Figure 38). In the overwhelming majority of cases, nasality appeared in at the beginning of the negative VOT (see Figure 41) and lasted roughly on average just past the halfway mark through the segment (see Figure 39). These results support the findings of Solé and Sprouse (2011) that nasality is indeed a component of voiced stops in Spanish, which take place at the beginning of the segment. While they consider stop nasalization to be an aerodynamic mechanism for attaining a difference in transglottal airflow pressure for voicing, their data shows nasalization to be taking place before phonation with a momentary nasal burst. Nasality, as a component of stops in this experiment however, shows all three languages maintain nasality after the onset of phonation.

This discrepancy led to an impromptu perceptual task where three Ecuadorian speakers of Urban Spanish (2 native, 1 near native and two being linguists) were asked to listen to the first syllable of several word-initial [d] tokens where intensity from the nasal track was greater than that of the oral and lasted just over half the duration of the segment. All three agreed the tokens sounded like [^{n}dV]. When the word was revealed in full however, they clearly heard [dV]. This interesting phenomenon however, requires further investigation with a more controlled experiment.

Another interesting finding shows that the few stops which had no indication of nasality, were considerably shorter in duration than their nasal counterparts (see Figure 40). This suggests that nasality might be in part responsible for the long negative VOT durations in all three languages.

It should be noted that while the 'Earbuds' method results are tantalizing, is still in its early phrase of development. Therefore, it will, undergo further fine-tuning as the method becomes more applied as a fieldwork/ laboratory technique for studying nasality. Chapter 5 looks at variations in production of the stop consonants under analysis thus far.

Chapter 5

Stop variations

5 Introduction

One of the main objectives of this dissertation is a thorough description of stop consonants in and across Media Lengua, Quichua, Urban, Rural, and L2 Spanish. Now that it has been established that the voiced stop series has entered both Quichua and Media Lengua productively and perceptually[15], and pre-nasalization appears to be a component of stop production, I now turn to variations in stop production in word-initial position across all five language varieties. Based primarily on post-hoc observations, the questions of interest investigated in this chapter are: (1) Beyond canonical stops, how are speakers varying their stop production in word-initial position? (2) Do these variations differ across language varieties? (3) Could variation across the language varieties be the result of how of Quichua and Media Lengua speakers acquired the voiced stop series as a phonemic conflict site? (4) How do the rural varieties of Spanish (Rural Spanish and L2 Spanish) deal with influences from Quichua?

This chapter describes several allophonic and usage variations of the stop consonants under analysis throughout this dissertation. Variation covered here includes: devoicing (5.1), fricativization (5.2), affrication in [tɾ] clusters (5.3), deletion (5.4), the use of voiced stops as fillers (5.5), and post-[g] frication (5.6). Each section contains a spectrogram and wave form of the variation under analysis. Statistics are also used to seek out variation in and across languages if the variation is large enough to warrant such investigation. I should emphasize

[15] For the Quichua group, the stop voicing contrast appears to be better marked for the younger participants than for the older ones.

once again that these particular variations stem from post-hoc observations of the stop data taken during the VOT segmentation of the production data from Chapter 2. This also means the participants and elicitation conditions are identical to those found in Chapter 2 e.g., word-initial stops, from both the elicited and reading list data (see Section 2.2). The variations described here may also reveal elements of 'unguided' acquisition of voiced stops in Quichua, L2 Spanish, Media Lengua, and reverse influence in Rural L1 Spanish from Quichua.

5.1 Devoicing

This section provides distributional observations for inter-group variation regarding the devoicing of stops in utterance-initial position across all five language varieties. Figure 42 provides an example of Urban Spanish [d] devoicing to [t] in word-initial position. I used categorical criteria to determine whether a segment underwent devoicing. If the VOT was 0 or positive where the original Spanish cognate showed voicing before the release, it was deemed to be devoiced. On the other hand, if any degree of negative VOT was present, it was still considered to be a voiced segment. The goal of this section is to reveal if any of the language varieties under investigation have a higher propensity towards devoicing over another.

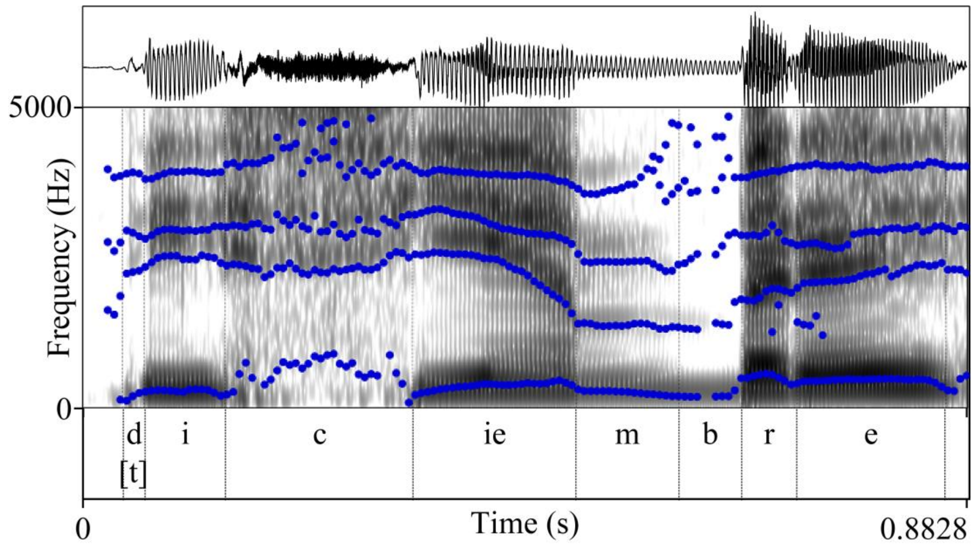


Figure 42: This utterance, produced by Urban Spanish consultant #101, shows word-initial [d] in the word *diciembre* 'December' was devoiced to [t].

Prior to conducting the statistical analyses in this section, voiced and devoiced segments were graphed to see whether devoicing was in fact variable enough to warrant searching for statistical differences across the language varieties. Figure 43 shows that the devoicing of voiced stops was quite rare in this dataset. Utterance-initial devoicing did not surface in the velar subset and never appeared in any Quichua voiced stop. For [b], Urban Spanish speakers showed only one instance out of 273; Rural Spanish showed 2 instances out 198, Media Lengua 1 instance out of 257, and L2 Spanish showed 1 instance out of 165. Given the low number of devoiced tokens for [b] in each language variety, statistical analysis was not undertaken.

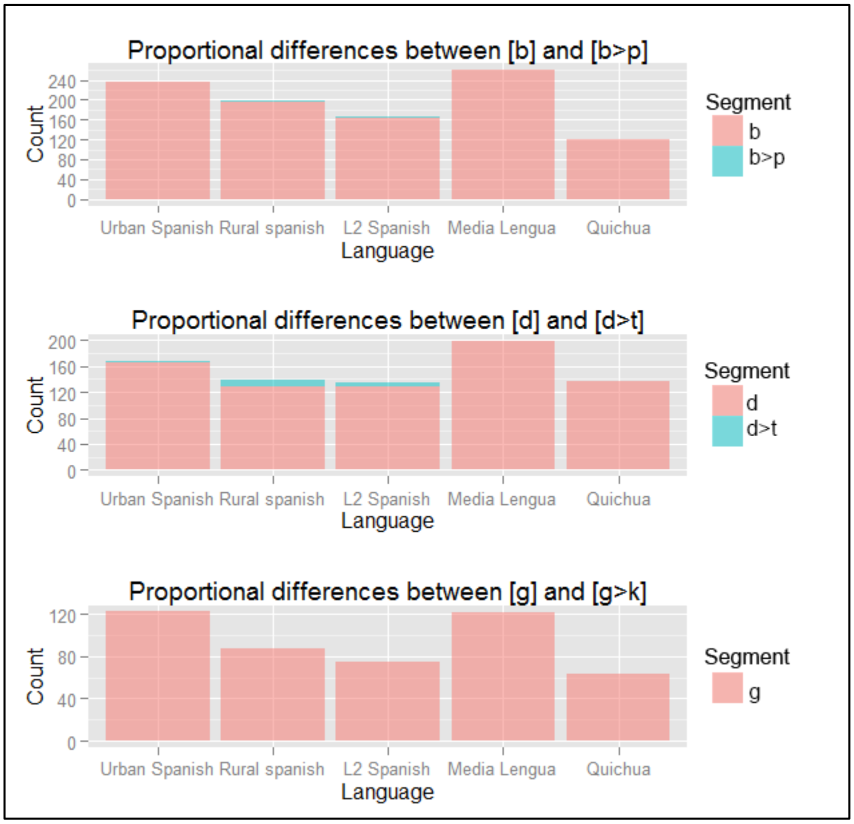


Figure 43: Proportional differences between voiced stops and devoiced stops in word-initial position from all five language varieties. The top chart illustrates the difference between [b] and [b>p], the middle chart shows the differences between [d] and [d>t] while the bottom chart contains [g] and [g>k].

The fact that there are so few instances of devoicing further supports the claim that speakers from all five language varieties, are contrasting stops by voice, both productively and perceptually. If no contrast were present, I would suspect a higher degree of devoicing for two reasons: (1) speakers would be interpreting both series as the same so there would be no need to make a systematic distinction between voiced and voiceless stops and (2) as mentioned in Solé and Sprouse (2011), negative voicing in stops is more difficult to sustain. Therefore, speakers would probably prefer the unaspirated variant if there were a lack of contrast.

5.2 Fricativization

Another phonetic process which was apparent while segmenting the data was that of weakened voiced stops. The weakening of a stop consonant, also known as lenition, fricativization or spirantization, is a common synchronic and diachronic phonological process in which a stop consonant becomes a fricative. This section explores inter-group variation of voiced stop weakening in word-initial position across all five language varieties. Figure 44 provides an example from Quichua of [g] weakening to [ɣ] in word-initial position. As a phonemic conflict site in Quichua, Media Lengua, and L2 Spanish, I posit weakening may be the result of acquiring the non-native voiced stop series under 'unguided' conditions which tolerated free-variation between weakening and the full release of stops to cope with this foreign series of stops. Weakening seems like a probable alternative since voiced stops with negative VOT are often difficult to sustain cross-linguistically as discussed in Solé and Sprouse (2011). Voiceless stops in certain Spanish dialects (Central Colombian and Northern Spain) have also been shown to undergo weakening in intervocalic position as described in A. Lewis (2001). I used categorical criteria to determine whether a segment undergoes weakening. If there was any indication of a loose supralaryngeal construction e.g., absence of release at the onset of the vowel along with a gradient F1 and F2 formant transitions into the vowel for voiced stops, the stop was deemed to be weakened (Figure 44). On the other hand, if a release was observed at or near the vowel onset and any degree of prevoicing or aspiration was present preceding the release, either in the spectrogram or wave form, it was deemed a full stop.

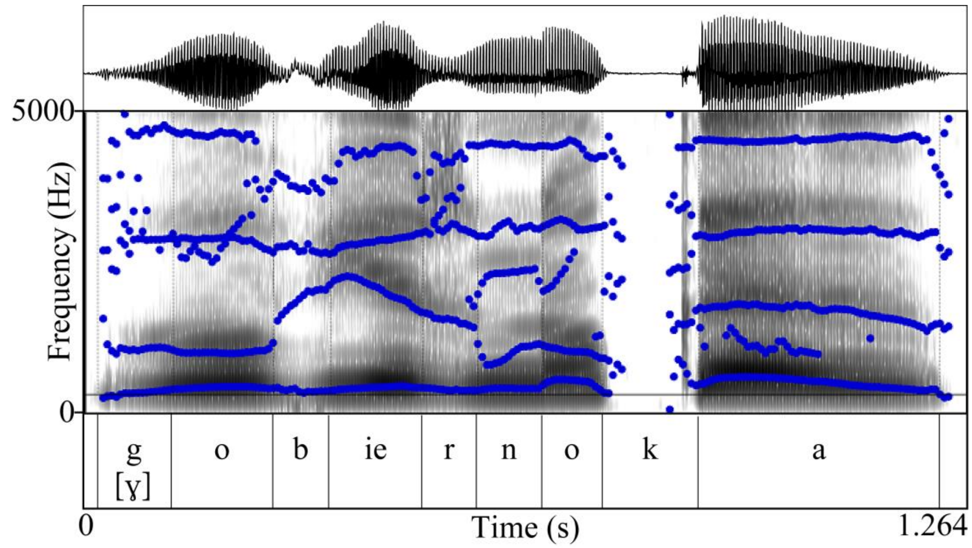


Figure 44: This utterance, produced by Quichua consultant #65, shows word-initial [g] in the word *gobiernoka* 'government' was weakened to [ɣ].

Prior to conducting the statistical analyses in this section, each canonical and weakened stop was graphed to see whether weakening was in fact variable enough to warrant searching for statistical differences across the language varieties. Figure 45 shows that weakening of voiceless stops in word-initial position was extremely rare in this dataset. Both Urban and Rural Spanish along with Quichua showed no instances of word-initial stop weakening while Media Lengua showed three out of 1740 tokens— two instances of [p] to [ɸ] and one instance of [k] to [x]. L2 Spanish also showed two instances of weakening out of 184 tokens— one instance of [t] to [θ] and one of [k] to [x]. Due to the lack of variation in the few instances of voiceless stop weakening in the dataset, this series will not undergo statistical analysis. I therefore conclude that stop weakening in word-initial position is a rare phenomenon in and across all five language varieties under analysis in this study. Since spontaneous data was not analyzed however, I do not consider this a definitive conclusion as there may be a higher degree of voiceless stop weakening in this type of discourse setting.

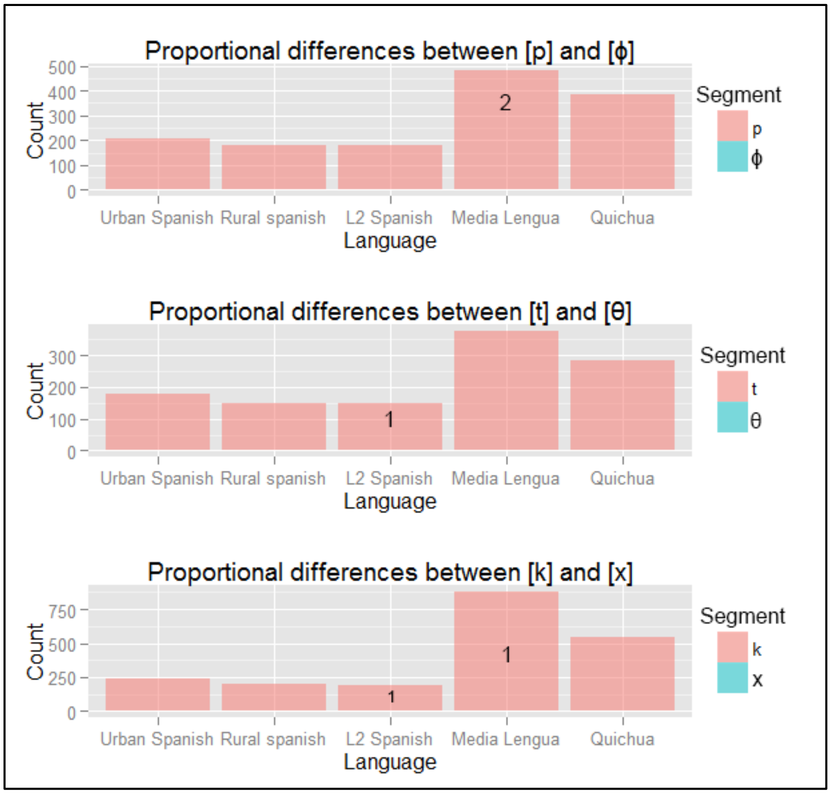


Figure 45: Proportional differences between canonical voiceless stops and weakened voiceless stops in word-initial position from all five language varieties. The top chart illustrates the difference between [p] and [ɸ], the middle chart shows the differences between [t] and [θ] while the bottom chart contains [k] and [x].

For the voiced series however, statistical analysis is warranted due to the large variation and a high number of instances of stop weakening. The goal of this analysis in this section is to identify which language varieties have a higher propensity towards stop weakening statistically.

5.2.1 Voiced stop weakening results

The goal of this analysis is to test whether there is a statistical difference between the frequency of voiced stop weakening across all five language varieties, all three places of articulation, and if any demographic or linguistic factors affect weakening e.g., age, gender, or phonological environment. The results from this analysis should provide further information relating to the degree of assimilation of the stop in Quichua, L2 Spanish, and Media Lengua to either the rural or urban varieties of Spanish. I hypothesize that Quichua and L2 speakers will show a significantly greater free variation when producing word-initial [g] based on number of instances identified in the dataset while Media Lengua will not (see Figure 46, Figure 47, and Figure 48).

For the statistical model, I built a generalized (logistic) linear mixed effects model fitted by the Laplace approximation to test the production of voiced stop consonants regarding the frequency of weakening versus canonical forms. This logistic regression helps answer the question is there a difference among the predictors at the intercept? For ordinal categorical predictors such as *age*, the question remains the same, but focuses on whether the frequency of weakened stops increases or decreases across the factors of age. In addition, to test whether a specific demographic or linguistic predictor applies to only specific languages, the model building process tested interactions between *language* and these predictors. This model was created in R 3.1.2 with the *glmer* function of the *lme4* package (Bates, 2012). Ninety-five percent confidence intervals (CI_{95}) were computed using the Wald test. The random effects *speaker* and *word* were taken into account in the model. Since the Spanish varieties only consisted of the wordlist data, I chose only use the wordlist data from Quichua and Media Lengua to offset some of the variation for this inter-group analysis. I also considered the following predictors when building the model (fixed effects): *language group* (Urban Spanish, Quichua, and Media Lengua), *age*, *gender, stress,* and *post segment.* The fixed effects: *level of Spanish, education, utterance position,* and *language of origin* are excluded from these models due to homogeneity of the predictors in one or more language varieties. The language predictors which are non-significant are removed from the final model. These results should provide a picture as to how much weakening varies across the language varieties under analysis and how they compare and interact with one another along the contact continuum in Figure 1.

We are most interested in the coefficient estimate (β), which is a conservative estimate of the average difference in log-odds (a measurement of probability) among the predictors in question. For example, a positive log-odd result for *language* means the likelihood of a specific language group producing a weakened stop over a canonical stop increases by *x* log-odds. The intercept can be defined as our 'starting point' or 'base value' in log-odds if none of the predictors were not applicable i.e., it is a 'basic' or 'average' value of the subset of data where all the predictors are their zero/ baseline value.

Figure 46, Figure 47, and Figure 48 contain bar graphs of the raw data based on place of articulation—[b-β], [d-ð], and [g-ɣ] in order to provide a visual representation of the number of canonical stops compared to the number of weakened stops. Unlike in Chapter 2, density and boxplots graphs are not used since they are preferred for averaging the distribution of continuous data and not raw data quantity counts.

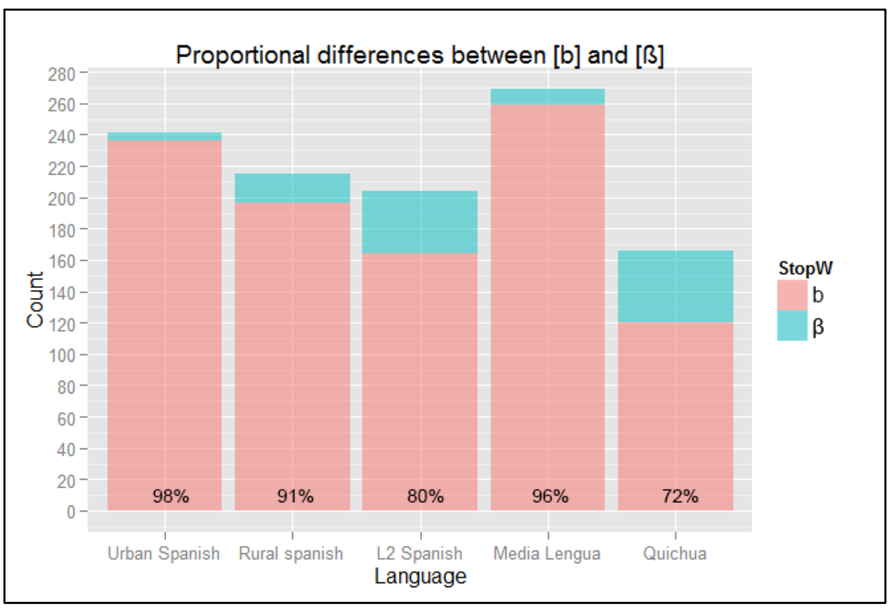


Figure 46: Proportional differences between the canonical voiced bilabial stop and its weakened counterparts.

Figure 46 shows that both Quichua (20%) and L2 Spanish (28%) speakers have a higher tendency to weaken [b] than Media Lengua (4%) and Urban Spanish (2%), while Rural Spanish (9%) falls in the middle.

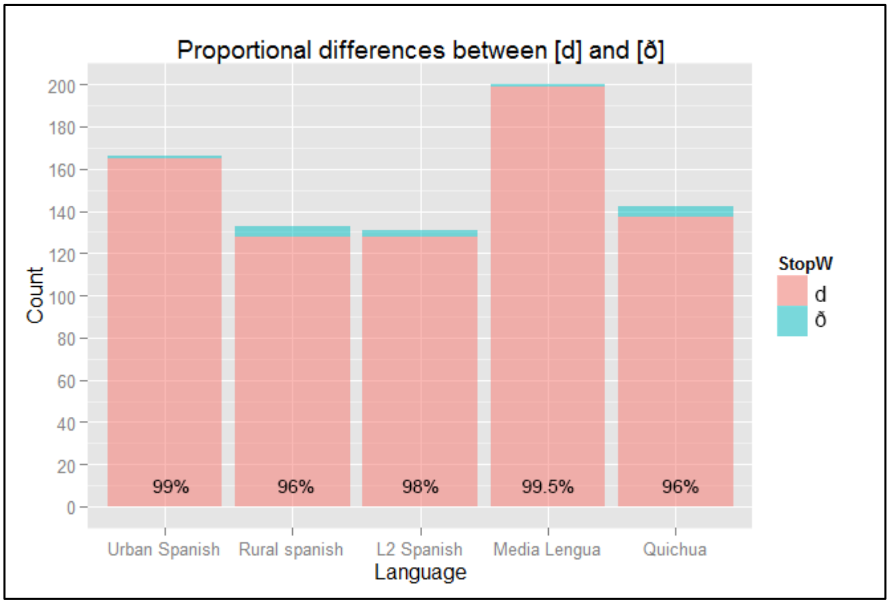


Figure 47: Proportional differences between the canonical voiced coronal stop ([d]) and its weakened counterparts.

Figure 47 on the other hand, shows that the weakening of [d] is less common compared to that of [b]. Rural Spanish showed the highest tendency of weakening which took place only 4% of the time in this dataset.

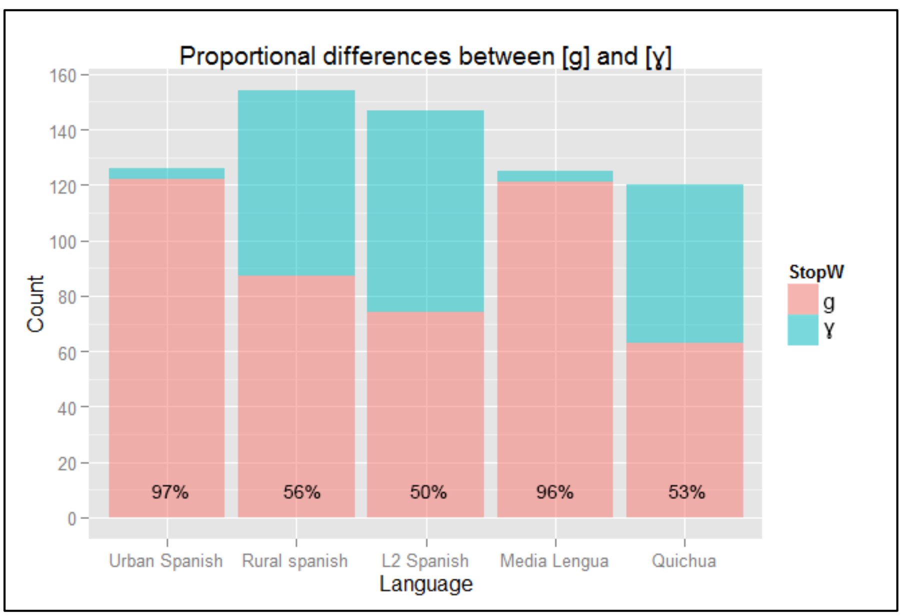


Figure 48: Proportional differences between the canonical voiced velar stop and its weakened counterparts.

In Figure 48 on the other hand, weakening is far more apparent for [g]. The data presented here shows that Quichua (47%), L2 Spanish (50%), and Rural Spanish (44%) have a very high tendency of velar stop weakening which reaches or nears 50%. Urban Spanish (3%) and Media Lengua (4%) speakers on the other hand show the opposite trend with very little instances of [g>ɣ]—similar to the tendencies found for the voiced bilabial and coronal stops.

Table 54 contains the results from the generalized linear mixed effects model using *weakened vs. canonical stop* as the dependant variable. Based on the model results, the intercept contains the following baseline categories: the Media Lengua and Urban Spanish stop production (which were non-significantly different from each other), and bilabial and coronal production (which were also non-significantly different from each other).

The intercept, with a 'base' value of -8.2 log-odds, suggests the probability that Media Lengua and Urban Spanish speakers produced canonical stops over weakened stops voiceless stop was 99.97% of the time. When a low vowel ([a]) follows a voiced stop, the vowel was found to be responsible for increasing the probability of weakened stop production by 0.1 log-odds or by 0.07% (-8.2 *intercept* + 1 *low vowel*). Velars were shown to weaken voiced stops with a higher degree of frequency than both bilabial and coronal stops with a log-odds value of 3. Rural Spanish speakers were more likely to produce a weakened form of a voiced stop compared to the other groups of language speakers, with a log-odds value of -3.5 (-8.2 *intercept* + 4.7 *Rural Spanish*).

Turning to interactions, there was a significant interaction between *Quichua* and *age* suggesting that the tendency to weaken stops increases by 0.091 log-odds per year (25 in total). Therefore the oldest speaker would hypothetically have a higher chance of weakening by 2.18 log-odds (0.091 *Quichua & age* * 24 *years in total*) than the youngest speaker. The same interaction was also found between *L2 Spanish* and *age* suggesting that the tendency to weaken stops increases by 0.1 log-odds per year (25 in total). Therefore the oldest speaker would hypothetically have a higher chance of weakening by 2.4 log-odds (0.1 *L2 Spanish & age* * 24 *years in total*) than the youngest speaker.

	Estimate	Std. Error	2.5%	97.5%	z-value	Pr(>|z|)
(Intercept)	-8.2	1.4	-10.9	-5.5	-6.0	1.47E-09
Low vowel [a]	1.0	0.28	0.45	1.6	3.6	0.00039
Velar stops	3.0	0.30	2.4	3.5	9.8	< 2e-16
Quichua	1.5	2.0	-2.4	5.4	0.76	0.45
Age	-0.0026	0.03	-0.059	0.054	-0.09	0.93
L2 Spanish	0.98	2.0	-2.9	4.9	0.49	0.63
Rural Spanish	4.7	0.85	3.1	6.4	5.6	2.51E-08
Quichua*Age	0.091	0.04	0.003	0.18	2.0	0.043
L2 Spanish*Age	0.10	0.05	0.013	0.19	2.2	0.025

Table 54: Generalized linear mixed effects model results for weakened and canonical stop forms

Without combining the predictors, the model appears to describe the raw data presented in Figure 47 (that of [d]) more than those of Figure 46 ([b]). Since there was a non-significant result between the bilabial and coronal voiced stops regarding the frequency of weakening, this model does not represent the greater instances of [b] weakening over that of [d] shown in the aforementioned figures. In order to for this model to approach the raw data for voiced velars in Figure 48 however, it is possible to combine the appropriate predictors in the model. For example, to calculate the best possible scenario that velars in Quichua will weaken to a similar degree as those shown in Figure 48, the following predictors need to be combined: *intercept* + *low* + *velar* + *Quichua* + *age* + (*Quichua & Age**23). This result is a log-odds value of -0.61, which only provides a probability result of 35% that Quichua speakers will weaken a voiced velar stop.

The best case scenario for Rural Spanish, which is non-significantly affected by age, provides the best approximation to the raw data for voiced velars presented in Figure 48. By combining the following predictors: *intercept* + *low* + *velar* + *Rural Spanish*, the log-odds result reaches 0.5, which suggests Rural Spanish speakers weaken the voiced velar stop 62% of the time.

The results from this section support my initial hypothesis that Quichua and L2 speakers have more free variation when producing word-initial [g], in fact far more variation compared to [b] and [d], without taking into account *age* and *language* interactions. The significant difference between how often Media Lengua/ Urban Spanish speakers and Quichua/ L2 Spanish speakers weaken [g] suggests that unguided learning allowed for Quichua and L2 Spanish speakers to deal with this phonemic conflict site by tolerating weakening as a variation of the word-initial [g] stops. Rural Spanish speakers on the other hand, show a similar trend to that of Quichua and L2 Spanish speakers though there was a non-significant interaction with the *age* predictor. This suggests there is no attempt by the younger generation to reduce the number of weakened voiced stops. I have two hypotheses as to why the Rural Spanish speakers weaken voiced stops with a higher degree of frequency that Urban and L2 Spanish stops and across all the age groups. In the first, I posit that since many L1 Rural Spanish speakers are the successors of Quichua speakers, the higher rate of [g] weakening may have been passed down from older generations who, as the data suggests, had a higher rate of stop spirantization. In the second, I posit that since the majority of contact outside their L1 Spanish language niche is with L2 speakers, this characteristic may have carried over or aided in maintaining the weakened variant of [g].

Media Lengua presents an interesting case being that the degree of weakening across all three places of articulation is quite low—comparable to that of Urban Spanish. This suggests the voiced stop series may have been acquired under different conditions or perhaps from a more urban variety of Spanish. This would make sense if the originators of Media Lengua acquired the Spanish vocabulary in a more urban-like setting. I expand more on this hypothesis in Chapter 6.

5.3 Affrication of [tɾ] clusters

This brief section provides post-hoc observations of Spanish-derived word-initial 'tr' clusters; therefore this specific variation was not intentionally elicited. Because of this, data was not available for all three Spanish varieties in this study.

Fifty-six word-initial 'tr' clusters were elicited during Media Lengua (46) and Quichua (8) elicitation sessions. Every instance of Spanish borrowings beginning with a 'tr' cluster e.g., *trabajo* 'work', *trago* 'alcohol', and *trigo* 'wheat', underwent affrication. Here, I use the voiceless retroflex [tʂ] to represent this affricate as per Black, Bolli, and Eusebio (1990). Figure 49 provides an example from Quichua of 'tr' having undergone affrication to [tʂ] in word-initial position. Since both Media Lengua and Quichua behave similarly, this suggests speakers of both languages adopted a similar strategy for dealing with this word-initial onset. This section requires further empirical analysis, especially with the Spanish varieties in order to gain a clear picture of possible contact-induced change.

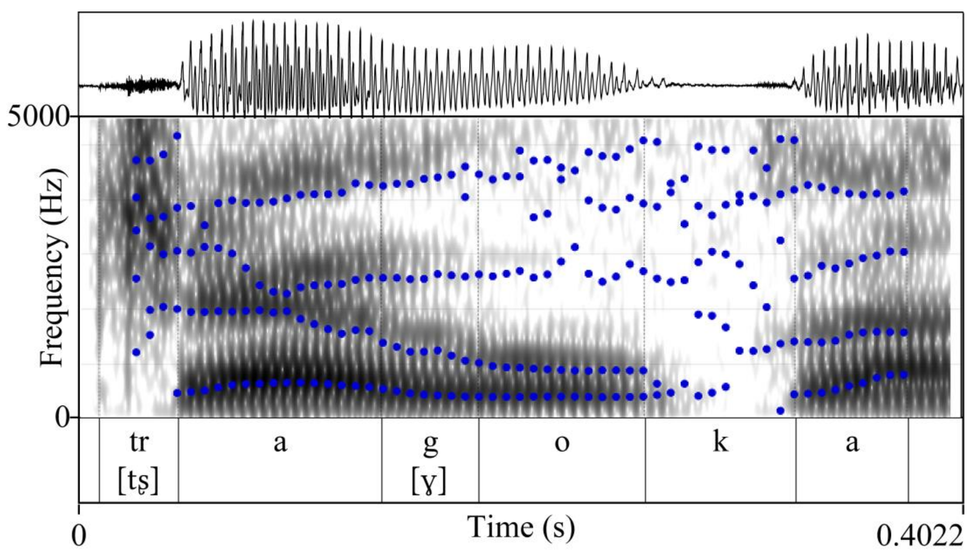


Figure 49: This utterance, produced by Quichua consultant #86, shows the word-initial /tɾ/ cluster in the word *tragoka* 'alcohol' underwent affrication to [tʂ].

Based on my own impressionistic observations, L2 Spanish speakers often make no noticeable shift towards Spanish in the pronunciation of 'tr' clusters. Rural monolingual Spanish speakers on the other hand, appear to produce a stop-tap sequence similar to 'pr' and 'kr' clusters which play out as: stop release + approximant-like tap aperture + tap closure + vowel onset (Figure 50).

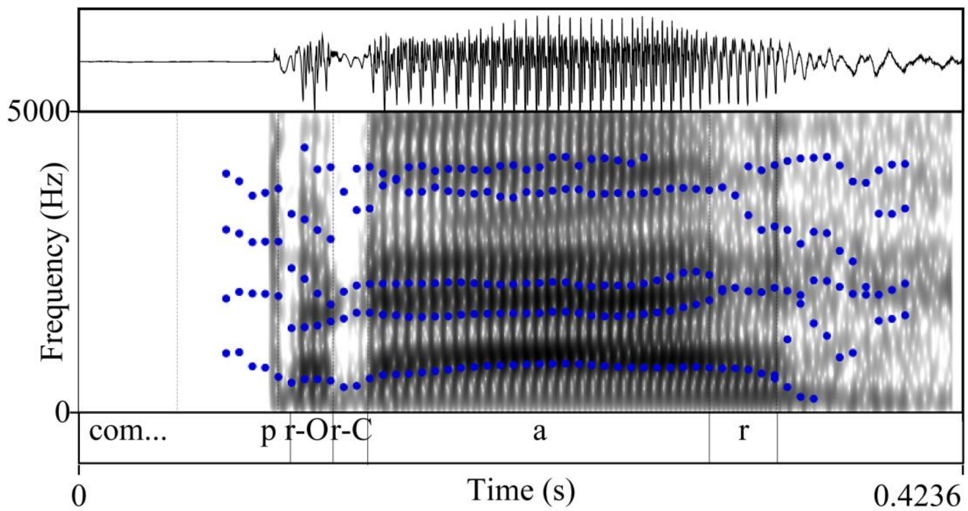


Figure 50: This utterance, produced by Rural Spanish consultant #87, shows a word-medial /pɾ/ cluster in the word *comprar* 'buy'. r-O = tap aperture, r-C = tap closure.

After having conducted the initial analysis, I was able to elicit an example of a word-initial 'tr' cluster from a speaker of Urban Spanish, which clearly shows the same stop-tap release + approximant-like tap aperture + tap closure + vowel onset pattern as revealed in the 'pr' word-internal cluster from Rural Spanish speaker #87, shown in Figure 50. Here, Figure 51 shows the expected stop release + approximant-like tap aperture + tap closure + vowel onset pattern which differs from the stop release-frication pattern shown in Figure 49. It should also be noted the word elicited in Figure 51, *trago* 'alcohol', is the Spanish cognate elicited in Figure 49 *tragoka* 'alcohol'.

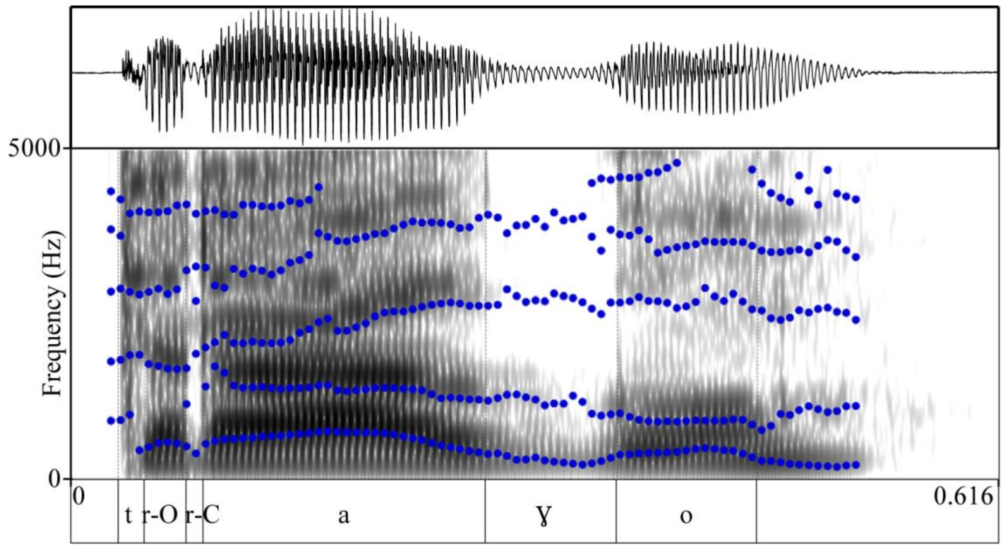


Figure 51: This utterance, produced by Urban Spanish consultant #107, shows the word-initial /tɾ/ cluster in the word *trago* 'alcohol' shows a clear stop release followed by an approximant-like section caused by the aperture of the tap then a brief moment of silence during the closure of the tap, and finally concludes it with the onset of voicing of the vowel.

5.4 Elision

This section provides brief post-hoc observations of deleted stops. Figure 52 shows an example of Rural Spanish [g] deleted from word-initial position in the word *gustar* 'like'. From the entire dataset, only three speakers from the Rural Spanish group were shown to have elided word-initial stops [b] and [g] (Figure 53). While only 7 total stops underwent elision, the fact that this phenomenon was produced by three different speakers (#92, #93, #95,) from the Rural Spanish group, during what might be considered a semi-formal elicitation setting, might suggest this phenomenon is more common in informal spontaneous speech. While the ages of these speakers varied from 34-56, all were males which may also suggest a gender bias towards elision. It should be noted that other demographic predictors do not seem to play a role in the outcome of deleted stops e.g., participants #93 and #95 were included in the lower education bracket while #92 fell in the higher education bracket. I used categorical criteria to determine whether a segment underwent elision. If there was any indication of a stop release, fricativization, or any other any other segmental activity before the vowel onset e.g., aspiration, a segment was deemed to be present (non-elided). On the other hand, if there was a complete absence of segmental activity before the onset of voicing, either in the spectrogram or wave form, the stop was deemed to have been elided.

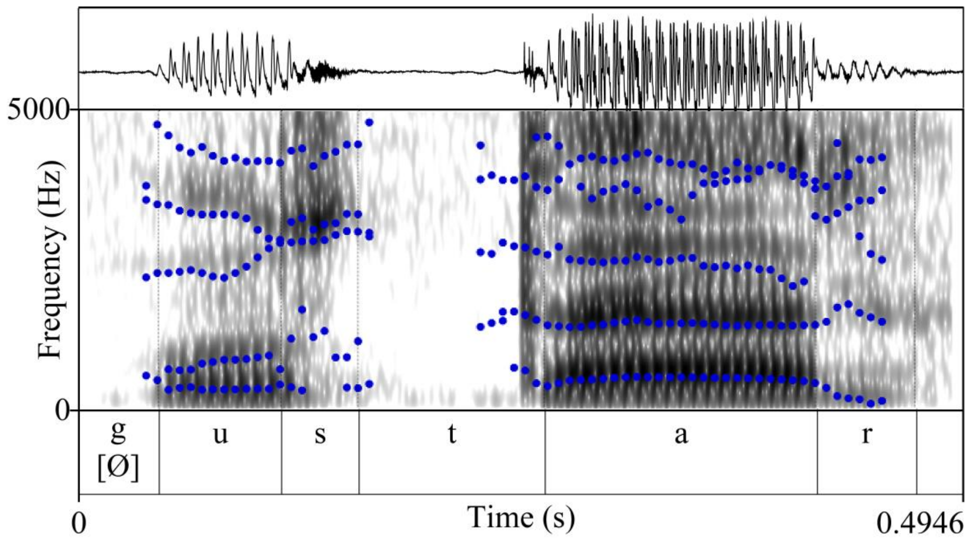


Figure 52: This utterance, produced by Rural Spanish consultant #92, shows word-initial [g] in the word *gustar* 'to like' was not released.

Figure 53 shows the distribution of the deleted stops with in Rural Spanish. No instances of [d]-elision appeared in this dataset, while four instances of [g] appeared followed by three instances of [b]. Like the previous section, this area of investigation requires further empirical analysis, especially with less formal data, preferably gathered from spontaneous speech, to see whether or not elision is in fact a common allophonic realization of stops.

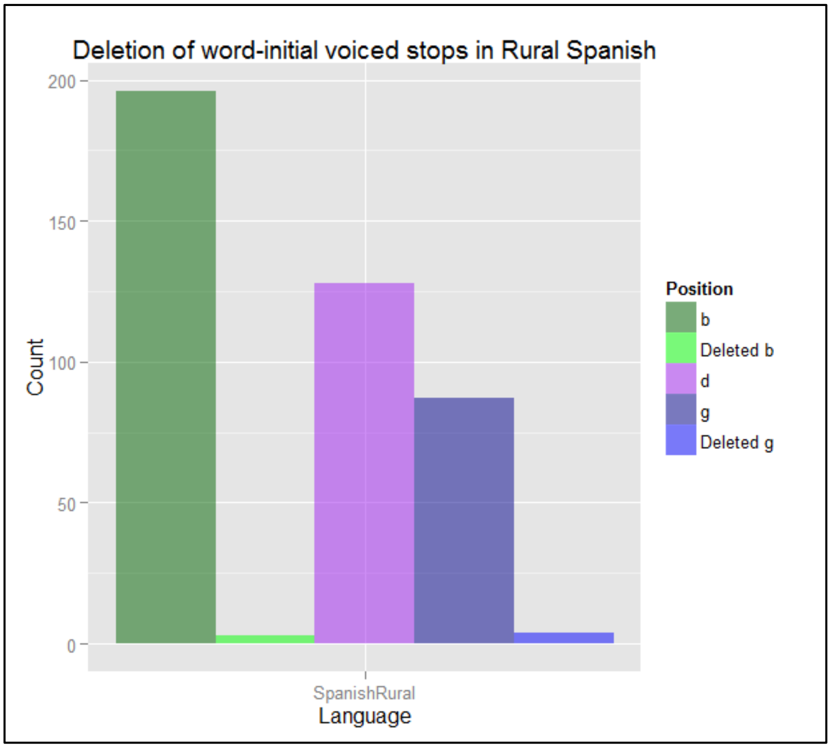


Figure 53: This figure shows the number of deleted stops compared to canonical stops in Rural Spanish.

5.5 Voiced stops as fillers

This brief section provides another post-hoc observation, but this time regarding a curious finding suggesting speakers might be taking advantage of the long negative VOTs in voiced stops as a type of word-internal segmental filler, akin to vowel or continuant lengthening e.g., the prolonged 's' in *dissssssertation.* Figure 42 shows an example of a [b] in Media Lengua with an extremely long VOT of 300 ms produced right after the filler *mmm*....

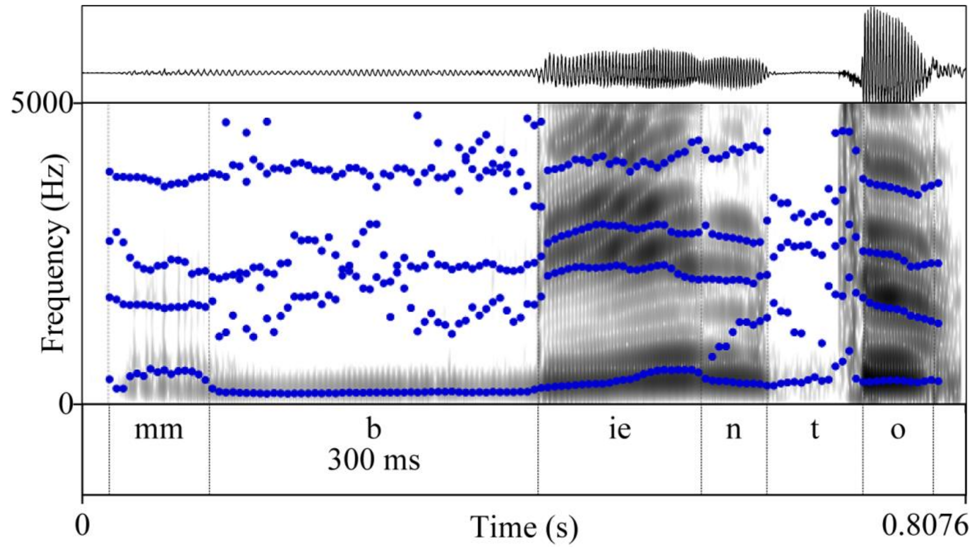


Figure 54: This utterance, produced by Media Lengua consultant #41, shows an abnormally long negative VOT in word-initial /b/ in the word *viento* 'wind' following a brief filler annotated as *mm*.

Fillers are described as individual utterances e.g., *hmmm, huh, umm,* often used to hold the floor during moments of high cognitive processing. Their word-internal counterparts however, often known as prolongations or lengthened segments, are defined as a type of non-disordered disfluency which causes speech segments to be lengthened beyond their expected duration given the specific linguistic context (McAllister & Kingston, 2005). In spoken languages, this type of disfluency is most common with segments such as fricatives and vowels, which are conducive to lengthening since the vocal tract articulators are organized in such a way to allow for continuous airflow from the lungs. In this case however, it appears that speakers can take advantage of the long word-initial negative VOT of voiced stops to benefit from additional cognitive planning. In this case, an increased cognitive load placed on some speakers (often those with lower reading ability) who have been asked to produce words which appear on a computer screen in a semi-formal setting.

It should be noted that disfluent lengthening was more common in weakened word-initial voiced stops, but the instances of prolonged voiced stops under analysis here all show a release before the following segment. That being said, since this is a post-hoc analysis, fillers were not consistently marked in the dataset.

As a follow up to this observation, I searched for the number of negative VOT durations over 2 standard deviations from the average in milliseconds (ms) of each stop in each language documented in Chapter 2. With 88 instances, lengthening of a negative VOT may in fact be a common strategy for dealing with moments requiring additional cognitive processing. I hypothesize that since this was a word-reading task, with the segments in question found in word-initial position, there may be a higher chance of encountering prolongations. This is based on the observation that speakers appear to often take an additional moment to sound out or mentally verify a word before fully uttering it—especially in cases where speakers had lower levels of literacy. This hypothesis is further strengthened by the fact that disfluencies are also more common in utterance-initial position (Bortfeld, Leon, Bloom, Schober, & Brennan, 2001)—the same position where lengthened negative VOTs are observed. Table 55 details the number of tokens greater than 2 standard deviations from the average VOT duration from section 2.2.3.

	Urban Spanish	Rural Spanish	L2 Spanish	Media Lengua	Quichua
[b]	9 < -124 ms	7 < -158 ms	6 < -149 ms	11 < -178 ms	4 < -197 ms
[d]	7 < -115 ms	5 < -154 ms	5 < -160 ms	7 < -162 ms	7 < -183 ms
[g]	4 < -114 ms	4 < -162 ms	3 < -158 ms	8 < -181 ms	1 < -162 ms

Table 55: Number of tokens greater than 2 standard deviations from the average VOT detailed by language and voiced stop.

It might seem counter intuitive that an individual is able to sustain a continuous airflow during complete occlusion of the vocal tract— a fundamental characteristic of any stop consonant. Based on the nasality results from Chapter 4 however, it is clear that the vast majority of stop consonants in the dataset from Urban Spanish, Media Lengua, and Quichua maintain some degree of velum aperture during stop production. This would allow for the increase of pressure, inherently associated with stops, to be constantly relieved through the nasal cavity. The results from Chapter 4 also suggest that the velum aperture is often maintained just beyond the 50% point of the total consonant duration, but in some cases up to 75% or more, thus allowing a speaker to prolong the segment until (s)he decides to continue the speech act. Since the majority of stops show this nasal-to-oral pattern in voiced stop production, after the velum closes making the rest of the segment completely oral, pressure can then be built-up for the subsequent release burst. While this section appears to support findings in Chapter 4, further empirical analysis specifically focusing on gathering disfluent voiced stop tokens is required, especially from spontaneous speech.

5.6 Post-[g] frication

The final section of this chapter looks briefly at post-frication following the release of [g] in all five language varieties. Figure 55 shows an example of post-[g] frication noise on the order of 27 ms following [g] in the word *gol* 'goal' from Media Lengua. In nearly every case of word-initial [g], turbulent airflow was detected in all five language varieties. Because this frication noise is not a characteristic of any other voiced stop, and co-articulation conditions are not conducive to the voiced-voiceless-voiced pattern created during this particular segment, I suspect the cause is an aerodynamic phenomenon. Because the velar place of articulation of [g] is further retracted that that of the bilabial and coronal stops, the reduced space behind the occlusion causes a build-up of greater pressure which requires a longer equalization time after release.

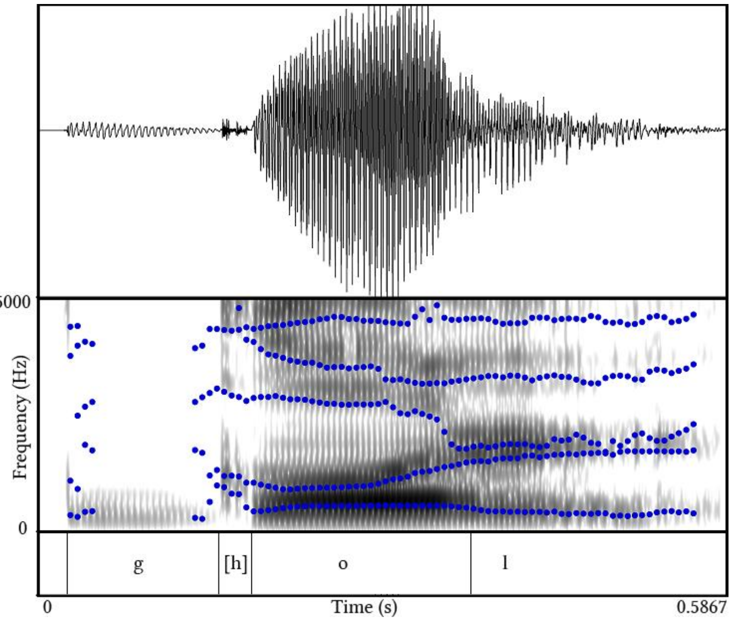


Figure 55: This utterance, produced by Media Lengua consultant #54, shows a region of frication noise 27 ms long after the release of word-initial [g] in *gol* 'goal'.

As revealed in Figure 33 and Table 43 from Chapter 3, voiced velar stop perception, for all the participants in each language group, was affected by this frication noise along a 10-step continuum. Based on the individual speaker results, almost all Urban Spanish speakers had varied responses (nearing the 50% point) or chose [g] over [k] during steps 6-8 where the frication noise was the only VOT portion along the continuum. On the other hand, only about half of the Quichua (4 of 10) and Media Lengua (7 of 11) speakers showed the same tendency. Several participants (from all three languages) reported that this this frication noised sounded more like [t] than [k], which made the target word *casa* 'house' appear perceptually as *tasa* 'cup'. These comments strengthen the fact this is probably an aerodynamic effect since contradictory linguistic information is transferred during the post-release phase of this stop—an event which is non-conducive to clear comprehension.

5.7 Chapter 5 summary

The goal of this chapter was to investigate and document stop variations observed throughout the data gathered for this dissertation. The first variation explored in this chapter focused on the devoicing of utterance-initial stops. While no significant difference was found across the language varieties and only [d] showed any real variation, Rural Spanish speakers devoiced [d] once in every 77 utterances and L2 Spanish speakers devoiced [d] once in every 91 utterances.

Looking at the fricativization of stops, it was found that the voiceless series in all five language varieties did not undergo weakening in word-initial position, no matter the word's position it the utterance, except in rare occasions. The voiced series on the other hand shows a great deal of variation across all five language varieties. The most consistent stop was [d] which showed very little weakening and little disparity between the numbers of canonical and weakened forms across the language varieties. The voiced stops [b] and [g] on the other hand show a greater degree of variation. The greatest contrast was found between Urban Spanish and Rural Spanish. One of the more unexpected results to come out of this analysis is the fact that in all three stops, Media Lengua speakers appeared to avoid weakening almost to the same extent as Urban Spanish speakers while Rural Spanish speakers weaken their stops to almost the same degree as Quichua and L2 Spanish speakers. If it is in fact the case that Media Lengua arose from contact with Rural Spanish, it is doubtful speakers are attempting to produce more canonical stops as a result of Urban Spanish influence, though there appears to be an effort to avoid weakening in utterance-initial position. I hypothesize in Chapter 6 however, that Media Lengua could have indeed arose from contact with Urban Spanish in the province of Cotopaxi.

The next stop variation under analysis in this chapter affected word-initial 'tr' clusters from Spanish borrowings in Quichua and Media Lengua. In this case, all word-initial 'tr' onsets underwent affrication to the voiceless retroflex [tʂ]. Unfortunately, being a post-hoc analysis, words containing word-initial 'tr' were not gathered for the Spanish varieties. Only impressionistic observations could be made regarding Urban, Rural, and L2 Spanish suggesting L2 Spanish speakers also affricate 'tr' while Rural and Urban Spanish speakers maintain distinct [t] and [ɾ] segments. In order for these impressionistic observations to be verified, further empirical analysis is required.

Following the 'tr' analysis, section 5.4 looked at instances of voiced stop deletion. While only manifested by three Rural Spanish speakers, the elicitation sessions were recorded in semi-formal settings, which often prompt speakers to use more careful speech than would otherwise be used in more informal settings. It may be of interest to future investigators to look at spontaneous speech in a less formal setting and see whether or not this phenomenon is more frequent than the current dataset suggests.

One of the more interesting instances of variation to come out of this chapter suggests that speakers may take advantage of voiced stops to prolong speech during moments of disfluency, similar to that of a filler or a lengthened vowel or fricative. This can be seen in voiced stop segments with extremely long VOTs— often beyond two standard deviations from the mean average. I posited that the only way a speaker can sustain constant negative VOT voicing, during complete occlusion of the oral tract, is by allowing pressure to be released into the nasal cavity. This hypothesis is supported by findings from Chapter 4 suggesting that velum lowering is indeed an articulatory gesture of voiced stop consonants in Urban Spanish, Media Lengua, and Quichua. The fact that speakers can take advantage of a word-initial negative VOT as a filler may be more beneficial than using a standard independent filler e.g., *mmm,* for holding the floor since the utterance has already been initiated. This may communicate to the listener that content is being produced rather than an attempt to buy time by filling a breakdown in the speech stream with noise.

The last section of this chapter described post-[g] frication as seen in Figure 55. Being that [g] is the only voiced stop to show post-frication, along with its retracted position, and the fact it is not conducive to fluid co-articulation transitions (namely the [+voice]-[-voice]-[+voice] transition), I determined the effect was more likely aerodynamic in nature rather than linguistic. This can be explained by the reduced space behind the occlusion which causes a greater build-up of pressure requiring longer equalization after the release.

The perceptual experiment from Chapter 3 used a 10-step continuum to test whether speakers of Media Lengua and Quichua perceived a clear contrast between [k] and [g] since, traditionally, there is no phonemic voicing stop distinction in Quichua. Since the method of constructing the continuum began at the longest negative VOT, to the moment of voicing (0 VOT), then to the longest positive VOT duration, steps 6-8 passed through this region of frication noise. As seen in Figure 33, this region affected perception in all three languages, but caused the greatest variation in responses among Urban Spanish speakers as indicated by the abrupt spike in the trend line. This helps support the aerodynamic hypothesis since this region does not appear to carry any linguistic information used by listeners to identify the segment.

This section also provided suggestive evidence further supporting the nasalization findings from Chapter 4. As seen in Figure 55, the word-initial [g] phoneme appears to have vowel-like formant resonances, which I suspect stem from the nasal cavity rather than from vowel production.

Since these stop variations were observed in data gathered in semi-formal elicitation sessions, there may be other manifestations not seen in this analysis. Future investigation may want to look at spontaneous data for other stop variations and see if some of the rarer stop manifestations are more common in less formal speech settings.

Chapter 6

Discussion

6.1 Overview

Three primary objectives were laid out at the beginning of this dissertation. The first was to thoroughly describe the stop inventories of Urban, Rural and L2 Spanish, Media Lengua, and Quichua— all language varieties in contact and spoken in the Ecuadorian highlands. The second was to explore how native and non-native stop consonants compare at the phonetic level across a language contact-continuum. The third was to begin an inquiry into whether categorical distinctions between so called 'mixed' languages e.g., Media Lengua, Michif, and Gurindji-Kriol (Section 1.2) and 'conventional' contact languages e.g., Quichua, Canadian French, and Guaraní (Section 1.1) can still be applied at the phonetic level.

To describe previous undocumented phonetic details of the stop inventories from each language variety, three elements were chosen for primary analysis: (1) voice onset time production (Chapter 2), (2) stop perception (Chapter 3), and (3) nasality as a feature of voiced stop production (Chapter 4). In addition, six observable stop consonant variations including: devoicing, fricativization, affrication, voiced stops as fillers, and post-[g] frication, were also described in Chapter 5.

The goals of each chapter were to describe intra-language production and/ or perception in each language variety in addition to analysing the inter-language integration strategies of the voiced stop phonemic conflict site identified in the phonological systems of Spanish and Quichua. Regarding these conflicting areas of convergence, the objective of Chapter 2 was to understand how voiced stops are produced in Quichua and explore any variation in L2 Spanish, Media Lengua, and possible influences in Rural Spanish via Quichua contact. Urban Spanish was used as a point of comparison since it has the least amount of influence from Quichua.

After identifying that voiced stops were indeed integrated productively into Quichua, L2 Spanish, and Media Lengua, the goal of Chapter 3 was to investigate whether there was a perceptual contrast between the voiced and voiceless stop series in Quichua and Media Lengua. Here, Urban Spanish was once again used as a point of comparison. This analysis was used to establish that the voicing contrast in stop production was indeed perceived as a phonemic feature of the language, rather than a perceptual merger like non-contrastive allophones or 'near-mergers' where speakers would not be able to easily distinguish the difference between the voiced and voiceless stop series.

Chapter 4 looked at a specific characteristic of voiced stops across dialects Spanish— nasality. Since the voiced series of stops was acquired under 'unguided' conditions, it was of interest to see if the nasal feature of the voiced Spanish stops carried over to Quichua and/ or Media Lengua. Finally, Chapter 5 expanded on this phonemic conflict site with an investigation into allophonic variations in stop production. These instances of variation included: devoicing, fricativization, affrication of [tɾ] clusters, elision, voiced stops as fillers, and post-[g] frication.

The language varieties described in this dissertation were chosen for a very specific reason— their long history of contact has created a well-marked language/ dialect continuum ranging from 'standard' prescriptivist varieties to extreme language mixing. This group of languages provided a unique platform for testing how conflict sites compare at the phonetic level across such a continuum. Therefore, after acquiring the abovementioned phonetic details, it was possible to explore the impact of contact in such a linguistic niche.

Table 56, Table 57, and Table 58 provide a summary of the stop conflict sites investigated in this thesis by language. The breakdown of Table 56 shows little variation in the stop characteristics with the exception of the pre-nasalisation of Quichua word-initial voiced stops and the affrication of [tɾ] clusters between the Spanish- and Quichua-based languages.

Conflict site/ Language Word-initial stops [p, b, t, d, k, g]	Urban Spanish	Rural Spanish	L2 Spanish	Media Lengua	Quichua
Devoicing	No	Rare	Rare	No	No
Voiceless stop weakening	No	No	Very rare	Very rare	No
Affrication of [tɾ]	~No	~No	~Yes	Yes	Yes
Voiced stops as fillers	Rare	Rare	Rare	Rare	Rare
Post-[g] frication	Yes	Yes	Yes	Yes	Yes
Deletion	No	Rare	No	No	No
Pre-nasalization	Yes	NA	NA	Yes	Variable

~Impressionistic observation only

Table 56: Summary of the stop conflict sites investigated in this dissertation by language

Table 57 and Table 58 on the other hand, provide the results of the statistical tests and include both language and age. Regarding whether stops are contrastive based on voicing, it is clear from Table 57 that speakers from all five languages make the required adjustments during stop production to justify labelling voiced and voiceless stops as two distinct allophonic categories, no matter their age. Table 58 shows however, that while each language is making the appropriate adjustments required to separate the stop categories by voicing, the durations of the negative VOT differ significantly— Urban Spanish speakers having the shortest, Quichua speakers having the longest, and Media Lengua, Rural, and L2 Spanish falling in the middle.

Table 57 also shows that while speakers of Urban Spanish and Media Lengua do not have a tendency to weaken word-initial voiced stops, Rural Spanish speakers and older L2 Spanish and Quichua speakers do. Table 58 shows that Rural Spanish speakers have the highest tendency to weaken voiced stops followed by L2 Spanish and Quichua speakers (via the older group). It also shows that when only the younger group is taken into consideration, there is a non-significant difference in the number weakened stops between L2 Spanish and Quichua, and Urban Spanish and Media Lengua.

Finally, Table 57 shows that speakers of Urban Spanish, Media Lengua, and Quichua perceive a difference in stop production based on the quality of voicing. The only exception being that of the older Quichua group which shows reduced perception. Regarding minute differences in perception, Table 58 shows Media Lengua speakers perceive the categorical boundary between voiced and voiceless stops before Quichua and Spanish speakers along the continuum. Table 58 also highlights differences between Media Lengua (light yellow) and Quichua (light orange) and their similarities (orange). While on the surface Table 57 suggests Media Lengua and Quichua are similar (with the exception of age), Table 58 shows that the majority (4 of 6) of the underlining conditions are actually distinct between both languages.

Conflict site/ Language	Urban Spanish		Rural Spanish		L2 Spanish		Media Lengua		Quichua	
Word-initial stops [p, b, t, d, k, g]	Younger	Older	Younger	Older	Younger	Older	Younger	Older	Younger	Older
VOT voicing contrast	Yes		Yes		Yes		Yes		Yes	
Voiced stop weakening	No		Yes		No	Common	No		No	Common
Perceptual voicing contrast	Yes		NA		NA		Yes		Yes	Reduced

Table 57: Summary of the stop conflict sites investigated in this dissertation by language and age group. See Table 58 for language groupings from this table based on the statistical results.

<table>
<tr><th>Conflict site
Word-initial stops
[p, b, t, d, k, g]</th><th colspan="6">Language groupings based on statistical differences</th></tr>
<tr><td>VOT production duration</td><td colspan="6">Shorter → Longer</td></tr>
<tr><td>Voiced VOT</td><td>Urban Spanish</td><td colspan="4">Rural Spanish, L2 Spanish, Media Lengua</td><td>Quichua</td></tr>
<tr><td>Voiceless VOT [-dorsal]</td><td colspan="6">Non-significant results</td></tr>
<tr><td>Voiceless VOT [+dorsal]</td><td colspan="3">Quichua, Media Lengua</td><td colspan="3">Urban Spanish, L2 Spanish, Rural Spanish</td></tr>
<tr><td>Perceptual boundaries</td><td colspan="6">Sooner along the continuum → Later along the continuum</td></tr>
<tr><td>Younger group [-dorsal]</td><td colspan="3">Media Lengua</td><td colspan="3">Quichua, Urban Spanish</td></tr>
<tr><td>Younger group [+dorsal]</td><td colspan="2">Media Lengua</td><td colspan="2">Quichua</td><td colspan="2">Spanish</td></tr>
<tr><td>Perceptual contrast</td><td colspan="6">Strong perceptual contrast → Reduced perceptual contrast</td></tr>
<tr><td>Older group</td><td colspan="2">Urban Spanish</td><td colspan="2">Media Lengua</td><td colspan="2">Quichua</td></tr>
<tr><td>Instances of weakening</td><td colspan="6">Few → Greater</td></tr>
<tr><td>Older group</td><td colspan="2">Media Lengua, Urban Spanish</td><td colspan="2">Quichua, L2 Spanish</td><td colspan="2">Rural Spanish</td></tr>
<tr><td>Younger group</td><td colspan="4">Media Lengua, Urban Spanish, Quichua, L2 Spanish</td><td colspan="2">Rural Spanish</td></tr>
</table>

Table 58: Language groupings from Table 57 arranged by statistical differences

Because each chapter summarizes and discusses the results of each individual case study analysis, the goal of this chapter is to tie together the findings presented hereto and inform on the bigger question: What is the phonetic nature of language contact under 'extreme' e.g., mixed languages such as Media Lengua, Michif, and Ma 'a, and 'conventional' contact languages e.g., Quichua and Guaraní, forms and is there a difference? Based the results presented hereto from the current contact and mixed-language literature, there appears to be enough information to begin speculating on Media Lengua and Quichua while providing commentary on other 'mixed' and 'conventional' language varieties. The following sections look at linguistic and social factors that may be more or less conducive to creating phonetic variation based on the number of borrowings, age of acquisition, degree of Spanish usage, among other factors.

6.2 Speculating on the nature of sound change at the phonetic level

Because of the complex interactions across the language varieties, their distinct evolutionary paths, speaker age, environments, degrees of contact/ influence, age of acquisition, history, social positions, linguistic systems and so on, there is no single straight-forward explanation as to why each group of speakers has diverged from their proto-forms. Instead, each one of these factors requires its own justification. While some have already been mentioned throughout this dissertation, the following sections elaborate on several factor-specific intricacies of sound change at the phonetic level in both 'mixed' and 'conventional' forms of language contact.

Section 6.2.1 looks specifically at the linguistic systems of Spanish and Quichua in an attempt to explain purely linguistic factors as a basis for divergence in sound production and perception among the language varieties explored hereto and those mentioned in the literature reviews. Section 6.2.2 focuses on social factors e.g., historical events and the geographical locations of the communities which may have played a role in shifting perception and production of sound segments from one regions to the next.

6.2.1 Linguistic factors

The focus of this section is to tie together the results from this dissertation with other recent phonetic research on 'mixed' and 'conventional' forms of contact, and to describe several linguistic factors that may be responsible for the current phonetic state of these languages. Beginning with Media Lengua and Quichua, one of the more apparent differences between stop production and vowel production, as described in Stewart (2011) and Stewart (2014), is the fact that the statistical predictor *language of origin* was shown to be non-significantly different in the voiceless stop analysis. These results suggest that in Media Lengua, the VOT duration of [k] in the Quichua-derived word *kusu* 'husband' is non-significantly different in duration from the [k] in Spanish-derived *cuna* 'cradle', whereas the [u] in the same words would be statistically different— the Spanish-derived 'u' slightly lower in F1 frequency compared to the Quichua-derived [u]. Similarly in Quichua, the VOT of [k] in both the native Quichua and Spanish-derived words would also show non-significant differences in duration. In contrast to the Media Lengua results however, the high vowel [u] in the same words produced by a Quichua speaker would also show non-significant differences in F1 frequency. Unless we are looking specifically at the voiceless velars however, we would not expect to find a *language of origin* effect since the differences in voiceless VOT duration across all five language varieties were non-significant from each other (see Table 31). Regarding the voiceless velar series however, there were significant differences between velar production in Media Lengua and Quichua compared to the Spanish varieties. As a series though, there is little contrast that could be used to create a division based on *language of origin* in either Quichua or Media Lengua voiceless stop production, rendering this point of comparison unusable.

A better point of comparison comes by way of the voiced stop series. Here, the results from Chapter 2 through Chapter 5 provide more tantalizing evidence that may suggest there may be in fact a difference between a 'mixed' language and 'conventional' forms of language contact at the phonetic level, where greater contact appears to result in a more precise interpretation of the phonology from the lexifier language. Here, the older group of Media Lengua and Quichua speakers show not only a distinction between the perception of stop series according to voice but also regarding stop weakening and the frequency with which it takes place. These age-based effects suggest older Quichua speakers show reduced perceptual contrast compared to their Media Lengua counterparts. In addition, the older Quichua speakers weaken the word-initial voiced stops more frequently than those in the older Media Lengua group. These groups of older speakers provide an interesting platform for exploring the effects of language mixing, since Spanish was not as pervasive in their day-to-day lives growing up and therefore, their phonology may not be as affected by Spanish compared to the younger group. Contrarily, the younger generations often prefer to communicate with their friends and family in Spanish. Nowadays, they also have also greater educational opportunities in Spanish, increased interactions with mainstream Spanish society, and greater access to Spanish media (TV, internet, etc). The constant and widespread use of Spanish in their day-to-day lives has almost certainly caused these speakers to adopt the voicing contrast to a similar degree of native speakers. The older groups of Media Lengua and Quichua speakers on the other hand, typically showed opposing social trends. This means that all else being equal, the degree of Spanish borrowings along with the age of acquisition of the stop voicing contrast may have in fact resulted in more Spanish-like perception and production in the Media Lengua group.

Based on the results from this dissertation, Stewart (2014), Jones et al. (2011), and Rosen (2007), I propose that if a language, 'conventional' contact or 'mixed', borrows enough vocabulary, speakers might benefit from contrast among non-native segments. The fact that 'mixed' language speakers are showing more lexifier language-like production and perception than their 'conventionalized' counterparts, is probably due to the increased number of borrowings resulting in the need for greater contrast. By adding in such a contrast, at the segmental level, the language does not have to shift its overall phonological system (segmental and suprasegmental) to that of the lexifier language, leaving it sounding like its systemic language—as is the case with Media Lengua and Ma'a. Having acquired such contrasts by birth, 'mixed' language speakers are able to nativize these contrasts with much greater detail that speakers of 'conventionalized' contact languages which may not require the contrast to such a degree.

As seen in the overlapping vowel systems, in Media Lengua, Gurindji-Kriol, and Michif, along with the stop results presented in this dissertation, it is also apparent that such contrasts require the ability to perceive and produce fine acoustic details allowing speakers to take advantage of the foreign segments. By not having fully created new categories acoustically, the contact language sounds even more like the systemic language. This also adds to why so many previous studies based on impressionistic observations describe intertwined mixed languages as having maintained the phonological system of the systemic language with the occasional usage of foreign segments (Gómez-Rendón, 2005; Mous, 2003a; Muysken, 1997). Other impressionistic studies, typically of mixed languages with a split between lexical categories (Michif, Gurindji-Kriol), claim separate phonologies based on the origin of a given lexical item (Bakker, 1997; McConvell & Meakins, 2005). The acoustic results in Gurindji-Kriol (Jones et al., 2011) however, show that the vowel systems are not separate but indeed overlap like those in Media Lengua. In addition, a study which is currently underway by Rosen, Stewart, and Olivia suggests the vowel system in Michif is more complex than a simple split based on the origin of a lexical category.

There are now several questions unanswered that need to be addressed: (1) how are speakers of these languages dealing with these complex systems of dual phonologies cognitively? (2) If speakers are able to navigate through such complex overlapping vowel systems and consistently interpret the fine acoustic details allowing for perceptual contrast, how can this phenomenon be explained? Since traditional phonological theory appears to break down at this level of specificity, the results presented in this dissertation require a more cognitive based approach to interpretation.

Based on phonetic studies of bilingualism focusing on vowels and stops, simultaneous bilinguals acquire native or near native-like categories comparable to those of monolinguals (Flege, 1991; Guion, 2003; MacLeod & Stoel-Gammon, 2005). Late bilinguals however, often assimilate L2 categories to their L1 as described in the perceptual assimilation model (Best et al., 2003) and as revealed in Quichua by Lipski (2015) and Guion (2003). Applying these findings to language contact along with the socio-historical evidence mentioned above, it may be possible to estimate the approximant age of acquisition of the first speakers of Media Lengua. Combining this data with exemplar models and code-switching, it is also possible to speculate as to why the phonological system of Media Lengua has been able to deviate from that of Quichua, albeit to a small extent. Building on these findings and interpreting work regarding 'unguided' or incomplete language acquisition to phonology (for example Hickey, 2010a), it may also be possible to understand the discrepancy in negative VOT durations among the voiced stops of the Spanish varieties and the higher degree of weakening in the older groups of Quichua and L2 Spanish speakers.

Based on the social situation at the beginning of the 20th century, when Media Lengua reportedly emerged, Spanish was often acquired later in life, typically upon migrating to urban areas in search of work or for selling goods. According to Guion (2003)'s age of acquisition findings and the extensive categorical overlap shown in Media Lengua vowel categories (Stewart, 2014), this would suggest the first generations of Media Lengua speakers may not have acquired mid and high vowel distinctions— suggesting they were mid to late bilinguals. Therefore only high vowel exemplar distributions, similar to those of Quichua [i] and [u], were available to the adopted Spanish vocabulary as a basis for assimilation. Once a higher degree of bilingualism became the norm, earlier bilingual speakers could then take advantage of the mid vowels by 'piggybacking' on their knowledge of Spanish. Since the age of acquisition for latter generations was still not native, the mid vowels would not be expected to shift very far from [i] and [u] as the fine acoustic detail needed to do so would not be available. However, as long as the distance was great enough to create a comparative basis for incoming stimuli, speakers could take advantage of the additional vowels.

Yu (2007) shows near-mergers are the result of extensive overlap of exemplar distributions. For Media Lengua however, the lack of native Spanish categories along with the desire for additional vowel categories may be responsible for the overlapping systems. Once this new category was created and nativized, there would be no need to shift the vowels any further apart since fine acoustic details needed for differentiating the mid and high vowel categories would be available perceptually. This explains the significantly different yet overlapping vowel spaces in the production data (Stewart, 2014), and the middle ground perceptual distinction between Spanish and Quichua described in Stewart (forthcoming). Similar parallels and can be made for the voiced stop consonants under investigation in this dissertation since a similar shift in production and perception is currently taking place within the Quichua group. Here, older speakers show less Spanish-like stop production and perception compared to the younger generations who have an overall greater degree of influence from Spanish. While the Quichua speakers have acquired the voiced stop series, the younger generation shows greater accommodation to Spanish-like values both productively (regarding voiced stop weakening tendencies) and perceptually. In Media Lengua however, it appears this shift has already taken place based on both the production and perception results.

Another interesting transition in the voiced stop series involves VOT which shows significant differences in duration between Quichua and L2 Spanish values. Here, the Quichua speakers appear to make use of two categories—a longer duration for Spanish-borrowings in Quichua and a shorter duration when speaking Spanish as an L2. This result may suggest speakers treat, albeit subconsciously, Spanish borrowings in Quichua as separate from those in their L2 variety of Spanish. This dual system suggests speakers are not just simply code-switching Spanish borrowings, but rather they have nativized these words into their lexicon. In future research, it would be interesting to test the L2 Spanish of Media Lengua speakers to see if there is a difference in VOT production.

For Media Lengua, the hypothesis that later generations were 'piggybacking' off their knowledge of Spanish (creating a larger perceptual contrast among mid and high-vowels) might also account for the Spanish-derived and Quichua-derived high and low vowel contrasts that have no clear contrastive explanation in Media Lengua. Here, the transfer of high and low vowel contrasts (based on language of origin) might be attributed to code-switching which may have played a larger role in Media Lengua formation than it is often given credit— an element often considered as a primary source in other mixed language formation (see McConvell & Meakins, 2005). This would also explain the differences in stop perception between Media Lengua and Quichua speakers based on age (see Chapter 3, Section 2). If the older generation of Media Lengua speakers transferred stop information partially based on their knowledge of Spanish, we might expect more Spanish-like perception and production values. It is commonly assumed that, unlike lexical borrowings which typically conform to the phonology of the language they have entered, code-switching utterances preserve phonological characteristics of the guest language. This of course, depends on a number of factors including social circumstances and the level of bilingualism of the speaker. Bullock (2009) suggests that instead of a clear cut transition from one phonology to the other, code-switching is often gradient. Myers-Scotton (1993) also suggests code-switching is manifested along a continuum from assimilated forms to non-assimilated forms. This type of gradiency provides an ideal platform for transferring phonetic elements such as the Spanish-derived and Quichua-derived high and low vowel contrasts, Spanish-like stop perception and production values (VOT and weakening tendencies) with a high, but not complete, level of assimilation.

6.2.2 Social factors

The current phonological state of all five language varieties is also, to a large extent, the consequence of sociolinguistic factors. For Rural Spanish, isolation from urban centres and greater contact with L2 Quichua speakers has created a noticeable shift away from Urban Spanish-like stop production. Here, voiced stops are not only significantly different from Urban Spanish in VOT duration, but non-significant differences were also found when compared to L2 Spanish. This suggests Rural Spanish voiced VOT production has more in common with L2 Spanish VOT duration than that of Urban Spanish. Anther shift in Rural Spanish stop production includes a significantly higher amount of voiced stop-weakening taking place compared to Urban Spanish. Being that many Rural Spanish speakers are the successors of Quichua speakers, the higher rate of weakening, especially regarding [g], may have been passed on from the older generations of Quichua speakers. Unlike the younger generations of Media Lengua and Quichua speakers, who are much more likely to prefer speaking Spanish over their L1, Rural Spanish speakers have no desire to 'sound more Spanish', since it is their own L1. Moreover, there is not a large difference between Urban and Rural Spanish weakening tendencies according to the statistical model in Table 54 and the raw data shown in Figure 46, Figure 47, and Figure 48. I Therefore their frequency of weakening remains unchanged across age. In addition, the majority of contact outside their L1 Spanish niche is often with L2 speakers. This may also contribute to maintaining the higher rate of stop weakening.

While Rural Spanish VOT duration has shifted towards L2 Spanish stop production, it is interesting to see that L2 Spanish has also shifted away from Quichua towards Rural Spanish. This symbiotic attraction has created new average stop production values that are neither Urban Spanish nor Quichua-like, but rather form a middle ground between both with certain characteristics that are nearly indistinguishable from each other. Since it has been documented that speakers of non-prestigious dialects will often consciously or subconsciously shift away from a non-prestigious speech form in an effort to conform to a prestigious speech style (Bucci & Baxter, 2006), it would be interesting to see the same results in a generation or two as Urban Spanish influences via media, higher education, and job opportunities, are adding pressure on rural speakers to sound more urban-like. As shown in Pasquale (2009) and (2001), contact between Peruvian Quechua and Spanish has already shown that social motivations are a main driving force for shifting the vowel spaces of Quechua-dominant bilinguals (an increase in mid-vowel height in pursuit of the raised high-vowels), as bilingual speakers desire, albeit subconsciously, to produce Quechua vowels more like those of Spanish. A similar effect, reported in Pasquale (2005), also shows Quechua-dominant bilinguals produced overall shorter VOT values than Quechua monolinguals— values which trended towards Spanish-like production. I believe similar trends are taking place in the voiced VOT durations in the speech of L2 Spanish speakers and similar trends will be taking place for speakers of Rural Spanish and Quichua speakers in the near future.

For younger Quichua speakers however, who have greater access to mainstream Spanish society than their parents and grandparents, their language's non-prestigious position has put them under constant pressure to sound more 'Spanish' as can be seen in the shifts towards rural stop production in their L2 Spanish VOT production. There are two possibilities that might explain why the long negative VOT durations in Quichua are both significantly and substantially longer than those in the Spanish varieties. The first posits that historically, Colonial Spanish had longer VOT durations than modern day Urban Spanish. Table 12 provides comparative evidence showing that in five other dialects of Spanish, negative VOT durations are roughly equivalent to those in Quichua. This would suggest that Rural Spanish, L2 Spanish, and Quichua have preserved these values from an earlier point, while negative VOT in Urban Spanish shortened over time. The second possibility is that via 'unguided' acquisition of Spanish, Quichua speakers overshot the negative VOT durations in an overemphasized attempt to produce the newly acquired phoneme. Evidence of 'unguided' acquisition can also be seen in the large quantity of weakened voiced stops in the older speaker's speech, which suggests they may have struggled to produce the voiced stops and instead often times settled on word-initial voiced fricatives. This same weakening tendency is also apparent in L2 speech in the older group. Whichever the case may be, Urban Spanish and older Quichua speakers differ substantially in voiced stop production allowing us consider these abovementioned possibilities as contact induced change.

Present day social, topographical, and historical factors which differentiate Quichua speakers from Chirihuasi/ Cashaloma from Media Lengua speakers from Pijal are actually quite few. In the early 20th century when Media Lengua purportedly emerged, many people from both communities worked in *huasipungos* (plots of land rented out in exchange for labour rather than payments), on haciendas, and sold textiles and agricultural goods in nearby communities and urban centres. My field sites were about a 12 km hike (43 km by main road) from each other around the eastside of Mt. Imbabura (see Figure 50).

Figure 56: Topological map illustrating the distances between Pijal and Chirihuasi. This map is available under the Open Database License © OpenStreetMap contributors.

Both locations have urban centres within a few kilometers and have common cultural festivities, gastronomy, traditional dress, rituals, music, and handicrafts. Ethnically however, the people from Chirihuasi and Cashaloma, identify as Karanki while people from Pijal identify as Kayambi. While historically these two pre-Incas peoples were culturally distinct, the Karanki and Kayambi both adopted the Quichua language and assimilated many Spanish and Quichua traditions. This ethnic distinction however, shows little observational linguistic variation in their Quichua[16] and when asked what separates group identity, answers usually involved variations in traditional clothing e.g., embroidery designs and handicrafts. When

[16] The only linguistic difference I have noticed between this group is the pronunciation of the first person pronoun. In Chirihuasi and Cashaloma, it is produced as [kwa] while in Pijal it is produced as [ɲuka].

asked specifically about language (Quichua) and pronunciation differences, consultants struggled to come up with a distinctions that could be attributed to phonology.

One specific topological factor however differentiates these communities. Between 1915 and 1929 the Ecuadorian Railways Company (*Ferrocarriles del Ecuador Empresa Pública*) constructed railway stretching from Quito to Ibarra passing near Pijal. While this event was a human rights travesty for many indigenous people as they were often forced to work on the railway in near-slave like conditions, the primary source of indigenous labour came from the provinces of Cotopaxi, Pichincha, and Imbabura (Clark, 1998). While information is scarce, this event may have been a catalyst for introducing Media Lengua to Pijal. According to commentaries from community members and a political representative mentioned in Stewart (2011), there was a relatively large migration of indigenous people from the province of Cotopaxi in the early 20th century. This can be seen in last names such as Chicaiza and Toaquiza in the community of Pijal which are originally of Cotopaxi origin. While no concrete evidence has yet to be uncovered, it is probable that the construction of the railway brought indigenous workers and their families from Cotopaxi northward. Before the railway, there was no completed roadway between Pichincha and Imbabura that was navigable year round and mule trails were still a common form of transporting goods.

In addition, there are several linguistic similarities between Media Lengua spoken in Imbabura and that of Cotopaxi which are difficult to explain away as chance innovation. From Stewart (2011), Stewart (2015), and Muysken (1997) these include: the absence of an allophonic voicing rule that voices stops after nasals for nominal morphology, processes of lexical freezing, lexical regularization and lexical reduction of select words, and increased productiveness in reduplicated forms not found in Quichua. Each of the following examples provides comparisons from both Imbabura Media Lengua and Cotopaxi Media Lengua[17]:

54 Quichua post nasal voicing rule in both Imbabura and Cotopaxi Quichua
[-continuant] → [+voice] / [+nasal]___
Chay-manta 'From-ABL' Consultant #86
[kaj-manta̠] → [kaj-manda] (Stewart, 2015, pp. 238-239)

55 Imbabura Media Lengua voicing not applied to nominal morphology
Ondemanta kangi?
onde-manta ka-ngi Consultant #50
where-ABL be-2 (Stewart, 2015, p. 239)
'Where are you?'
[ondemanta] → [ondemanta]

56 Cotopaxi Media Lengua voicing not applied to nominal morphology[18]
Donde-manta bini-ku-ngi? (Muysken, 1997, p. 411)
Where-from come-PROG-2
'Where are you coming from?'

57 Lexical Freezing – Imbabura Media Lengua
Auno conzashpallata makita lavani.
auno kozna-ʃpa-ʒata maki-ta lava-ni Consultant #41
before cook-SSC-TOT hand-ACC wash-1.PRES (Stewart, 2011, p. 51)
'Even before cooking, I wash [my] hands.'

58 Lexical Freezing – Cotopaxi Media Lengua
Aúnu 'not yet' (Muysken, 1997, p. 384)

59 Lexical regularization – Imbabura Media Lengua
Ese relojoka dañashkami.
ese ɾeloχu-ka daɲa-ʃka-mi Consultant #41
DET watch-TOP damage-PP-VAL (Stewart, 2011, p. 52)
'This watch is broken.'

60 Lexical regularization – Cotopaxi Media Lengua[19]
relóxo 'watch' (Muysken, 1997, p. 385)

[17] For further examples see Stewart, 2011 sections 4.4-4.7
[18] Muysken (1997, p. 365) Muysken mentions "the Quechua rule voicing the accusative case marker –ta to –da is not applied… in Media Lengua; Quechua dialectological evidence suggests this is a recent change". This statement also applies to Imbabura Media Lengua and Quichua regarding the lack of voicing in the accusative case marking, though I extend this to all instances of nominal case marking containing a post-nasal stops.
[19] Muysken (1997, p. 385) shows the Quichua borrowing of Spanish *relój* 'watch' is *rílux* which is not the case in either dialect of Media Lengua.

61 Optional lexical reduction—reportative *dizina* ‘say’ or *zina* Imbabura Media Lengua
Doctorka ocho pastillata tomachun ziwarkami.
doktoɾ-KA oʧo pastiʒa-TA toma-ʧUN zi-WA-ɾKA-MI Consultant #49
doctor-TOP eight pill-ACC take-DS.SUBJ say-1DO-3.PST-VAL (Stewart, 2011, p. 53)
‘The doctor told me to take eight pills.’

62 Optional lexical reduction—reportative *dizina* ‘say’ or *zina* Cotopaxi Media Lengua[20]
Dizi ~ *zi-* 'say, want' (< Sp *decir* 'say') (Muysken, 1997, p. 385)

63 Reduplication – Imbabura Media Lengua
Yo comprangapaka caro carotami pedirka.
jo kompɾa-nɣapa-ka kaɾu kaɾu-ta-mi pedi-ɾka Consultant #50
1 buy-SS.SUBJ-TOP expensive expensive-ACC-VAL ask-3.PST (Stewart, 2011, p. 53)
‘[The price] he/she/they asked [was] too expensive for me to buy [it].’

64 Reduplication – Cotopaxi Media Lengua[21]
Yo-ga bin-bin tixi-y-da pudi-ni.
1-TOP well-well weave-INF-ACC can-1
'I can weave very well.'

The timing of the northern railway project and the migration from Cotopaxi along with striking linguistic resemblances between Imbabura and Cotopaxi Media Lengua suggests there is chance that Media Lengua was in fact brought northward and did not originate in Imbabura. Without abandoning the railway hypothesis, it may have also been possible that a large workforce from Pijal worked on the project and developed Media Lengua in contact with Spanish speaking workers. This however does not explain the linguistic similarities with the Cotopaxi variety.

6.3 Possible origins of Media Lengua

[20] Muysken (1997, p. 384) mentions two examples of lexical reduction, *dizi-* to *zi-* 'say' and *yuya-ni* to *ya-ni* 'I think'. The latter is of Quichua origin and both are also found in Imbabura Media Lengua. The alteration to *yani* is absent in both Imbabura Quichua and Cotopaxi Quichua as well. For Cotopaxi Quichua, Muysken (1997, p. 385) states "Interestingly enough, the alternation is absent in Quechua (even though the verb *yuya* occurs in Quechua), and with *yuya-* it is limited to the first person." In Imbabura Media Lengua *yani* is also restricted to first person.
[21] Regarding reduplication, Muysken (1997, p. 384) mentions in neither of his examples would "we encounter reduplication in Spanish."

Based on commentary by Muysken (1997) and Dikker (2008), Quichua men acquired a high level of Spanish after having left their communities to work in Urban centres. This shift in language usage and the age of acquisition of Spanish might be partially responsible for the creation of new vowel categories, more Spanish-like stop production and perception, and other contrastive stop qualities found between Urban Spanish and Quichua speakers e.g., the stop nasalization tendencies seen in Chapter 5. I would suspect however, that if these workers were indeed able to achieve such a fine degree of acoustic detail, much of this information would be lost once the language was taught to monolingual Quichua speakers as an L2 upon returning to their communities, especially if the phonetic subtleties were no longer supported by a learner's knowledge of Spanish. This hypothesis is grounded in the research by Lipski (2015) and Guion (2003), which shows late acquisition of Spanish often results in merged vowel categories. Therefore, we would not expect the workers to achieve such a fine degree of acoustic detail in the first place and let alone pass it along to other L2 learners. This point is especially relevant since monolingual Quichua women, who apparently would not be the originators of the language, were often responsible for raising children while men were off working. In other words, women having acquired the details as an L2, from older L2 male speakers would have been responsible for transferring both perceptual and productive cues required to recognize the minute differences in vowel quality in the overlapping systems. Moreover, Media Lengua from Pijal is actually spoken nowadays by more women than men, which suggests they would be the ones to transmit the language.

During background interviews in Pijal, it was common for consultants to state that their parents or grandparents did not speak Spanish. I can support these statements after having met several older women with little knowledge of the language. How is it then possible that non-Spanish speaking women were able to acquire the fine acoustic details that show significant or observational shifts towards Spanish e.g., vowel categories, stop weakening tendencies, minute shifts in voiceless VOT durations, stop nasality tendencies, and vowel and stop perception? While it is possible that there was a generation of high level bilinguals preceding them, which were able to pass the details to their children who did not learn Spanish, this seems unlikely since Spanish, the language of prestige was not passed along as well. Why was this the case?

I hypothesize it was probably women and children who created and evolved the language to its current state rather than men. This would not be surprising given ample evidence suggesting women often lead the way in linguistic innovation (Dale, 1976; Labov, 1990; López Rúa, 2006; Powell, 1979; Springer & Deutsch, 1989; Yang, 2001; inter alia). This may have taken place in the weekend markets in urban centres where women and their children would sell agricultural and textile products to Spanish speaking urban Mestizos. While Spanish may never have been fully acquired, the constant reinforcement from negotiating may have been enough to solidify the fine acoustic details—especially if children were involved in the process and were fascinated by the language exchanges between their parents and clients. This may have evolved into a 'school-yard' language in the communities which quickly increased in Spanish lexicon while the children learned more and more Spanish.

The lack of Spanish transfer to the current older generations in Pijal by their parents however, is an oddity; if speakers had a high level of Spanish, and Quichua was the non-prestigious language why did the interviews reveal several generations of non-Spanish speaking Media Lengua speakers? I believe the answer lies once again in the 'railroad' hypothesis. Based on recent surveys in Cotopaxi (Shappeck, 2011; Stewart, 2011), Media Lengua is no longer spoken or spoken by very few people, suggesting Spanish indeed was passed on and Media Lengua was eventually phased out as would be expected. If the language had gone north however, to a monolingual community like Pijal, this would answer the question as to why the grandparents of the current Media Lengua speakers were non-Spanish speaking— they learned Media Lengua as an L2 from Cotopaxi speakers who settled in the area. It should be noted that if Media Lengua was in fact brought to Imbabura via migration, much of the morphological differences between the Quichua dialects would have undergone levelling.

6.4 Future research

This section provides avenues for future research into the phonetic nature of language contact in Spanish, Media Lengua, and Quichua along with in other mixed languages and their proto-forms. In Section 2.2.2.1.2 (Figure 15), a bimodal distribution was identified in the production of Rural Spanish [d]. Since no predictors in the statistical model seemed to account for this variation, further analysis was conducted. Results suggest some of the variation was caused by a split in back vowel production. Because only three words began with word-initial [d̪+o] and no combinations of [d̪+u] were elicited, this area requires further investigation with a larger sample of words in order to properly identify what is causing the split.

Another avenue of future investigation might be to identify any linguistic differences between Quichua speakers who identify ethnically as Karanqui, Kayambi, and Otavaleño. While these neighbouring groups maintain separate social and ethnic distinctions, little is known about within-group dialectal variations. Many researchers, including myself, generalize Imbabura Quichua as a homogenous language dialect without having conducted the proper research to make such a claim. For starters, one observation, made in Footnote 16, shows a variation in the pronominal system, where the first person singular pronoun *ñuka* is produced as [ˈɲuka] (standard pronunciation) in Pijal (Kayambi) while those in Chirihuasi (Karanki) say [ˈkwa].

From a typological/ comparative perspective, future research with Media Lengua should also focus on identifying similarities between Imbabura and Cotopaxi Media Lengua in hopes of establishing or negating a genetic link between the language dialects. This would help support or reject my current hypothesis that the two dialects have a common origin.

For researchers interested in L1 contact language acquisition, it has been reported that children are currently still acquiring and speaking Media Lengua in the community of Angla and other nearby communities located about 5-10 minutes by bus from Pijal (Gómez-Rendón, 2008b). This would provide a fantastic opportunity to better understand how children are accommodating and manipulating all three languages.

For other researchers looking to do fieldwork exploration, Media Lengua is often very difficult to come by and geographical surveys are lacking. In would be of great interest to find other varieties of Media Lengua throughout Ecuador and especially in Peru or Bolivia where no cases of Media Lengua have yet to be documented. My one suggestion when searching for this language is not to ask if a given neighbouring community speaks Media Lengua, since this term has come to mean any degree of mixing of Spanish into Quichua. Instead, have a recording on hand or come up with comparative sentences and ask people something like: "In Quichua people say *"Ñukaga misidami munani."*. Do you know anyone who might say *"Yoka gatotami kirini."?* That simple sentence (translating to "I want a cat." led me to Pijal.

For those interested in psycholinguistic research, a full scale experiment based on the impromptu perceptual task described in Chapter 4, Section 3, may provide interesting results on how nasality in voiced stops are perceived in insolation. This experiment would call for judgements on word-initial voiced stops from a variety of words and asking participants what they hear.

Another observation briefly touched upon in this dissertation, requiring further investigation, is that of word-initial 'tr' clusters and how they are produced in all three Spanish dialects. Since data was only analyzed from Quichua and Media Lengua, there is no phonetic evidence indicating as to how L2 Spanish speakers accommodate these non-native clusters and whether Rural Spanish speakers prefer affrication over individual segment production. Anyone looking to focus on this area, should also pin-point the exact place of articulation of the 'tr' affricate e.g., postalveolar, retroflex, palatal.

Outside of phonetics, phonology, and psycholinguistics there are endless amounts of questions that remain unanswered concerning contact between Spanish, Quichua, and Media Lengua—most notably in the area of semantics.

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