THIRD LANGUAGE ACQUISITION: A STUDY OF UNSTRESSED VOWEL REDUCTION

by

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To my Family: by blood, water, and love.

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LIST OF ABBREVIATIONS

BP	Brazilian Portuguese
CLI	Cross-linguistic Influence
CPT	Carrier Phrase Task
DP	Determiner Phrase
L1	First Language
L2	Second Language
L3	Third Language
LMEM	Linear Mixed-Effects Model
LEAP-Q	Language Experience and Proficiency Questionnaire
NP	Noun Phrase
PPH	Phonological Permeability Hypothesis
RQ	Research Question
SLA	Second Language Acquisition
SLE	Societas Linguistica Europaea
PRT	Paragraph Reading Task
TLA	Third Language Acquisition
TPM	Typological Primacy Model
VOT	Voice Onset Time

ABSTRACT

A great deal of the research on cross-linguistic phonetic influence demonstrates that a speaker's knowledge of their first language (L1) significantly affects their ability to perceive and produce sounds in any other language. While current studies show that cross-linguistic transfer occurs at the L3 level, some research suggests that properties of both L1 and L2 are present in the production of L3 (Ionin, Montrul & Santos, 2011). Many studies have addressed perception, production and factors that influence foreign speech in Second Language Acquisition (SLA) (Watkins, Rauber & Baptista, 2009). As the number of multilingual individuals rises, so does the need for studies that investigate not only SLA but also that of additional languages (i.e., Third Language Acquisition). This dissertation examines how cross-linguistic influence (CLI) occurs among English, Spanish, and Brazilian Portuguese (BP), examining instances of vowel reduction, an aspect of phonological production. English and BP are assumed as vowel reducing languages, whereas Spanish displays negligible vowel reduction in comparison. The vowel productions in L3 BP of two multilingual groups, L1English-L2Spanish-L3BP (ESP) and L1 Spanish-L2 English-BP (SEP) were investigated in two tasks: a paragraph reading task (PRT) and a carrier phrase task (CPT). The study sought to determine whether i) a native speaker of a vowel reducing L1 and a non-vowel reducing L2 displays more or less vowel reduction in a vowel reducing L3 than a native speaker of a non-vowel reducing L1 and vowel reducing L2 and ii) how length of exposure to an L3 affects phonological production. Three fixed effects were considered: duration ratio, intensity ratio and height (F1). The goal was to ascertain whether the Typological Primacy Model (TPM) (Rothman 2011, 2015) or the L2 Status Factor Model (Bardel & Falk 2007, 2012; Hammarberg, 2001) would be a better predictor for how vowel reduction would occur in the L3. Results for duration ratio and vowel height showed no significant difference between groups ESP and SEP. Results for intensity ratio suggest L2 Status as a better predictor, as group SEP displayed more phonological transfer than the ESP group. A hybrid approach to L3 acquisition models is proposed.

CHAPTER 1. INTRODUCTION

English has rapidly gained competitors for its unofficial primary status in the United States, as languages such as Spanish garners an increasing number of speakers, with English-Spanish speakers representing half of all bilinguals. The number of families that speak more than one language in the United States has been increasing over the years, with the percentage of bilinguals rising from 11 to close to 20 percent just since 1980 (Grosjean, 2012). Furthermore, there are over 60 million individuals in the US that speak a language other than English at home (United States Census Bureau, 2015). In other countries, English is often among the most spoken languages in addition to the country's native languages, and Mandarin is becoming a language of commerce throughout the world.

Multilingualism (or plurilingualism) is a linguistics term to refer to a speech community that uses two or more languages. Bilingualism, therefore, can be taken under this definition, though sometimes these terms are used contrastively (Crystal, 2009). There are more people who are bilingual or multilingual in the world than those who are monolingual, and there is an increasing awareness that multilingualism is in fact the rule, and not the exception (Cabrelli Amaro & Wrembel, 2016). In this context, investigating issues of multilingualism possesses a rapidly growing applicability. The reality is no longer that of individuals who possess linguistic knowledge in "only" two tongues, but often, knowledge of a third language (L3), leading to an ever more pressing need to understand how languages interact.

There is much discussion within research over the definition of bilingual and multilingual. Some definitions would suggest that there is virtually no difference at all between the terms, but key distinctions must be recognized. Recent studies (e.g., Singleton & Little, 2005) demonstrate that multilingual speakers are able to draw information from both their native (or highest proficiency) language, in addition to any other language in their repository, and naturally this is not a possibility for bilingual speakers, given that they would only be choosing from a first language (L1) and second language (L2). Researchers are becoming more conscientious in using the terms bilingualism and multilingualism precisely because of the qualitative distinctions between both realities (Aronin & Singleton, 2012). A similar issue arises in the discussion of Second Language Acquisition (SLA) and Third Language Acquisition (TLA).

Studying TLA allows for a better grasp of the acquisition processes and of cross-linguistic influence (Hammarberg, 2009). Understanding how a learner uses an L3 provides insight into much more than just their usage of that one language in particular. The focus in SLA, is traditionally on determining comparisons and establishing contrasts between two languages. By design, in a context with two languages, it must be assumed that influence occurs from one given language into the other, even if influence can occur positively or negatively; that is, either from the native language into the learned language or vice-versa. Adding a third language empowers the asking of questions that seek to further explain interactions between not only the native language but also the learned languages themselves. The assumption that languages that are typologically similar therefore infer more cross-linguistic interference is ubiquitous. This study sought to provide this discussion with quantitative data, based on an aspect of phonetic production that is subconscious (i.e., vowel reduction), which reduces potential bias.

The present study aims to clarify how cross-linguistic influence occurs among English, Brazilian Portuguese (BP) and Spanish, focusing on instances of vowel reduction, an aspect of phonological production. The choice to use vowel reduction as a means of measurement will be discussed in the next chapter. Vowel reduction manifests itself in that unstressed vowels are generally shorter than their stressed counterparts, and it is more difficult to attain distinct vowel qualities in instances where vowel length is shorter (Crosswhite, 2004). Both BP and English display vowel reduction, whereas Spanish is a non-vowel reducing language.

The literature reviewed in the next chapter points to two main factors that have an influence on L3 acquisition: Typology and L2 status. The hypotheses in this study propose that the L2 status factor could be a better predictor of how vowel reduction occurs in L3 production, but most importantly, that one singular approach might not be sufficient to fully account for vowel reduction in the L3. Further, it is hypothesized that longer exposure to the L3 will impact the results.

1.1 Dissertation Outline

The main goal of this dissertation is to, through quantitative data, clarify how cross-linguistic influence occurs within TLA, and by doing so, to create a more robust understanding of current theoretical views and to provide insight into further research approaches. To that end, the chapter that follows contains a review of current and past literature on Third Language Acquisition and vowel reduction. In Chapter 3, the methodology is described in detail, elaborating on the research questions, participants, pertinent materials, and procedure. In Chapter 4, the results of the study are presented, as well as relevant statistical analyses. Additional discussion of the results is detailed in Chapter 5. Lastly, in Chapter 6, conclusions, further directions of study, limitations, and possible implications of the current study are discussed.

CHAPTER 2. LITERATURE REVIEW

The fundamental principle in the research of multilingualism and L3 (third language) acquisition is the idea that all human beings have the potential to be multilingual (Falk & Bardel, 2010). Linguistically, one of the great advantages of studying Third Language Acquisition (TLA) resides in that, as originally observed by Flynn, Foley and Vinnitskaya (2004), examination of the role of previous linguistic knowledge in the acquisition of an L3 allows for deeper appreciation of the influence of previous language experiences in acquisition. Indeed, carrying out L3 research gives us an unparalleled opportunity to determine the development of language study (Cabrelli Amaro, Flynn & Rothman, 2012). In section 2.1, first, terms within TLA, bilingualism, and multilingualism are operationalized. Then, Cross-linguistic Influence (CLI) and Phonology in general in TLA are discussed. Third, various Multilingual Models are presented, and vowel reduction within English and Portuguese and vowels in Spanish are examined. Lastly, the Research Questions and subsequent hypotheses that attend this study are presented.

2.1 TLA and Bilingualism and Multilingualism

2.1.1 Operationalizing Terms

As Cabrelli Amaro, Flynn, and Rothman (2012) note, “multilingualism has always been a linguistic reality; however, it is only recently that multilingualism has not been considered simply an additive extension of bilingualism, but rather a field that demands to be acknowledged in its own right.” (p. 2). It has been assumed that what researchers have found in bilingualism can be transposed into the study of a situation in which more than two languages are present. This can only occur if a view of bilingualism is taken such as that of Grosjean’s (1982, 1985) wholistic view which focuses on the bilingual individual as a competent speaker-hearer. Grosjean (1985) presents the bilingual as an entity that cannot be separated into two individual monolinguals, but rather as a cohesive and unique entity with a specific linguistic profile. Within this view, then, the bilingual speaker is competent in both languages, and uses them according to the intended purpose or context at hand.

Some researchers still consider the idea that bilingualism and multilingualism are to be interpreted as a double or multiple type of monolingualism (Kibbee, 1998). Presupposing that perspective, however, would completely sever the connections between the research of SLA (Second Language Acquisition) and multilingualism/bilingualism (Cenoz & Jessner, 2000). Scholars who study bilingualism would agree that there are probably more people in the world who would identify themselves as bilingual or multilingual than those who would call themselves monolingual (Bialystok, 2001). The difficulty with identifying as a bilingual comes from the fact that proficiency in an L2 can have an enormous range, anywhere from some basic conversational fluency, to being able to function within all scopes of linguistic ability, such as speaking, reading, and writing (Bhatia & Ritchie, 2008). When an individual learns only a given L1 for the first part of their life and later in life (and generally in a different location) they come to learn an L2, they are coordinate bilinguals (Grosjean, 1982). When an individual learns two languages at the same time and in the same location, then they are compound bilinguals. Compound bilinguals tend to be more proficient in expressing emotion and thought in both languages (Bhatia & Ritchie, 2008). TLA is a more complex phenomenon than second language acquisition given that, in addition to all of the individual and social factors that affect SLA, the process and product of acquiring a second language can potentially influence the acquisition of a third. L3 learners have more experience acquiring and utilizing different languages and have been found to present more strategies and a higher level of metalinguistic awareness (Cenoz & Jessner, 2000).

Current TLA research has chiefly investigated the role of bilinguals learning an L3, with the basic claim that bilinguals are more successful at performing L3 tasks than monolinguals (Garcia, 2013) (see section 2.2 on Phonology in TLA for further discussion). The forerunner of this claim was Ringbom in his 1987 study comparing the acquisition of English as an L2 (second language) or L3 in Finnish monolinguals to Finnish-Swedish bilinguals. The results of this study showed that, indeed, in a translation task, the bilingual group outperformed its monolingual counterpart. Ringbom (1987) focused on Finland as it provided an opportunity to analyze participants who grew up in similar sociological and educational environments, whilst being native speakers of different languages, with different linguistics structures (Swedish and Finnish) as they learned L3 English. Finnish is not structurally similar to English, while Swedish is formally much more so. Ringbom utilized data collected from a project done by the Department of English in Åbo Akademi (a Swedish-language university in Finland), and analyzed it in terms of how L1(first language) affects L2 learning, performing tests that feature English comprehension in the two sets of participants (L1 Finnish and L1 Finnish/L2 Swedish). Overall, Ringbom's results show that

Finnish-Swedish bilinguals do better than Finnish monolinguals in oral skills and comprehension, that lexical errors tend to be affected by Swedish, while semantic errors tend to occur by the influence of the participants' native language.

Ten years later, Hammarberg (1997) was still calling attention to a disproportionately low number studies present in the area of TLA phonetics and phonology.

Thomas (1988) compared English monolinguals to Spanish-English bilinguals regarding the acquisition of grammar and vocabulary in L2/L3 French. She tested the two sets of students on French vocabulary and grammar. The word inventory for the French vocabulary test was comprised of isolated French words, with half of them being Spanish cognates, whether visually or semantically. In turn, the grammar task tested word order, agreement, negative sentence formation, and word order. For this grammar test, incomplete sentences were shown, and students had to select the best completion from three possibilities, of which only one was grammatically accurate. Thomas found similar results to those of Ringbom (1987); the bilingual group consistently outpaced the monolingual for these tasks. In this study, Thomas also tested students' ability in writing short compositions, specifically in terms of comprehensibility. Again, after just one semester of formal instruction, bilingual students outperformed monolinguals. It is worthy of note that Thomas separated the bilingual group into two groups based on their learning background of L2 Spanish, specifically that of growing up in a bilingual household or having learned it in an academic setting in an L2 classroom. The bilingual group that learned L2 Spanish in a formal classroom did marginally better than the bilingual group that learned L2 Spanish in a bilingual household in the vocabulary test, and much better in the grammar acquisition test. According to Thomas, this study's results corroborate the idea that "bilinguals have a facility for learning a third language." (Thomas, 1988, p. 240).

Sanz (2000) investigated the acquisition of L2/L3 English in monolingual Spanish speakers and Spanish-Catalan bilinguals and reached analogous conclusions. Sanz analyzed the results of linguistic background and demographic questionnaires, as well as vocabulary and structure proficiency tasks given to 201 students. Of these, 77 were Spanish monolinguals, and 124 Spanish-Catalan bilinguals. In the background questionnaire participants reported demographic information such as age, gender, and socioeconomic status. Participants' intelligence and exposure to English was also measured, and their motivation to learn English and attitudes towards British and United States populations were evaluated. Motivation and exposure were shown to positively contribute towards better performance in the English tests. Bilinguals reliably showed better results in L3 proficiency tests than the monolingual group did on the L2 proficiency tests. Sanz argues for the need of more linguistics research in L3 specifically the kind that is "psycholinguistic in nature" (Sanz, 2000, p. 38).

The need to continue researching how bilinguals learn the L3 is clear, and the present study addresses that call. In the next section, Cross-Linguistic Influence is discussed.

2.1.2 Cross-linguistic Influence (CLI)

Cross-linguistic influence is defined as the effect that languages which were previously learned could have in the process of learning a new language. This term first appeared in research in the 1980s (Kellerman, 1984; Sharwood-Smith, 1983). For the purposes of our study, we conflate the terms CLI and transfer, as it has been done by various authors, including Cabrelli Amaro and Wrembel (2016). A great deal of the research on cross-linguistic phonetic influence points to the idea that a speaker's knowledge of their L1 significantly affects their ability to perceive and produce sounds in any other language. Many of the studies have examined perception, production and other factors that influence foreign speech in SLA. As the number of multilingual individuals has risen, so has the need for studies that investigate not only L2 acquisition but also that of additional languages.

For many researchers (e.g., Odlin, 2003), CLI is included among the primordial processes in SLA, but CLI also comes with a fair amount of divergence among scholars when it comes to deciding what causes it, how it happens, to what extent in happens, and in what areas of language it happens (Llama, Cardoso, & Collins, 2010). The current study sheds some new light on the aspect of how it happens, and investigates an area of language, and specifically phonological acquisition, in which it has been shown to occur.

While current studies show that cross-linguistic transfer definitely occurs at the L3 level, some research suggests that properties of both L1 and L2 are present in the production of L3 (Ionin, Montrul, & Santos, 2011). In this study, Ionin et al. (2011) examined the results of an Acceptability Judgement Task and a proficiency test in three languages: English, Spanish and BP (Brazilian Portuguese). The focus of their study was plural Noun Phrases (NP), seeing as all three languages manifest this feature, but do so differently: English utilizes plural NPs without articles for generic readings while Spanish accomplishes the same goal with definite articles, and in BP both options are a possibility. The proficiency test was comprised of both a vocabulary test and a cloze test. For the English test, they evaluated English native speakers as a control; for the Spanish test, they had one set of participants who were native Spanish speakers, and a second set who were L1 English and L2 English learners; for the BP test, one set of participants were BP native speakers, and the other L1 English, L2 Romance Language (Spanish or French), and L3 BP. Ionin et al. found that participants mostly drew from either L1 or L2 depending on which language they perceived as having the most similar structure to the L3.

Results from other studies propose that L2 influences L3 more greatly as the level of exposure of the learner to the L2 is also greater. Tremblay (2006) examined the effect that L2 proficiency and exposure had on cross-linguistic influence from L1 English and L2 French on L3 German. The participants in Tremblay's study were all L1 English, L2 French and L3 German, having had explicit instruction in French in school, and currently studying German at the university level. These participants were split into groups according to their L2 proficiency and exposure; exposure was determined through a questionnaire, and proficiency through a proficiency test. She compared the rates of lexical inventions and language shifts for these L3 learners based on oral samples in the L3 that were collected while participants described the story they thought was taking place through 25 sequential cartoons. The results suggest that while L1 is the primary source of influence on L3, regardless of exposure, the learner's L2 had a greater influence on the L3 for the individuals who were more exposed to the L2 (Tremblay, 2006).

The notion that L3 learners have an advantage over L2 learners appears in research from early on. Based on Hufeisen's (1998) model, Jessner (2008) promotes the idea that L3 learners are better equipped than L2 learners, given that L3 learners have already acquired language learning strategies and are therefore subconsciously affected by their previous learning.

What is known for L2 acquisition is insufficient to answer the questions that come with cross-linguistic influence between more than two languages. This necessitates further research into the L3 cross-linguistic influence, as it is potentially more complex (Lipińska, 2015) than its L2 counterpart (Diaz Granado, Simonet, Warner, & Carvalho, 2011).

Exposure to an L2 or L3 via formal or informal pathways is generally accepted to influence language development (De Angelis, 2015). From a psychological perspective, the mere-exposure effect (Zajonc, 1968) suggests that just being exposed to something repeatedly causes a natural likeness of whatever that thing is, irrespective of any external associated reward. Linguistically, there has been increasing mention of the importance of research in the early stages of L3 acquisition. González Alonso et al. (2020) argue that "testing L3/Ln knowledge as early as possible in the developmental continuum affords the best chance of disentangling representational transfer and/or its precursors (evidence of what gives rise to ultimate selection) from CLI effects (p. 2).

In this section, we discussed how CLI fits within SLA and TLA. Specifically, the concepts of multilingualism and bilingualism were defined, and the possible directionality of language transfer was reviewed. The next section delves into why phonological acquisition was the elected focus of the present study.

2.2 Phonology in TLA

To date, phonology is still an underexplored area in TLA. Scholars have pointed out that phonological acquisition should be given special attention within the field (e.g., Cabrelli Amaro, 2012; Hammarberg, 1997; Wrembel, 2015). Even though TLA is still a recent area of study, there are aspects of language that have undergone a fair amount of analysis in the area, namely syntax (Bardel & Falk, 2007; Leung, 2005), and lexis (Cenoz, 2001; De Angelis & Selinker, 2001; Dewaele, 1998; Hammarberg, 2001; Ringbom, 2001; Tremblay, 2008). Missaglia (2010) suggests that scholars customarily research areas in which adult learners of L2 outperform child learners of L2, and this would put forth an explanation as to why syntax and grammar have received more attention than phonetics or phonology in TLA studies. In recent years, the area of phonology in TLA has been increasingly explored, and "can be acknowledged as a subfield in its own right." (Cabrelli Amaro, 2017, p. 1). In 2010, the *International Journal of Multilingualism* published an issue focused on transfer in L3 Phonology, with several articles that offered new methods and approaches to the study of L3 phonological acquisition. Several articles cited in this dissertation come from this pioneer and necessary publication (e.g., Gut; Marx & Mehlhorn; Missaglia; Wrembel; 2010). Heightened interest in the area can also be noted in its growing presence at noteworthy conferences, such as the International Conference of Third Language Acquisition and Multilingualism, and also the creation of workshops focusing specifically on the area, such as the workshop focusing on Advances in the Investigation of L3 Phonological Acquisition carried out at the Societas Linguistica Europaea (SLE) conference in 2014, a workshop focusing on pronunciation of L3 English at New Sounds in Denmark in 2016, or more recently, a workshop on Multilingual Language Acquisition, Processing and Use at the University of Konstanz.

Thus far, publications in TLA show complex patterns of transfer between native languages, L2 and L3, and yet they are still inadequate to give us a clear picture of the factors that condition CLI in L3 speech (Cabrelli Amaro & Wrembel, 2016). In the next section, pertinent studies in L3 Phonology are reviewed.

2.2.1 Previous Studies in L3 Phonology

Segmental properties have been more researched within phonological studies in TLA than suprasegmental properties. Vowel formants (e.g., Lechner & Kohlberger, 2014; Missaglia, 2010; Sypiańska, 2016; Wrembel, 2015) and voice onset time (VOT) (e.g., Llama & López-Morelos, 2016; Tremblay, 2008; Wrembel, 2011; Wunder, 2010) have been considerably explored, as far as segmental properties go.

Within suprasegmental properties, research has been more limited. Gut (2010) explored speech rhythm and vowel neutralization, Gabriel, Stahnke & Thulke (2014) also examined speech rhythm, and Cabrelli Amaro (2013, 2017) looked at vowel reduction (the latter being especially pertinent studies for the present research). Gut (2010) examined vowel reduction, fluency, and speech rhythm in four L3 learners with distinct L1s in comparison to native speakers. Gut did so based on three tasks: reading of a passage, retelling of a passage, and free speech through an interview. Of the four participants two had German as an L3, and two English as an L3; the first participant was L1-Polish, L2-German, L3-English; the second participant was L1-Russian, L2-German, L3-English; the third participant was L1-Hungarian, L2-English, L-3 German; the fourth participant was L1-Spanish, L2-English, L3-German. In terms of fluency, Gut found that performance was task-dependent, with higher fluency being usually displayed in the reading task. Participants showed different levels of fluency in L2 and L3, with consistently better fluency results in their L2. For vowel reduction, none of the L3 participants displayed vowel reduction to the extent that native speakers do, whether it be in L3 German or L3 English. That is, native speakers reliably show greater vowel reduction than the L3 learners. Considering speech rhythm, which Gut (2010) describes as "the durational difference between full-voweled and reduced-voweled syllables" (p.31), all L3 participants displayed greater speech rhythm in English over German. Gabriel et al. (2014) examined a group of thirteen multilingual participants and compared them to three counterpart control groups in order to determine how much the various languages prompt language transfer in the acquisition of French speech rhythm. These multilingual learners possessed a diverse linguistic background, with L2 English and L2 French, and a mix of various Chinese languages (such as Mandarin or Cantonese) and German as L1s. The control groups contained monolingual German speakers, the second Chinese monolinguals, and the third French monolinguals. Three tasks were completed: one consisted of reading, the second of separate sentences, and lastly, a task with nonce words in carrier dialogues specific to each language. Gabriel et al. concluded that not only linguistic but also extra-linguistic factors affect and effect CLI in terms of speech rhythm, specifically in timing patterns. They determined that the interaction between rhythm, participants' attitudes towards each language, and metalinguistic and phonological awareness benefited multilingual participants with Mandarin Chinese in their background more so than that of German monolinguals. They posited that this occurred into French, given that multilingual participants had the possibility to positively transfer rhythm features from their various languages into French. This is a particularly interesting finding, in that it suggests that even a language that is typological distinct from the targe language, can contribute towards better performance in the L3. Ultimately, Gabriel et al. posited that "the results of [our] study speak in favor of an intensified collaboration of linguistics and language pedagogical research in order to better meet the challenges posed by the complex constellations of linguistic and cultural diversity (…)" (2014, p. 1279). The present study seeks to contribute towards this end.

Cabrelli Amaro (2013) investigated the acquisition of BP of bilingual speakers of English and Spanish, looking to test potential regressive phonological influence from BP to Spanish. To this end, the author conducted a cross-sectional study of these bilinguals differing in age and context of acquisition of Spanish, and she also conducted a longitudinal case study looking at phonological perception and production of Spanish of a L1 English L2 Spanish bilingual speaker, before exposure to BP and 11 weeks after, following a six-week intensive immersion program in Brazil. Her investigation centered around the acquisition of BP reduced word-final unstress vowels [ɪ] and [ʊ]. The results showed no evidence of BP influence on the participants' Spanish perception. However, the case study data showed the participant producing vowel segments that were more BP-like, and an overall less native-like accent during the second testing. This means that the participant's L3 grammar might have affected his Spanish production, and hints at the possibility that L3 can influence a native-like system of a language that is structurally similar. Cabrelli Amaro (2017) looks at the extent to which L1 phonological systems resist influence from an L3, as compared to an L2 phonological system. The author examined the same types of sequential bilinguals used for the present study, namely L1 English L2 Spanish and L1 Spanish L2 English. Once again, she tested both perception and production based on vowel measurement. Just like in the current study, the author analyzed formant structure, duration, and intensity of vowels. For perception, she used a forced-choice goodness task, and for production, a delayed repetition task. The results revealed that L2 Spanish production data is different in terms of vowel height for the Spanish bilingual and its control counterpart, further corroborating the idea that there is CLI occurring among these language pairings as far as vowel reduction is concerned. A review of the literature shows a great dearth of information regarding L3 studies focusing on intonation. At the time of this dissertation there was no available literature on the topic, providing an opportunity for future work.

Some researchers suggest that the greatest influence on L3 phonology is that of L1 phonology, in the form of negative transfer (e.g., Pyun, 2005; Ringbom, 1987; Hammarberg & Hammarberg, 1993). Hammarberg and Hammarberg (1993) examined phonetic influence into L3 Swedish a trilingual of L1 English and L2 German. This trilingual speaker was recorded narrating a story in L3 Swedish, both shortly after arrival in Sweden and then after around a year had elapsed. These recordings were subsequently judged by native Speakers of Swedish who were unaware that they were listening to the same individual in both recordings. These native raters perceived the speaker in the first instance to be a native speaker of German (that was the speaker's L2) and in the recording after a year, they perceived them to be a native speaker of English, which was the case. Hammarberg and Hammarberg (1993) suggest that the L2 has a stronger influence at the beginning of L3 acquisition. They also posit that the dependence on L1 or L2 is prompted based on different functions, with L1 being persistently relied upon on a basic language constraint, and L2 being relied upon as a coping strategy at the early stages of L3 phonetic acquisition. In later research, Hammarberg (2001) observed that L2 influence tendentially fades away twice as rapidly as that of L1, and that L1 influence lasts longer overall.

Llama et al. (2010) focused on voice onset timing of /p, t, k/ in speakers of L3 Spanish speakers who were either Francophone (L1 French – L2 English) or Anglophone (L1 English – L2 French) bilinguals. The aim of the study was to clarify whether typology or L2 status would be a stronger predictor when selecting a source language for phonological influence in L3 acquisition. Both Francophone and Anglophone groups produced compromised VOTs in their L2 and L3, and these were different values from those produced by monolingual speakers of their respective L1s. The results suggest L2 status as the stronger determining factor when selecting a source of language in L3 Spanish for both groups, when it comes to the production of voiceless stops in stressed onset position. Falk and Bardel (2010) cite Llama et al.'s (2010) study as one with "carefully planned combinations of languages" with "larger data collections" (p. 211). The setup of the present study is partly inspired by that of Llama et al. (2010). Still in the realm of VOT studies, Wunder (2010) researched participants with L1 German – L2 English – L3 Spanish profiles. Here, participants once again displayed evidence of compromised VOTs in their L2 and L3, but in this case the author suggests an effect of L1 transfer. Gut (2010) looked at four L3 speakers with different L1 backgrounds in order to identify if transfer was occurring because of the L1 or L2 of the participants. Vowel reduction and speech rhythm were measured, and participants did not display any direct influence from their L1 on their L3 for these variables. They did, however, show evidence of influence of the L2, as they produced reduced vowels in the L3 with hybrid values. These hybrid values could have been influenced by the L2, given that three speakers did not display vowel reduction in their respective L1s (Polish, Hungarian, and Spanish). Blank and Zimmer (2009) analyzed L1 BP – L2 French – L3 English speakers, for the acoustic features of their vowels, specifically formant values and duration. They suggest a combined transfer source, as their study shows evidence of influence in these acoustic features of vowels both from the L1 and L2. Cabrelli Amaro and Rothman (2010) carried out a longitudinal study with two speakers of L3 BP (both bilinguals of English-Spanish, one successive, the other simultaneous). They measured features in phonology such as vowel nasalization and reduction (present in BP), and spirantization of intervocalic stops (present in Spanish), features which are different in Spanish and BP. The English-Spanish successive bilingual displayed greater negative regressive transfer from L3 to L2 as their L3 proficiency developed, whereas the simultaneous bilingual displayed no regressive transfer from L3 to L1, given the assumption that the simultaneous bilingual possesses two native language systems. These results allude to the idea that native and non-native phonological systems are inherently different. A further prediction suggested that the simultaneous bilingual would display progressive negative transfer from L1-Spanish to L3-BP, and that the L3 would not improve as quickly as the successive bilingual. This prediction is birthed out of the Phonological Permeability Hypothesis (PPH), which holds the underlying assumption of different development in phonology depending on the stability of languages which were previously acquired. Bailey (2013), analyzed the vowels of six native speakers of BP, and compared them to those of four Spanish-English bilinguals with L3-BP. The researcher measured and compared the vowel and nasal murmur duration and formant frequencies. The results of this study point towards cross-linguistic similarity and positive transfer in learners of languages that are typologically similar, being that the findings did not show much difference in production between the L1 groups of learners. The author suggests that "(a) comparison of trilingual with different orders of language acquisition (e.g., a mirror-image pairing of the current study or learners of unrelated languages) could help further determine the source(s) of transfer for different types of L3 learners" (Bailey, 2013, p. 14).

Another phonological aspect, pronunciation (in L3), is the focus of a study in which one of the working hypotheses proposes that a speaker's native language acts as a dominant source of influence (Lipińska, 2015). Llisteri and Poch (1987) corroborate this postulation, in their study comprised of an acoustic analysis the vowels in L3 for native speakers of Catalan with L2 Spanish in which L1 seemed to affect L3 production in an exclusive manner. Wrembel (2013) reached similar conclusions, in a study with Polish native speakers who were L2 English speakers, and L3 French speakers. They used expert raters who evaluated recorded speech samples, rating accent, confidence level, acceptability, and intelligibility. In this case, L1 looked to be the most relevant source of transfer, but the influence of L2 was also noteworthy. A byproduct of the present study, given its setup with two distinct L1 languages, is that it might also give us further indication on potential L1 transfer into the L3. Marx (2002), a case study, suggests that when considering early stages of L3 acquisition, L2 carries a strong influence on L3 pronunciation. This case study failed to provide any acoustic analysis, nevertheless. Wrembel (2010) investigated L1 Polish speakers, with L2 German and L3 English, recorded their oral production, and had language experts making perceptual assessments regarding their production. Results of this study suggest that at initial stages of L3 acquisition, L2 had a more significant effect on L3 production, and subsequently became less of an influence with the development of L3.

De Angelis (2005) postulates that any non-native language goes into a category of "foreign language" in a learner's mind, and this causes a cognitive association to be formed between said non-native languages. The idea is that because L1 does not sound "foreign" to the learner, it is not associated with the other languages, and is therefore excluded and blocked. The author names this an "association of foreignness" (2005, p. 11), and as it has a preference for non-native transfer, it allows for the L2 to obtain a privileged status (Lipińska, 2015). In other lexical and pronunciation research (e.g., Llama et al., 2010), L2 is also shown as possessing a particularly significant impact on the L3.

Tremblay (2008) carried out acoustic analyses of the VOT in the production of L3 Japanese by L1 English L2 French bilinguals. The results seem to point towards L2 influencing the L3. In 2011, Wrembel examined the VOT of the L3 French of L1 Polish and L2 English bilinguals. The results propose a combined cross-linguistic influence of Polish and English in the production of L3 French and point toward the incidence of the L2 in the L3 acquisition of phonology.

Some patterns emerge that are fundamental for the present study; both L2 status factor and typology (see discussion in section 2.3) pose as obvious candidates to inform CLI. The present study seeks to further elucidate this yet unclear paradigm; which one of these (or even a potential different alternative explanation) are better predictors in the selection of a known language in L3 phonological acquisition? To further establish our understanding of the models that inform these patterns, the next chapter elaborates on L2 status factor, typology, and other TLA models.

2.3 Multilingual Models

Typology and L2 status are the most consistently cited factors claimed to have an influence on the L3. Typology has to do with the relative distance among languages, whereas L2 status deals with any languages that a learner knows on top of the L1 (Llama, Cardoso, & Collins, 2010). As explored in the previous section, research has shown that typological proximity is an influential factor when it comes to the L3 lexical acquisition (e.g., Cenoz, 2001; Singleton, 1987). However, other authors have suggested that the L2 has a stronger influence on the pronunciation of the target language (e.g., Marx, 2002; Tremblay, 2006; Williams & Hammarberg, 1998). Even before other research on L2 status had surfaced, Odlin (2003) already called for more research on typology with regards to order of acquisition, or the distance between the target languages, even when recognizing that at the time there seemed to be more evidence agreeing with the role of typology. While in more recent years, more research has been done investigating these two approaches to TLA. We will continue discussing typology and the L2 status in the next sections.

2.3.1 Typology

In a basic sense, typology has to do with the relative distance between several languages. Rothman (2011) puts forward the Typological Primacy Model (TPM), in which he posits that

> Initial State transfer for multilingualism occurs selectively, depending on the comparative perceived typology of the language pairings involved, or psychotypological proximity. Syntactic properties of the closest (psycho)typological language, either the L1 or L2, constitute the initial state hypotheses in multilingualism, whether or not such transfer constitutes the most economical option (p. 112).

Although psychotypological and typological proximity are not always the same, that is generally the case for Romance languages, so we will disregard the difference for the purposes of this study. In this 2011 experiment, Rothman investigated the syntactic and semantic acquisition of Romance Determiner Phrases (DP). The control group was comprised of native speakers of Spanish and BP, and the two subject groups were comprised of L3 intermediate learners, one group of Italian native speakers with L2 English and learning L3 Spanish, and the second group English native speakers, with L2 Spanish and L3 Portuguese. In accordance with the TPM, transfer was predicted from the acquired Romance language instead of English, regardless of the chronology of acquisition, given the typological similarities between Romance languages (Rothman, 2011).

In 2015, Rothman further develops and clarifies the claims on TPM. Here, he posits that the detection of lexical similarities is clearer than that of phonological similarities. And that morphological and syntactic similarities require an even higher degree of exposure to the L3 and a more implicit understanding of the L3. Rothman makes it clear that the TPM intends to have universal application. Rothman maintains that according to the TPM, L3 transfer is indeed determined by the structural proximity between L1 and/or the L2 and L3 (2015, p. 1). The L2 Status Factor model is presented in the following section.

2.3.2 L2 Status Factor

Hammarberg (2001) describes the L2 status factor as "a desire to suppress L1 as being "non foreign/ and to rather rely on an orientation towards a prior L2 as a strategy to approach the L3" (pp. 36-37, 2001). This approach to TLA was first suggested by Williams and Hammarberg (1998). Recent studies (e.g., Bardel & Falk, 2007; Leung, 2005; Rothman & Cabrelli Amaro, 2010), suggest that in the initial stage of L3 syntax, L2 may take on a stronger role than L1 (Bardel & Falk, 2012). Bardel and Falk (2007) examined the status of syntactic transfer at the beginning stages of L3. From this investigation, they search to support the L2 status factor, which proposes that the role of L2 is considerably stronger than that of the L1 at the initial morphosyntactic stages of L3 acquisition (Garcia Mayo & Rothman, 2012). The L2 status factor further suggests that L2 morphosyntax will be transferred with greater ease than that of L1, being that L2 is maintained as a way to block access to the L1 (Rothman, 2011). Bardel and Falk (2007) found that L2 was given preference as a source of transfer in L3 syntax at the initial stage of L3 learning. Falk and Bardel (2011) examined the L2 status factor in a larger set of learners at the intermediate L3 level and discovered that learners still had the same propensity to prefer L2 as a source of transfer in L3. The authors suggest that "the L2 status factor is an outcome of the higher degree of cognitive similarity between L2 and L3 than between L1 and L3" (Bardel & Falk, 2012, p. 3). Simply put, the L2 status factor model posits that, for L3 production, the L2 is more accessible than L1, and that this occurs because both the knowledge of L2 and L3 are process-oriented, while L1 knowledge is more data-oriented.

The discussion continues into present time, and as the body of evidence cited so far shows, it is still impossible to conclusively say whether L2 status or typology is a stronger predictor when selecting a language for phonological acquisition in L3 acquisition (Llama et al., 2010; Cabrelli Amaro, 2017). The current study addresses this still very present gap.

In the next section, the use of vowel reduction as a measurement in phonological acquisition is explained.

2.4 Vowel Reduction

Vowel reduction occurs commonly among world languages. In essence, some vowels experience qualitative changes when in unstressed positions (Crosswhite, 2004). In other words, vowel reduction refers to a change that occurs to the acoustic quality of a vowel that is conditioned by stress (Cabrelli Amaro, 2017).

Vowel reduction generally comes up given that unstressed vowels are generally shorter than their stressed counterparts, and it proves more cumbersome to attain distinct vowel qualities in instances where vowel length is shorter. Vowel reduction chiefly tends to neutralize height contrasts, as opposed to rounding or backness contrasts. So much so, that the most habitual patters of reduction do away with mid vowels or the distinctions between lower mid and higher mid vowels, but do not in actuality neutralize the contrasts between front-back. These backness and rounding distinctions can indeed be neutralized via reduction, but only under specific circumstances (Flemming, 2005).

Phonetics and phonology, although both linguistic branches, focus on different specific areas. Phonetics largely deals with the study of the sounds produced by the human voice and the articulation of speech, whereas phonology handles the study of the distribution and patterning of speech sounds in a given language, encompassing the rules by which pronunciation is governed. Phoneticians and phonologists tend to have diverging understanding of vowel reduction. From a phonetician's point of view, it customarily speaks of the tendency that vowels have to centralize under conditions of shortened duration and given factors such as stress. When one refers to reduction in this case, it has to do with "the reduction in the size of vowel space for vowels appearing in durationally longer contexts." (Herrick, 2003). In the case of phonologists, reduction tends to denote a neutralization of vowels given circumstances that are dependent upon stress (Crosswhite, 2001). As we know, phonetics and phonology are deeply interrelated, and in recent years, theories have attempted to demonstrate that in terms of vowel reduction. As Herrick (2003) explains:

> Unstressed vowels are shorter than stressed vowels. The decrease in duration makes it more difficult to achieve the jaw lowering necessary for low vowels, and this results in considerable formant undershoot (in F1 - the correlate for vowel height) for low vowels. This F1 formant undershoot effectively raises the floor of the vowel space causing the overall vowel space to shrink (phonetic vowel reduction). In this shrunken vowel space, the perceptual distance between vowels also shrinks, neighboring vowels are more easily confused, and ultimately this leads to neutralization (phonological vowel reduction). (pp. 16, 17)

English displays such reduction, and as Ladefoged (2006) points out, [ə] is used to symbolize many vowels which have a central, reduced vowel quality. As Hammond (2001) suggests, in the case of American English vowels, "stressed vowels are much longer than unstressed vowels" and "unstressed vowels are always realized as reduced vowels." Furthermore, Hammond (2001) posits that "Spanish vowels do not vary in their length or duration as much as they do in English whether they are found in stressed or unstressed syllables." In BP, vowel reduction occurs generally by the raising of [-high] vowels and the centralization of [-back] vowels (in the case of the high non-back vowel, only if in the final syllable of the world). The high back vowel does not change its quality. Vowels that come before a consonant which arises from the simplification of two consonants separated by a morpheme boundary, and nasalized vowels are among the specific instances that do not tendentiously show reduction (Frota, 2014).

These considerations give us an adequate general idea of where our target languages fit within the realm of vowel reduction. To solidify our knowledge of vowel reduction of the target languages at hand and to elaborate on some choices later expounded upon in the methodology chapter, in the next three subsections, we will take an individual look at vowel reduction in each of the target languages of the present study.

As mentioned before, Cabrelli Amaro (2013, 2017) looks at the same language pairings that are the target of this study, so our vowel reduction considerations will be based on the information she offers in those analyses, in addition to considering some other researchers who have investigated vowel reduction in BP, Spanish, and English.

In continuation, vowel reduction will be discussed specifically in BP. A section on Spanish vowels will follow, and then, vowel reduction in English will be examined. A discussion on language activation completes this section.

2.4.1 Vowel Reduction In BP

The BP vowel inventory is comprised of /i e ɛ a ɔ o u/, in stressed position (see Figure 1 for complete BP vowel inventory). In pretonic syllables, /ɛ/ is neutralized to /e/ and /ɔ/ to /o/ (Oh, 2018). The number of contrastive vowels goes down according to the grade of weakening of the syllable, in unstressed position (Cabrelli Amaro, 2017).

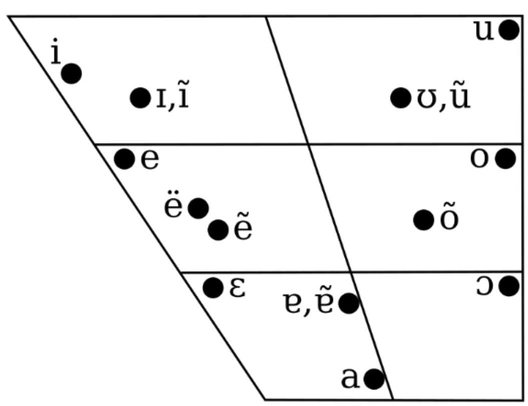


Figure 1 Brazilian Portuguese Vowels adapted from (Barbosa & Albano, 2004) [1]

[1] Retrieved from https://commons.wikimedia.org/wiki/File:Brazilian_Portuguese_vowel_chart.s

Posttonic syllables occur as the weakest (Barbosa & Albano, 2004). In this position, as vowels experience further reduction, /a/ turns into [ɐ], /e/, i/ neutralize to [i], and /o/, /u/ to [u] (Oh, 2018). In unstressed syllables, reduction occurs to five vowels /i, u, e, o, a/ in BP. In unstressed syllables in word-final position, further reduction to just three vowels /i, u, ɐ/, which possess a binary height contrast. (Kenstowicz & Sandalo, 2016). BP is supposed to have preserved the seven-vowel system of Proto-Romance in the stressed syllable position, exhibiting a loss of the open-close mid vowel contrast in unstressed non final syllables (Barbosa & Albano, 2004). Further reduction occurs as a binary height distinction in unstressed word-final syllables (Kenstowicz & Sandalo, 2016).

For the present study, and like Cabrelli Amaro (2017), we chose to limit our research to the final syllable, provided that the vowel inventory in that particular position has been found to be the most stable across multiple BP dialects (Oliveira Silva, 2012). Following the same pattern of reasoning, [ɐ] was left out from our research, given its instability across dialects, as also found by Oliveira Silva (2012).

Vowel reduction governed by stress is generally linked with alterations of formant frequency (the F1 of [e o] is higher than the F1 [ɪ ʊ]) or said in other words [e o] take up a lower portion of the vocalic space (Cabrelli Amaro, 2017). The F2 for [e], a front vowel, is also generally more front (or higher) than the reduced [ɪ], and F2 of [o] is more back (lower) than the reduced [ʊ] (Callou, et al., 2002). As pointed out later, reduced vowels are generally shorter than vowels that are fully realized. For example, [ʊ] is shorter than [ɪ] in posttonic position (Oliveira Silva, 2012). This suggests that relative duration (i.e., duration ratio) values should be smaller for /e/ than for /o/ (Cabrelli Amaro, 2017). Lower sonority reduced vowels [ɪ ʊ] are lower in intensity when compared to the higher sonority vowels [e o] (Massini-Cagliari, 1992).

As mentioned at the beginning of this Vowel Reduction section, vowel reduction is a common phenomenon across languages. Qualitative change in vowel and reduced duration are features of vowel reduction. Major (1985) notes phrase-final lengthening can influence the existence of vowel reduction in BP. And that even in the case of pretonic vowels, raising can occur to a certain degree in informal or fast speech. While centralization of formants (F1 and F2) is common in vowel reduction (Lindblom, 1963), in BP in reduction, raising tends to occur in vowel reduction, which can erase some of the height distinctions in vowels that BP features in stressed syllables. Next, the Spanish vowel inventory and features will are examined.

2.4.2 Spanish Vowels

Spanish does not display vowel reduction like English and BP, and possesses a more stable vowel inventory, [a e i o u] (Figure 2), not altered by stress (Quilis & Esgueva, 1983). Naturally, vowel reduction could still occur in Spanish, only to a very negligible degree when compared to English or BP. For simplicity, we will refer to Spanish as a non-vowel reducing language.

Spanish formant frequencies are predicted to stay stable regardless of being in stressed or unstressed position, and that intensity does not contain any correlation to stress in the Spanish vowel inventory. Thus, Spanish speakers are expected to display vowel production with similar quality, irrespective of stress (Cabrelli Amaro, 2013).

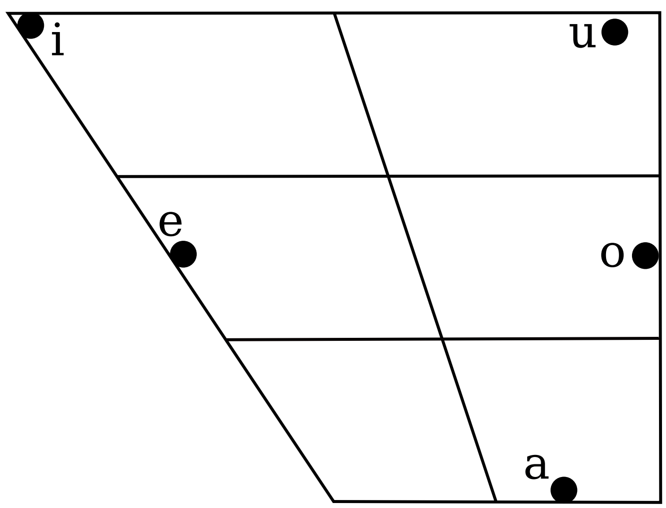


Figure 2 Spanish Vowels (Ladefoged & Johnson, 2011)

In a study focusing on Spanish and Catalan, Ortega-Llebaria and Prieto (2011) considered measurements of stress correlates in those two languages. Catalan displays a form of vowel reduction similar to that of BP. The authors show that formant frequencies are stable in Spanish both in stress and unstressed position. Furthermore, they also determine though it is a correlate of stress in Catalan, intensity is not a correlate of stress in Spanish. Lastly, they confirm duration as a correlate of stress both in Catalan and Spanish.

Some research suggests evidence for the support of transfer occurring from Spanish to BP based on psychotypological similarity (e.g., Cabrelli Amaro et al., 2009; Montrul, Dias, & Santos, 2011), which, in a vacuum, would lead us to pose that our participants would transfer non-vowel reducing characteristics from Spanish into BP at the initial stages L3 BP. Nevertheless, and as previously noted, it is very possible that English reducing characteristic would transfer into BP, instead of or even in addition to Spanish (Cabrelli Amaro, 2013). This tension further justifies the design of the present study and its research questions. Vowel reduction as it happens in English is discussed next.

2.4.3 Vowel Reduction In English

Vowel reduction is present in English, and it is informed by both whether a syllable is open or closed (its structure) and stress. Vowels fluctuate immensely between different English varieties (Ogden, 2009). The American English stressed vowel system is comprised of 11 monophthongs (see Figure 3) and its word-final unstressed inventory for vowels is /i o ə ɚ/ (Flege, 1997).

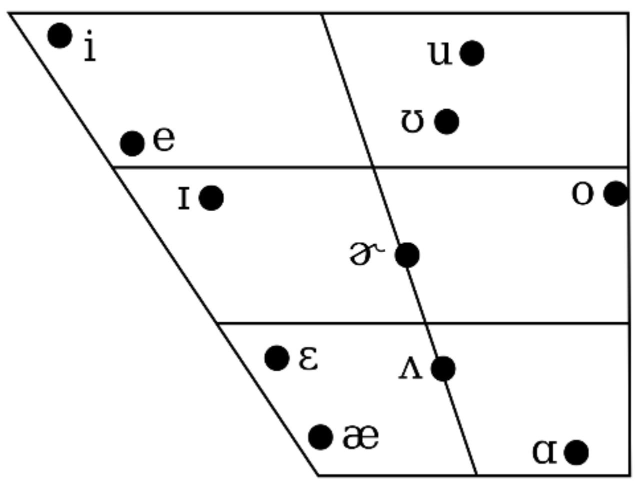


Figure 3 American English Vowels [2]

First formant (F1) is a good correlate of vowel height, and close vowels possess a low F1, and open vowels, a high F1. In terms of vowel duration, in American English, there are short and long vowels. Duration is also affected by the following syllable-final consonant: preceding voiced

[2] Retrieved from https://commons.wikimedia.org/wiki/File:California_English_vowel_chart.png

consonants, vowels tend to be longer, but when preceding voiceless consonants, shorter. (Ogden, 2009). English allows for a narrower range of vowels in unstressed syllables over those permitted in stressed syllables (Ogden, 2009).

In stressed position, vowel production possesses greater intensity and duration than in unstressed position. and are more perceptually salient to listeners (Flemming, 2009). Vowels in unstressed position are unable to extend into the "periphery of the oral cavity" (Byers & Yavas, 2017), and as such, schwas embody neutralization in terms of vowel quality contrasts (Flemming, 2009).

For the purposes of the present study, we will assume BP and (American) English as vowel reducing languages, and Spanish as a non-vowel reducing language. In the next section, language activation is discussed, and the way in which it is used in this study is explained.

2.4.4 Language Activation

A key issue to consider in TLA is that of language activation, whether between some or all of the known languages for a multilingual (Sánchez, 2015). De Angelis (2007) describes language activation as "a process by which an entire language – or some elements of it – are stimulated and accessed during the execution of a receptive or productive task" (p. 70). De Angelis elucidates that this concept is often thought of in the context of connectionism or parallel-distributed processing, and that authors within the field recognize that the concept of connectionism is sedimented in an effort to identify relationships between language, biology and neurobiology. Mitchell, Myles and Marsden (2019) define connectionism as "(a) cognitive theory that views language as a set of nodes with weighted links between them" (in Glossary of Second Language Learning Theories). In parallel-distributed processing the notion is that this information is processed at distinct levels, in a parallel fashion (De Angelis, 2007). While it is true that activation can be explored under many different lenses, for the purposes of this study, activation will simply refer to the accessing of a language in terms of raising or lowering the levels of activation of a given language or a specific aspect within a language (Grosjean, 2001).

At the lexical level, research in TLA demonstrates that the several languages of a multilingual are intertwined when acquisition begins. When the goal is to look at phonological processing, Jared et al. (2012) found that children activate phonological representations of a set of two languages even when given a task that is meant to elicit only one. For adult bilinguals the evidence points to the idea that the activation of phonological representations is not necessarily selective when reading in their L1. The evidence is, nevertheless, overwhelmingly in support of the idea that one must account for language activation when researching within TLA.

Based on these multilingual models and considerations, in the following section, the research questions that motivate this study are presented, as well as their attendant hypotheses.

2.5 Research Questions (RQs)

The present study is motivated by the following research questions, and their associated hypotheses.

- Research Question #1: Does a native speaker of a vowel reducing L1 and a non-vowel reducing L2 (ESP) display more or less vowel reduction in a vowel reducing L3 than a native speaker of a non-vowel reducing L1 and vowel reducing L2 (SEP)?
    - Hypothesis #1: SEP will display more reduction than ESP in accordance with the postulations of the L2 status factor.

This hypothesis proposes the L2 status factor as a stronger predictor. In this case, SEP is predicted to display more reduction than ESP: SEP has English, a reducing language, as an L2, and given the primacy of the L2, there is, therefore, a greater chance for reduction.

If the TPM is the stronger predictor, SEP would display less reduction than ESP. Both ESP and SEP will possess transfer from Spanish. SEP, however, is comprised of participants whose L1 is Spanish (stronger Spanish than group ESP) and their Spanish is likely to exhibit less reduction. Therefore, SEP participants would reduce less in BP based on typology as defined by Rothman (2011, 2015).

- Research Question #2: Does longer exposure to an L3 affect phonological production in such a way as to modify the results?
    - Hypothesis #2: Participants will reduce more in BP the longer they are exposed to the language, but not significantly enough to modify the previous results.

It is expected that the longer participants are exposed to a language, the more their production would mirror its features, in this case, vowel reduction.

In the next chapter, Methodology, the methodology used in the present study is explained, specifically expounding on methodological choices. This methodology further justifies the Research Questions that drive the present study.

CHAPTER 3. METHODOLOGY

In this study the manner in which the subcategory of Cross-linguistic Influence (CLI), language transfer, occurs into the L3 (third language) is investigated, focusing on a facet of language production, namely that of vowel reduction. To determine how this transfer occurs, experimental data obtained from the production of vowels of two groups of multilinguals speakers of L3 Brazilian Portuguese (BP) are analyzed. Group ESP is comprised of individuals with the following linguistic profile: L1 (first language) English, L2 (second language) Spanish, L3 BP, whereas individuals in Group SEP display L1 Spanish, L2 English, L3 BP. Participants completed both a carrier phrase task and a paragraph reading task in BP, their L3.

The methodology for this study is inspired by that of Llama et al. (2010), in which the authors focused on voice onset timing of /p, t, k/ in speakers of L3 Spanish who were either Francophone (L1 French - L2 English) or Anglophone (L1 English - L2 French) bilinguals. The aim of their study was to clarify whether typology or L2 status would be a stronger predictor when selecting a source language for phonological influence in L3 acquisition (see 2.2.1 for more detail on this study); one of the research questions of the current study is based on the same aim. In their study, participants completed two L2 tasks (reading of an L2 word list, and an L2 vocabulary test), and three L3 tasks (reading of an L3 word list, an L3 vocabulary test, and description of 15 pictures in Spanish). For the readings of the word lists, participants were exposed to a PowerPoint presentation which would display one word at a time and would then produce all the tokens in isolation.

The current study differs from Llama et al. (2010) in a number of ways. They used word lists as the main instruments being tested. Instead, here, words prompted by carrier phrases are used, and within a paragraph to elicit more natural speech. Nonce words are also utilized to avoid tapping into participants' previous phonetic knowledge which could have potentially created skewed data favoring words with which participants were previously familiar. This chapter is organized as follows: first, Participants are presented followed by the examination of Materials and Procedure, and Stimuli. Further notes on Procedure are then discussed.

3.1 Participants

The participants were all university students currently attending a Midwestern university in the United States, ranging from 18 to 49 years of age. All participants had normal or corrected vision and normal hearing. There are two L3 groups from which experimental data are obtained (see Table 1). Group ESP (*n* = 9) is comprised of students with the following linguistic profile: L1 (native speakers of) English, L2 Spanish, L3 BP. Every Group ESP participant grew up in the United States of America and acquired Spanish after the age of 12. Group SEP – Hispanic speakers (*n* =3) is comprised of L1 (native speakers of) Spanish, L2 English, L3 BP. Group SEP participants grew up in Central or South America, and acquired English after the age of 12, possessing proficiency in English sufficient to be enrolled at an American university. One SEP participant grew up in the United States of America, but exclusively spoke Spanish at home until beginning school in first grade. All participants had at least one course of BP classroom instruction. Controlling the data collection environment was an important consideration during this study. Given the specificity of vowel reduction and how easily recorded production can be affected by background noise, it was imperative to obtain quality recordings. Background noise could lead to an overestimation of intensity minimums, which in turn would adversely impact the calculation of intensity ratios: for instance, if the vowel in stressed position had an artificially inflated ratio, this would cause an inversely proportional error. Particularly in L3 research, language activation also needed to be accounted for (Sánchez, 2015). These factors necessitated participants coming into a controlled language and acoustic environment. Materials and Procedure are discussed next.

Table 1 *Linguistic Profiles of Participants*

Group	L1	L2	L3	N
ESP	English	Spanish	BP	9
SEP	Spanish	English	BP	3

3.2 Materials and Procedure

Prior to coming in for a recording session, participants filled out an adapted Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian, Blumenfeld, & Kaushanskaya, 2007) (see Appendix A) through an online Purdue Qualtrics survey which informed eligibility to participate in the study (see section 3.2 for more on eligibility). Cabrelli Amaro (2013) suggests that conducting research on participants' language background information is imperative, and that it

> should minimally include age of acquisition, length of residence in the country where the L2 is spoken (in the case that the learner is in an immersion environment), education in the L1 and L2, self-reported use (context and frequency) of the L1 and L2, as well as scalar self-ratings of reading, writing, speaking and aural comprehension in the L1 and L2 as well as an L3/Ln where applicable. (2013)

Thus, the adapted LEAP-Q questionnaire for this study included name, age, languages known in order of dominance and acquisition, prior instruction in known languages, and number of years spent in each language environment. Eligibility to participate in the study was determined by the results of the questionnaire. In order to be eligible for the study, participants must have taken at least one Portuguese course and had to have more advanced knowledge of their L2 than their L3 (Portuguese). Participants were assured that neither their choice of whether to participate in the study nor the results of the study would in any way affect their standing or relationship with the university.

Participants were recruited during the Spring semester, and data was subsequently recorded at the end of the semester. Recruitment occurred by way of posting flyers at the university. The stimuli and its selection are justified in the next section.

3.3 Stimuli

The selection of stimuli was informed by those of Cabrelli Amaro (2017), a study that examined the same target languages as the present study, and also used vowel reduction as a measurement (see Literature Review for further discussion on this study).

The same master set of stimuli was used for all testing of the experimental groups. To minimize the potential for lexical interference (the target languages possess a considerable number of cognates), and to also minimize the potential for participants to tap into any previous phonological or even phonetic knowledge (Strange & Shafer, 2008), only nonce words were considered in this study. Every token had a /C(C)V.CV/ structure, with the first vowel always being an "a" (V1 = a) and the second vowel always being either an "e" or an "o" (V2 = e/o) (e.g., /ma.fo/, /pla.be/). All tokens were comprised of two syllables, as in Cabrelli Amaro (2017). Forty tokens were recorded. Thirty tokens were used for analysis[3]: on each second syllable, eight tokens a /k/ phoneme, eight tokens possess a /f/ phoneme, eight tokens possess a /b/ phoneme, three tokens possess an /n/ phoneme, and three tokens possess a /d/ phoneme (see Figure 4). All tokens were measured (critical tokens).

1. baco
2. daco
3. faco
4. gaco
5. laco
6. daque
7. gaque
8. placo
9. bafe
10. cafo
11. glafe
12. jafe
13. jafo
14. lafo
15. mafe
16. mafo
17. glabe
18. mabe
19. mabo
20. plabe
21. tabe
22. fabe
23. labe
24. trobe
25. glane
26. lano
27. glano
28. flade
29. lade
30. pade

Figure 4 Tokens

3.4 Procedure

It was important to account for language activation prior to recording (Llama et al., 2010; De Angelis, 2007), and thus all participants were welcomed by the interviewer in their native language, and then filled out a consent form in English.

Participants completed two tasks in their L3, BP: the reading of several nonce words (Figure 4) using a carrier phrase and reading of a paragraph where all those nonce words appeared in a randomized manner. All instructions for the tasks were received in either Spanish or English (half of the participants received instructions in either language to normalize for language

[3] 40 tokens were originally recorded. 10 (*naque, paque, glafe, rafo, pobe, pabe, fano, bano, dade, cade)* were eliminated prior to analysis for a total of 30 critical (measured) tokens. Four tokens were eliminated to avoid lexical interference: *cade* was eliminated given potential confusion with the BP expression “cadê”; *bano* was discarded to avoid confusion with the Spanish word “baño”; *naque* was discarded given its phonetic similarity to the English word “knack”, and *paque* for the same reason in relation to the English “pack”. The token *glafe* was doubled, so its second iteration was eliminated. To maintain a balanced number of tokens for each sound, the remainder five original tokens were discarded semi-randomly.

activation). The audio for both tasks was recorded using a Turtle Beach Ear Force PX22 headset with microphone. All participants recorded tokens in a soundproof booth. Both tasks, CPT and PRT are discussed in continuation.

3.4.1 Carrier Phrase Task (CPT)

For the carrier phrase task, the question "É em referência a quê, por favor?" [What is it in reference to, please?] was displayed, followed by the carrier phrase "É em referência a [ ], por favor." [It is in reference to [ ], please.] plus a nonce word (e.g., É em referência a plafe, por favor.) [It is in reference to plafe, please.]. This carrier phrase was chosen based on Cabrelli Amaro (2017), given the fact that it does not possess any /e/ or /o/ in unstressed word final position. The ending "por favor" [please] was also added to minimize end of utterance effects. Participants were to read the carrier phrase in conjunction with the nonce word. Before the task began, the researcher made sure that the participants were comfortable with the carrier phrase.

Python[4] software was used to create a program that would both set up each screen with the randomized nonce words for each task, and also to record and compile the information for posterior statistical analysis. This task was comprised of 120 randomized trials per participant, using the 30 critical tokens (n = 15 of V2 = e and n = 15 of V2 = o), and 10 discarded tokens (40 total x 3 repetitions).

3.4.2 Paragraph Reading Task (PRT)

For the paragraph reading task, participants read a paragraph displayed on a screen (see Figure 5). Forty tokens (30 critical) were randomly inserted into each blank. Tokens were not marked for the desired syllabic stress that one would expect to occur in BP so as to allow for participants to read tokens based on their natural linguistic intuition. Each participant read the paragraph twice, yielding 80 tokens per participant. Only critical tokens were submitted for acoustic analysis (n = 60). An explanation of how data was analyzed is found in the following section.

[4] Python Software Foundation. Python Language Reference, version 2.6. Available at http://www.python.org

Na segunda-feira, fazia muito frio e o ____era forte. Eu estava bebendo um ___, quando de repente, ___entrou em minha casa. Eu fiquei muito___! Chamei ____ para me ajudar, mas não tinha nenhum. Então, eu procurei o ___. Depois de o encontrar, decidi ir a ___. Ali, vi ___. Meu amigo que ___muito, correu ___ até mim. Ele me falou que tinha comido __ e ___ e que por isso agora estava___. Fomos ao hospital, onde a médica deu ___ a meu amigo para tomar de duas em duas horas, depois de ___. Ele disse que podia ___ mas que não queria ___. Decidi voltar a casa, onde vi minha bicicleta ___. Eu tinha ___ minha bicicleta no ___ no ano passado. Eu gosto de viajar pela ___ e visitar meus amigos. Na semana ___, eu fui de bicicleta ao cinema junto a ___. O filme se chamava "___" e foi muito divertido. Meu primo e minha ___ estavam no cinema. Eles tinham tentado comprar ___ mas não tinha mais. Eu dei meu ___ a eles porque somos amigos. Depois fui ___ para casa. No dia seguinte, acordei ___ e fui para a universidade. Esqueci meu ___ em casa, por isso regressei. Pelo caminho, eu ___ dois cachorros e um gato. Voltei para a universidade, onde tive aula de ___ e de ___. No final da aula, eu apanhei o ônibus até ___ onde tinha ___. Ali, joguei futebol sem sapatos ou ___. Foi muito ___. Depois de tomar banho, fui a ___, vesti o pijama e comi ___. Amanhã vou a ___e vai ser fantástico.

Figure 5 Paragraph Reading Task Text

3.5 Data Analysis

Praat Software (Version 6.0.12 released on 24 January 2016: Boersma & Weenink) was used for the measurement of vowels. In accordance with the recommended values in the Praat Manual, the Praat formant tracking algorithm was set to its default values. These standard values are: using the Burg method, five formants, pre-emphasis starting at 50 Hz (Hertz), and an analysis range of 50 to 5,500 Hz for the female participants and of 50 to 5,000 Hz for the male participants. Some of the tokens were excluded from analysis because of insufficient recording quality. Excluding these tokens from analysis occurred because of presence of glottal pulses (creaky voice) or undefined F0 values given lack of voicing. This is a customary find in vowel reduction production and analysis (Cabrelli Amaro, 2017). The exact numbers of tokens removed from analysis is present in the Results chapter.

A Praat Vocal Toolkit (Corretge, 2012) script was modified to identify target vowels. The measurement of vowel reduction in the present study was based on the work of Herrick (2003) regarding formant frequency and also Cabrelli Amaro (2013, 2017) in regard to duration and intensity.

After the script to mark vowels was run, each critical token vowel was checked individually (see Figure 6). Another script using *Python* was written to extract intensity, formants, and duration, and vowel position information and compile it into an Excel file.

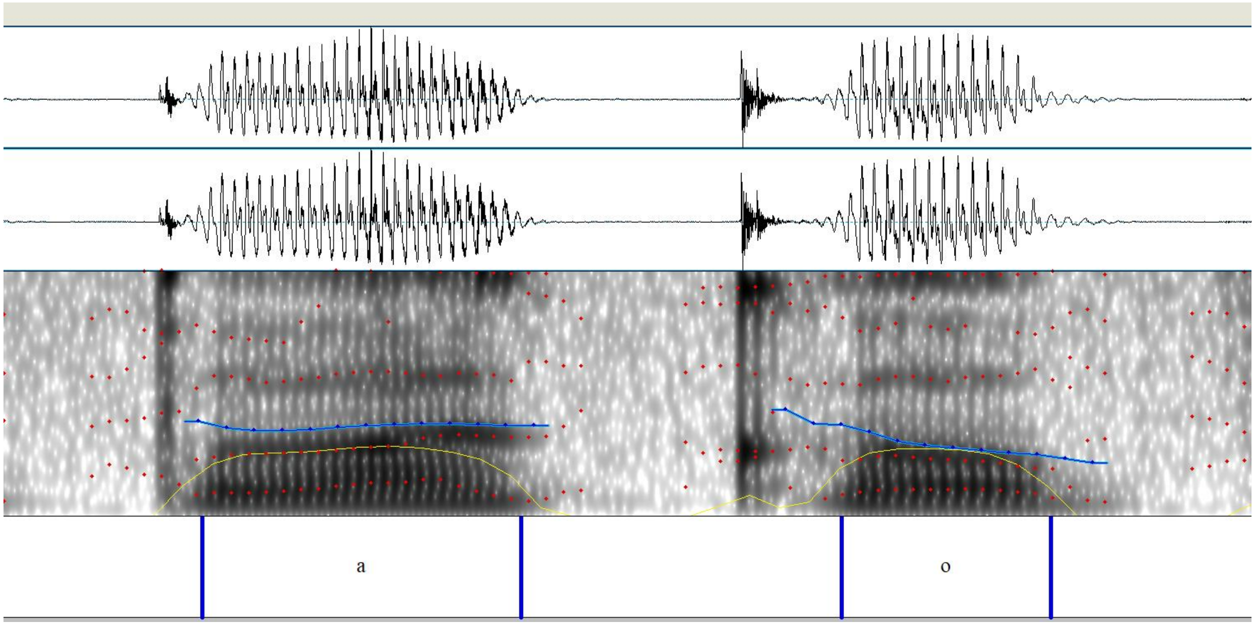


Figure 6 Example demarcating vowels in Praat

A discussion on Formant Frequency, Duration Ratio, and Intensity and how these were measured is found in the next three sections.

3.5.1 Formant Frequency

F1 (first formant) and F2 (second formant) measurements were collected from the temporal midpoint between the onset and offset. Other studies focused on vowels, and specifically vowel reduction utilize the midpoint for collection of the formant values (e.g., Kenstowicz & Sandalo, 2016). The midpoint was selected to minimize any effect of coarticulation caused by the preceding consonant. Fundamental frequency was obtained as the measure of F0 at midpoint. While F0, F1 and F2 were measured, only F1 was considered for the statistical models. F0 and F2 worked only as a measure to ensure quality of the recordings and identify potential issues like vocal fry or voicelessness.

Lobanov's (1971) vowel normalization methodology was used in this study, as it is dependably rated among the best for research comparing formant values of vowels spoken by a given participant (Adank, Smits & van Hout, 2004; Flynn & Foulkes, 2011). Vowel normalization is pertinent since the oral cavity size for each participant is different. This means that the way formants resonate is different for each participant. Thus, in order to compare formants among different genders and different people with varying mouth sizes, normalization is pertinent. Adank, Van Hout, and Smits (2004) point out that

> using normalization procedures in language variation research is not without drawbacks. It has been reported that some normalization procedures introduce artificial variation patterns into the description when the vowel systems of the languages/dialects to be compared are not phonologically equivalent (Disner, 1980). Moreover, there are indications that applying normalization procedures reduces sociolinguistic variation in the acoustic representation along with the anatomical/physiological variation (Hindle, 1978).

Other researchers (i.e., Labov 2001) later reevaluated these procedures and concluded that sociolinguistic variation was in fact mostly kept even after normalization (Adank et al., 2004). In addition to accounting for difference in oral cavities and preserving sociolinguistic differences among vowels, normalization can also be helpful to preserve phonological distinctions (Disner, 1980). For the purposes of this study, vowel normalization was necessary, as participants for each group have different Spanish dialectal variations, and to also account for the presence of more participants that identify as female vs. those that identify as males.

3.5.2 Duration Ratio

Duration Ratio was obtained by considering the duration of the (word-final) unstressed vowel and dividing it by the duration of the stressed vowel. This measurement in form of a ratio was used in order to be able to compare vowel productions within the same speaker (Kato, Truong, Kitamura, & Yamamoto, 2019).

All durations were measured in milliseconds. A larger duration ratio represents less reduction; if duration ratio is greater than 1, the unstressed syllable is longer than the stressed syllable. Duration ratio was measured with the objective of controlling for speech rates.

3.5.3 Intensity Ratio

In order to measure intensity ratio (relative intensity), the intensity at midpoint observed in the word-final unstressed vowel was divided by the intensity at midpoint observed in the stressed vowel (as measured in Rallo Fabra, 2015). Intensity was measured in decibels. Vowels are more reduced as the relative intensity is lower. Parker et al. (2008) suggest that the perceived loudness of a sound, intensity, is the best acoustic correlate of phonological sonority.

3.6 Statistical Analysis

The data gathered through the Carrier Phrase and Paragraph Reading tasks were analyzed statistically in order to reveal a potential significant difference between Group ESP and Group SEP. Linear mixed-effects model (LMEMs) were conducted for each task, and for each variable: duration ratio, intensity ratio and height (F1) (see 4.2 Statistical Models for more detail). Item and participant effect were also considered. The data analysis was generated using The R Project for Statistical Computing software (R Core Team, 2020) RStudio Version 1.1.447, lme4 for mixed-effects modelling (Bates, Mächler, Bolker, & Walker, 2015). Python scripts were also developed to aid in data compilation into a searchable database, both for participant information and data rendering.

Since not every speaker produces speech at the same rate, a measurement for words per second was obtained. Taking duration as an example: for one participant, the average duration for all tokens is used as a normalizer to standardize duration measurements. A covariate of how long it took a participant to read the paragraph in seconds considering the number of words present in each paragraph (270 words + 30 randomized tokens = 300 words) was considered. The two iterations of participants reading paragraphs were averaged.

A post-hoc test was not used since only two groups are analyzed in the current study. Formant frequency, duration, and intensity (obtained in the manner explained above) were compared among Group ESP and Group SEP.

In the following chapter, Chapter 4, the results of statistical analyses and descriptive results are presented. In Chapter 5, these findings are subsequently discussed in detail.

CHAPTER 4. RESULTS

In order to address the research questions presented in chapter 2, a carrier phrase task and paragraph reading task were performed, as described in section 3.5. In this chapter, the data collected from those tasks is presented, along with its subsequent analyses. The Research Questions intend to elucidate: 1) whether a native speaker of a vowel reducing L1 (first language) and a non-vowel reducing L2 (second language) displays more or less vowel reduction in a vowel reducing L3 (third language) than a native speaker of a non-vowel reducing L1 and vowel reducing L2, 2) how exposure to an L3 affects phonological production, and would this exposure affect these results.

Research Question 1 examined whether an L1 speaker of a vowel reducing language and a non-vowel reducing L2 (ESP) displays more or less vowel reduction in a vowel reducing L3 than a native speaker of a non-vowel reducing L1 and vowel reducing L2 (SEP). The models Duration Ratio in PRT and Duration Ratio in CPT were used to address this question regarding duration ratio; in terms of relative intensity, models Intensity Ratio in PRT (Paragraph Reading Task) and Intensity Ratio in CPT (Carrier Phrase Task) were used; finally, models Height in (F1) in PRT and Height (F1) in CPT informed the F1 (height) results.

Research question 2, explored how exposure to an L3 affects phonological production, and if a participant's overall exposure to L3 over their lifetime would affect these results. All models were used to investigate this question, as they all had Exposure, and Group by Exposure as a fixed effect.

In this chapter, results from both CPT and the PRT are presented (4.1), the statistical models are explained (4.2), and subsequently the results for each model are shown (4.3,4.4,4.5).

4.1 Carrier Phrase Task (CPT) and Paragraph Reading Task (PRT) - Analysis

For the Carrier Phrase Task 6,480 values were measured and analyzed (12 participants x 30 critical tokens = 360 tokens; 360 tokens x 3 repetitions = 1,080 tokens; 1,080 tokens x 2 vowels = 2,160 total vowels for measurement). 2,160 datapoints were measured for each of the three categories - duration, and F1 and intensity for the total of 6,480 measured values. Trials where devoicing or creaky voice were present resulted in 330 undefined F0 values (15.4%), 21 undefined

F1 values (0.98%), and 22 undefined F2 values (1.03%). If formant values were undefined, those trials were excluded from analysis. The R Project for Statistical Computing software (R Core Team, 2020 - RStudio Version 1.1.447), with lme4 for mixed-effects modelling (Bates, Mächler, Bolker, & Walker, 2015) weas used for data analysis and creating plots.

For the Paragraph Reading Task, 24 trials (12 participants x 2 repetitions) were conducted. Tokens were analyzed (12 participants x 30 tokens = 360 tokens; 360 tokens x 2 repetitions = 720 tokens; 720 tokens x 2 vowels = 1,440 total vowels for measurement). Each token possessed 2 vowels, and they were marked for duration, and F1 and intensity. Thus, 4,320 PRT datapoints, were eligible for statistical analysis. Trials where devoicing or creaky voice were present resulted in 257 undefined F0 values (18.7%), 24 undefined F1 values (1.78%), and 15 undefined F2 values (1.82%). If F1 and F2 values were undefined, those trials were excluded from analysis. R (R Core team, 2020) with lme4 package (Bates, et al., 2015) was used for data analysis and creating plots.

Each critical token had two vowels, one in position 1 (assumed stressed position) and one in position 2 (assumed unstressed position). Formants (F0, F1, F2) and intensity were obtained at midpoint. Overall length of exposure to L3 were also used as variables in the analysis. Vowel duration was measured in milliseconds and subsequently duration ratio was calculated (duration of unstressed vowel/duration of stressed vowel), formants were measured in Hertz (Hz), exposure in numbers of years, and intensity in decibels (dB).

For both tasks, each critical token had two vowels, one in position 1 (assumed stressed position) and one in position 2 (assumed unstressed position). F1 and intensity were obtained at midpoint. Overall length of exposure to L3 was also considered in the analysis. Vowel durations were measured in milliseconds but then transformed into a ratio, formants were measured in Hertz (Hz), overall length of exposure in numbers of years, and intensity in decibels (dB) but then turned into a ratio (see section 3.5 for further details on Data Analysis).

4.2 Statistical Models

Both the CPT and the PRT data were analyzed through three linear mixed-effects models (LMEMs) (Bates et al., 2015) for a total of six models.

Table 2 *Statistical Models*

	Paragraph Reading Task	Carrier Phrase Task	Fixed Effects
Duration Ratio	Duration Ratio in PRT	Duration Ratio in CPT	Group,
Intensity Ratio	Intensity Ratio in PRT	Intensity Ratio in CPT	Exposure,
Height (F1)	Height (F1) in PRT		Group*Exposure

A maximal random effect structure was attempted using the methodology present in Barr, Levy, Scheepers, & Tily (2013). Barr et al. (2013) suggest that the fixed effects are of critical interest, then random effects matching those fixed effects should be evaluated. They also urge researchers to include detailed information that allows for the replication of the random effect structure. Models included either duration ratio, intensity ratio, or height as the dependent variable. Fixed effects included group (SEP, ESP), Exposure, and their interaction. Random effects included participant and item as random intercepts. More complex random effects structure, including random slopes, did not permit model convergence. This same maximal effects structure was used for each of the models detailed in section 4.3. All random effects tables can be consulted in Appendix C.

4.3 Duration Ratio Results

4.3.1 Duration Ratio in PRT

The Duration Ratio in PRT model evaluated the impact of Group and Exposure on duration ratio, using Group, Exposure, and Group by Exposure as fixed effects. These variables were evaluated here for the Paragraph Reading Task. The random effects accounted for in this model were subject and item.

Table 3 *Fixed Effects*: *Unstressed/Stressed Vowel Duration Ratio in Paragraph*

Parameter	*β*	SE	*df*	*t*	*p*
(Intercept)	0.87	0.20	7.98	4.41	.002
Language Order Classification (SEP)	0.74	0.44	8.02	1.67	.134
Length of Exposure to Portuguese	-0.04	0.08	8.04	-0.52	.615
Language Order Classification: Length of Exposure to Portuguese	-0.07	0.10	8.04	-0.70	.503

Significance was not found for any of the fixed effects in the Duration Ratio in PRT model. No significance was found in duration ratio between Groups (β = 0.73, SE = 0.44, t(8.02) = 1.66, p = .13). The effect of Exposure on duration ratio was not significant (β = -0.04, SE = 0.08, t(8.04) = -0.52, p = 0.61). No significance was found in the interaction between Group and Exposure (β = -0.06, SE = 0.09, t(8.03) = -0.70, p = .50).

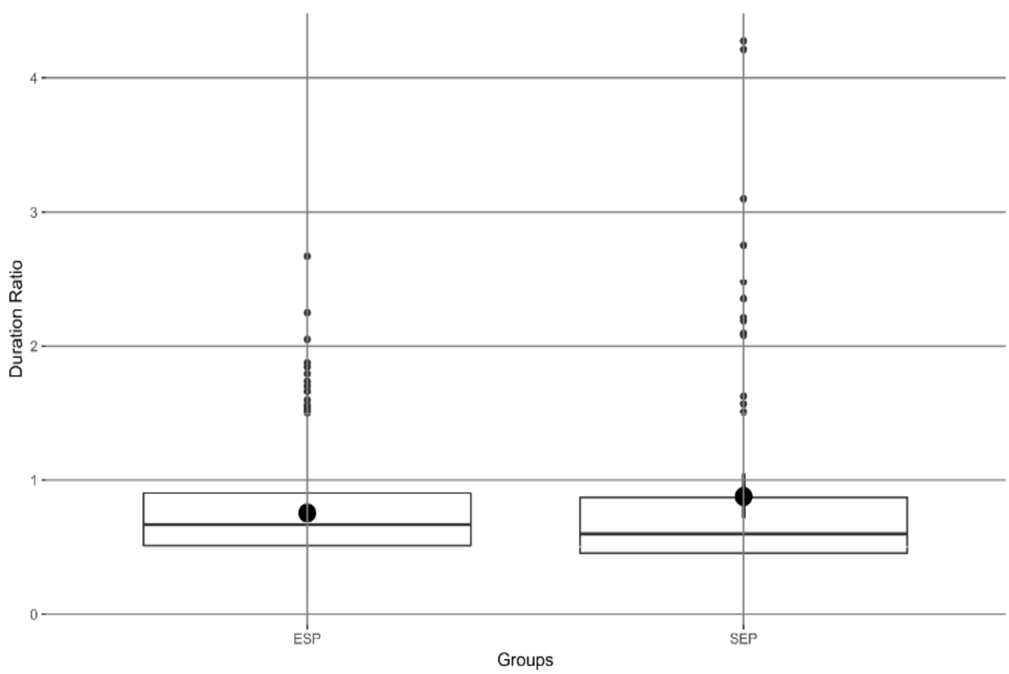


Figure 7 Duration Ratio by Group – PRT

In terms of duration ratio across groups, as seen in Table 4, the mean for SEP is higher than that of ESP.

Table 4 *Duration Ratio Across Groups*

Group	Mean	SD
A (ESP)	0.746	0.332
B (SEP)	0.911	0.571

4.3.2 Duration Ratio in CPT

The Duration in CPT model evaluated the impact of Group and Exposure on duration ratio, using Group, Exposure, and Group by Exposure as fixed effects. Here, these variables were evaluated for the Carrier Phrase Task. The random effects included participant and item as random intercepts.

Table 5 *Fixed Effects: Unstressed/Stressed Vowel Duration Ratio in Carrier Phrase*

Parameter	*β*	SE	*df*	*t*	*p*
(Intercept)	0.88	0.20	7.95	4.46	.002
Language Order Classification (SEP)	0.24	0.41	7.62	0.59	.574
Length of Exposure to Portuguese	-0.06	0.08	7.75	-0.82	.436
Language Order Classification: Length of Exposure to Portuguese	0.02	0.09	7.68	0.23	.823

Significance was not found for any of the fixed effects in the Duration Ratio in CPT model. There is no significant difference in duration ratio between Groups (β = 0.24, SE = 0.41, $t(7.62)$ = 0.58, p = .57). The effect of Exposure on duration ratio was also not significant (β = -0.06, SE = 0.07, $t(7.74)$ = -0.82, p = 0.44). Significance was not found in the interaction between Group and Exposure (β = 0.02, SE = 0.09, $t(7.68)$ = 0.23, p = .82). As such, both groups appear to implement vowel reduction in the L3 similarly with respect to vowel duration. Moreover, the length of exposure does not appear to influence the degree of vowel reduction.”

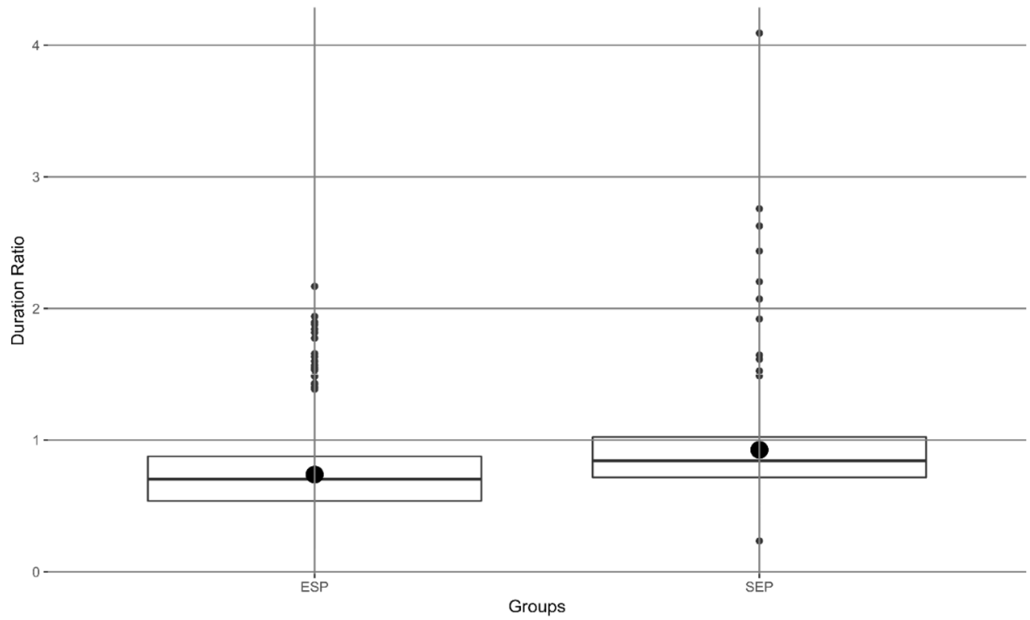


Figure 8 Duration Ratio by Group - CPT

4.4 Intensity Ratio Results

4.4.1 Intensity Ratio in PRT

The Intensity Ratio in PRT model evaluated the impact of Group and Exposure on intensity ratio, using Group, Exposure, and Group by Exposure as fixed effects (Table 6). This model evaluated the aforementioned fixed effects for the Paragraph Reading Task. The random effects included participant and item as random intercepts.

Table 6 *Fixed Effects: Unstressed/Stressed Intensity Ratio Without Vowel Fixed Effect in Paragraph*

Parameter	β	SE	*df*	*t*	*p*
(Intercept)	0.90	0.01	7.91	83.01	< .001
Language Order Classification (SEP)	0.07	0.02	8.65	2.92	.018
Length of Exposure to Portuguese	0.02	0.005	8.37	3.40	.009
Language Order Classification: Length of Exposure to Portuguese	-0.03	0.01	8.47	-4.97	< .001

There is significant impact of group in intensity ratio between Groups. SEP displays a lower intensity ratio than ESP (β = 0.07, SE = 0.03, $t(8.65) = 2.92$, $p < .05$), as can be seen in Figure 9. SEP, therefore, has more reduction, as a higher intensity ratio signifies less reduction. SEP reduces more in terms of intensity ratio.

The effect of Exposure on intensity ratio was also significant (β = 0.02, SE = 0.004, $t(8.37) = 3.40$, $p < .01$). As Exposure increases, the intensity ratio increases. This positive relationship indicates that there is less reduction as Exposure goes up, contrary to hypothesis.

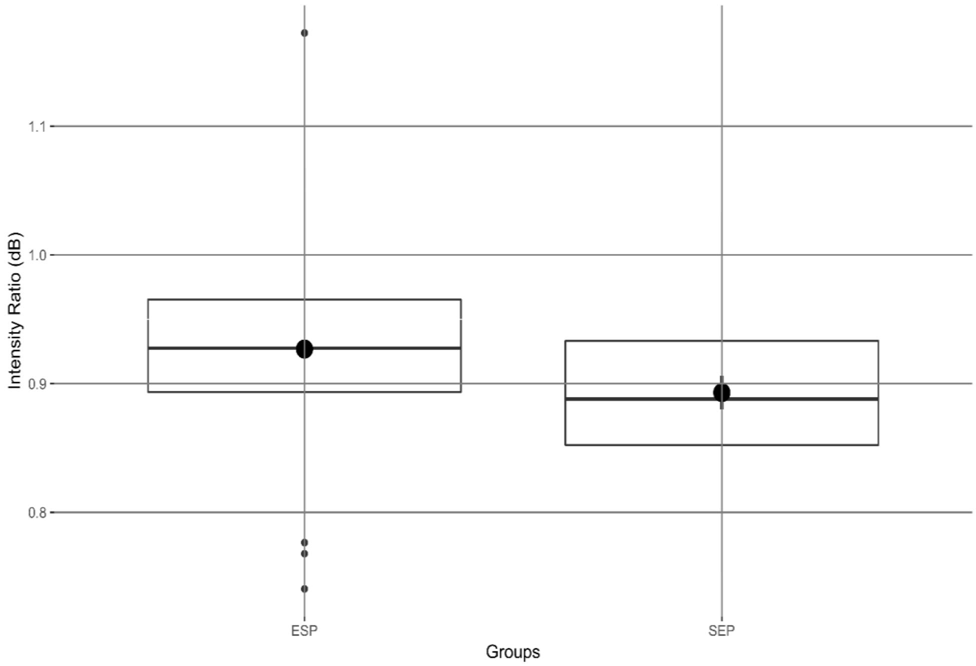


Figure 9 Intensity Ratio by Group - PRT

There is significance between Group and Exposure (β = -0.03, SE = 0.005, $t(8.47) = -4.97$, $p < .001$). For every one year increase in Exposure in the SEP Group, intensity ratio decreases .011 (.015-.026 =-.011). As Exposure increases, intensity ratio in Group SEP is decreasing, which represents more reduction, as shown in Figure 10. The trend for ESP is represented in Figure 11, though the model specifically demonstrated significance for the relationship between Group SEP and Exposure.

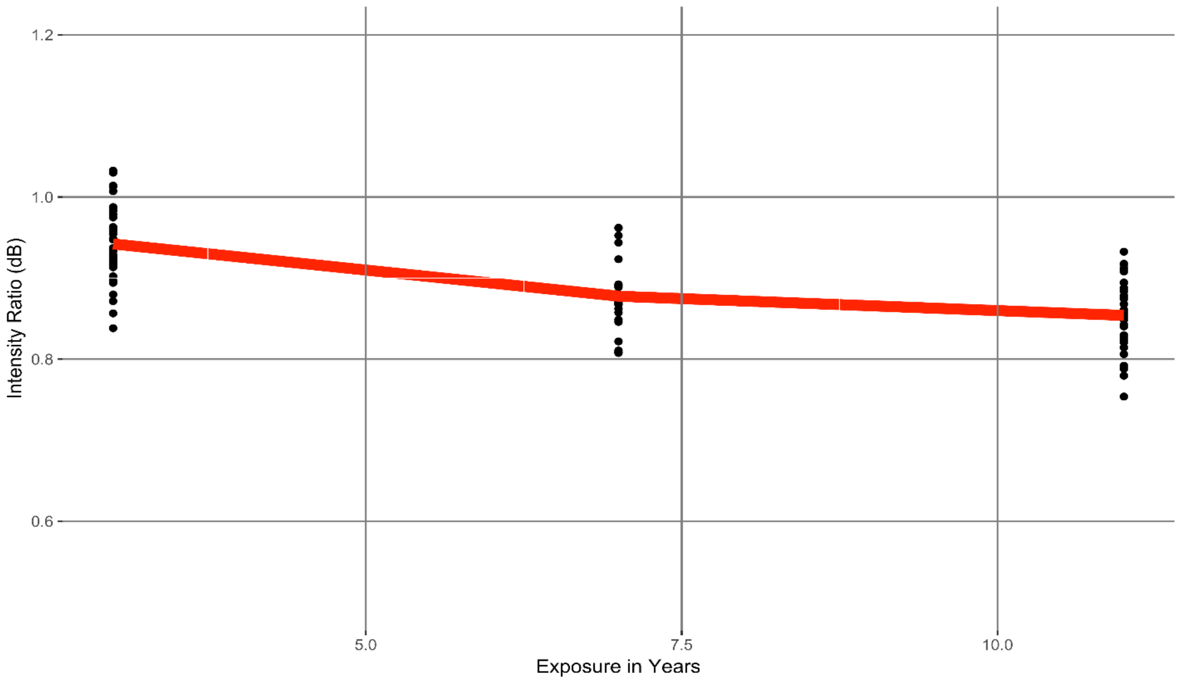


Figure 10 Intensity Ratio by Exposure for PRT - SEP Group

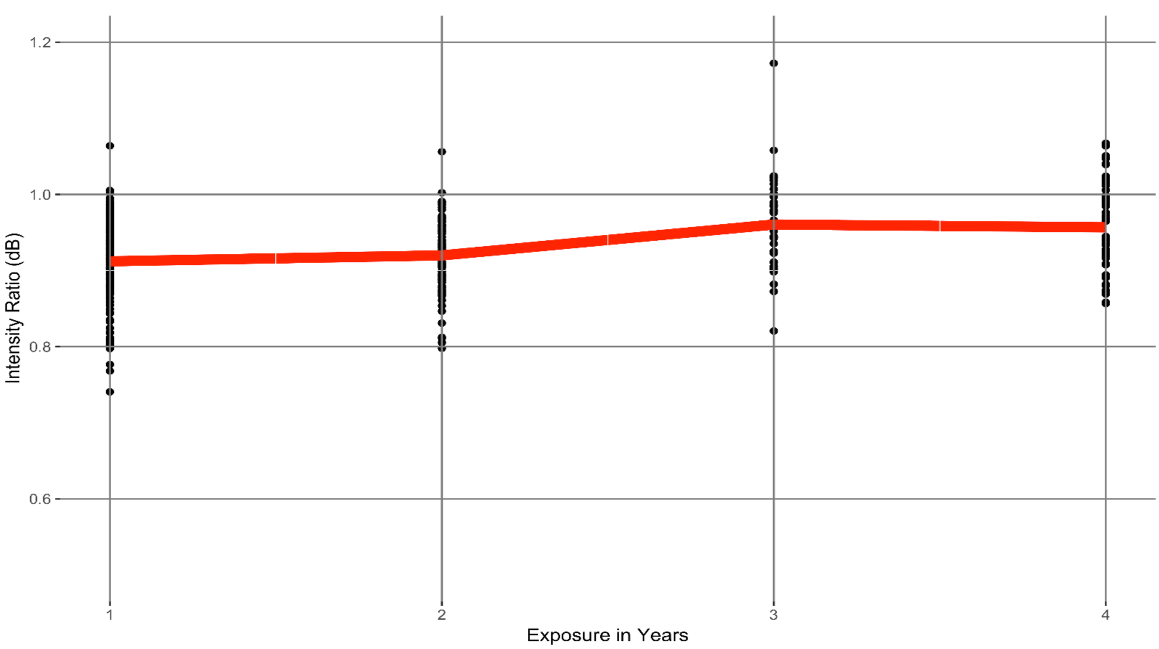


Figure 11 Intensity Ratio by Exposure for PRT - ESP Group

4.4.2 Intensity Ratio in CPT

The Intensity Ratio in CPT model evaluated the impact of Group and Exposure on intensity ratio, using Group, Exposure, and Group by Exposure as fixed effects (Table 7). This model evaluated the aforementioned fixed effects for the Carrier Phrase Task. The random effects included participant and item as random intercepts.

Table 7 *Fixed Effects: Unstressed/Stressed Intensity Ratio Without Vowel Fixed Effect in Carrier Phrase*

Parameter	β	SE	*df*	*t*	*p*
(Intercept)	0.82	0.04	8.12	22.07	< .001
Language Order Classification (SEP)	0.15	0.08	7.83	1.99	.082
Length of Exposure to Portuguese	0.03	0.01	7.94	2.23	.056
Language Order Classification: Length of Exposure to Portuguese	-0.04	0.01	7.89	-2.45	.040

There is near significant impact on group intensity ratio between Groups. SEP has a higher intensity ratio than ESP (β = 0.15, SE = 0.08, $t(7.83) = 1.99$, p = .08). SEP has less reduction specifically considering intensity.

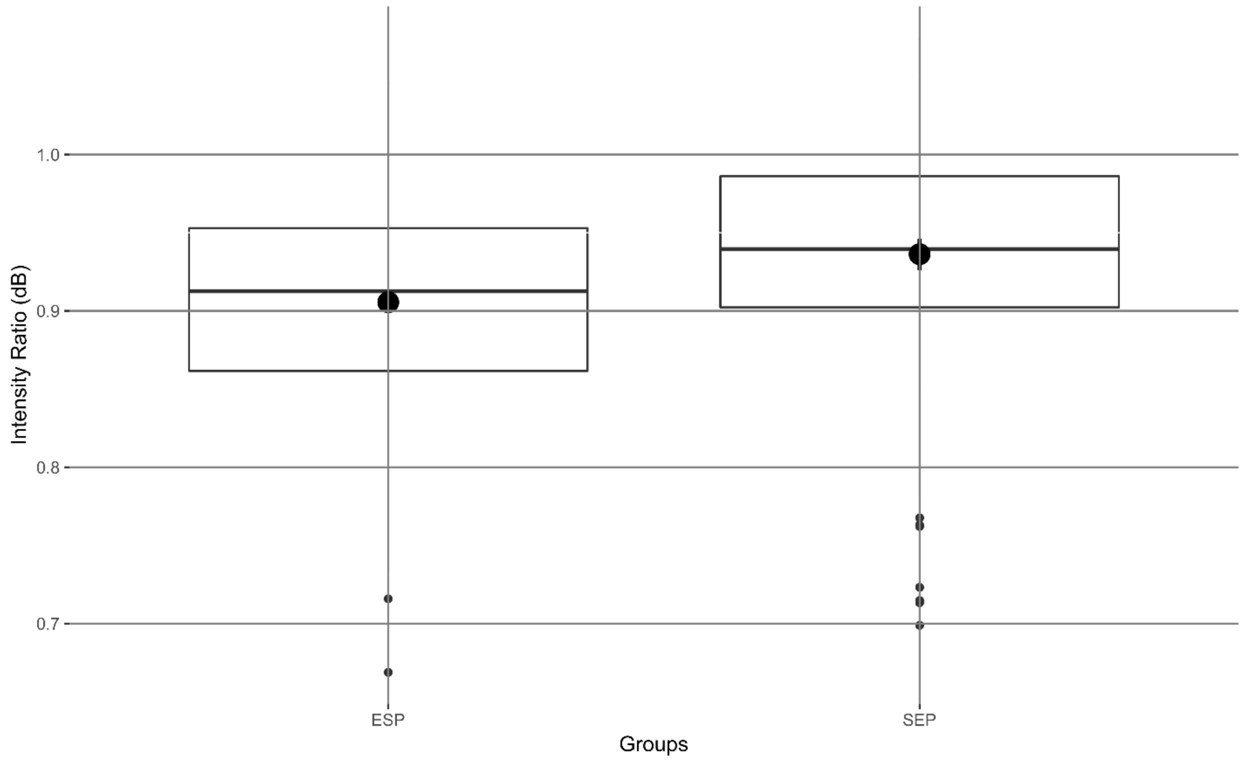


Figure 12 Intensity Ratio by Group - CPT

The effect of Exposure on intensity ratio approached significance. As Exposure increases, the intensity ratio also increases. Less reduction is present as intensity ratio increases (β = 0.03, SE = 0.01, $t(7.94) = 2.23$, $p = .05$).

There is significance between Group and Exposure (β = -0.04, SE = 0.02, $t(7.89) = -2.45$, $p < .05$). For every one year increase of Exposure in the SEP Group, intensity ratio decreases .009 (0.033 - 0.04 = -0.009). As Exposure increases, intensity ratio in Group SEP is decreasing, which represents more reduction. Although the SEP Group had fewer participants, this general downward trend is visible in Figure 13, and can be contrasted with the trend in Figure 14.

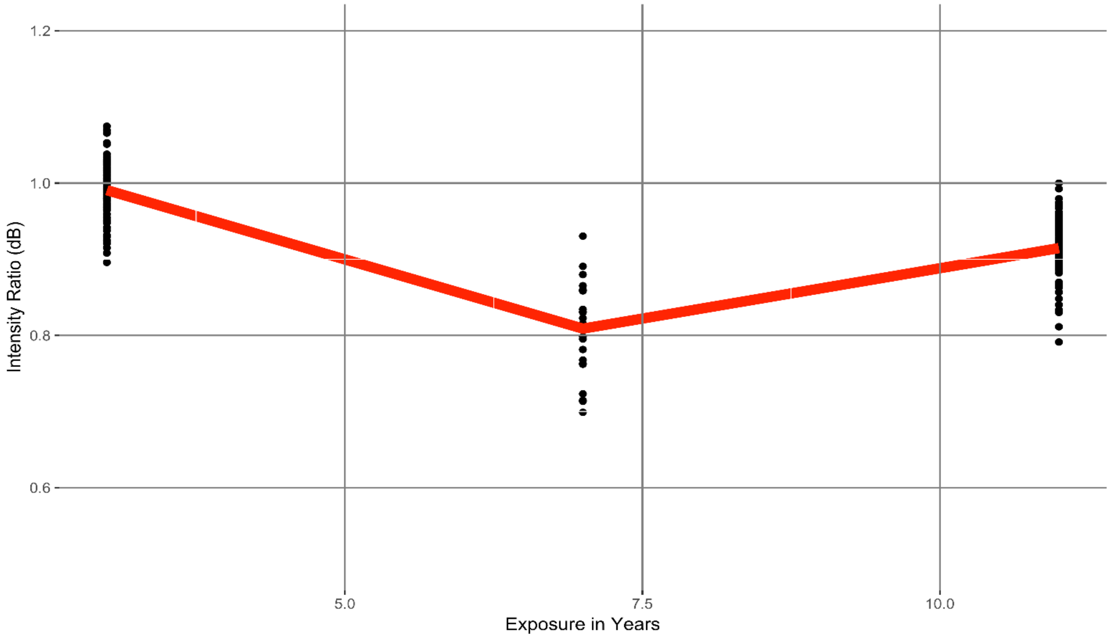


Figure 13 Intensity Ratio by Exposure for CPT - SEP Group

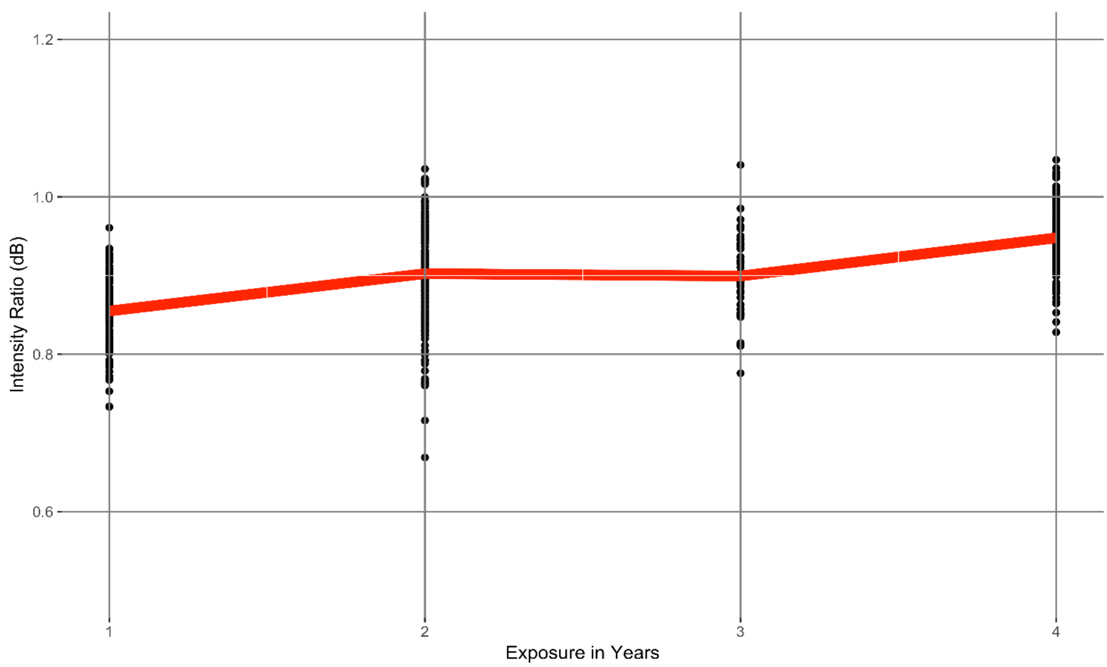


Figure 14 Intensity Ratio by Exposure for CPT - ESP Group

When considering both tasks, the intensity ratio mean for the PRT is lower than that of the CPT, as seen in Table 8. This suggests that the PRT presents less reduction than that of the CPT considering intensity ratio.

Table 8 *Intensity Ratio at Midpoint by Task*

Task	Mean	SD
Phrase	0.914	0.0661
Paragraph	0.921	0.0601

4.5 Height (F1) Results

4.5.1 Height (F1) in PRT

The Height (F1) in PRT model evaluated the impact of Group and Exposure on normalized F1values of unstressed vowels, using Group, Exposure, and Group by Exposure as fixed effects (Table 9). F1 values were not relative, which limits what can be inferred from the results, in that the comparisons have to be established among groups, rather than through a ratio in the same speaker. The Height (F1) in CPT model evaluated these variables for the Paragraph Reading Task. The random effects included participant and item as random intercepts.

Table 9 *Fixed Effects: Unstressed Normalized F1 in Paragraph*

Parameter	*β*	SE	*df*	*t*	*p*
(Intercept)	-0.91	0.08	8.94	-10.68	< .001
Language Order Classification (SEP)	0.07	0.18	7.94	0.36	.727
Length of Exposure to Portuguese	0.02	0.03	7.15	-0.70	.504
Language Order Classification: Length of Exposure to Portuguese	0.002	0.04	7.42	0.06	.958

Significance was not found for any of the fixed effects in the Height (F1) in PRT model. No significance was found in duration ratio between Groups (β = 0.067, SE = 0.18, t(7.94) = 0.36, p = .73). The effect of Exposure on duration ratio was not significant (β = -0.02, SE = 0.03, t(7.15) = -0.70, p = .50). No significance was found in the interaction between Group and Exposure (β = 0.002, SE = 0.04, t(7.42) = 0.06, p = .96). Even though significance was not found for the fixed effects in this model, the measured data is visually represented in Figure 15 for reference.

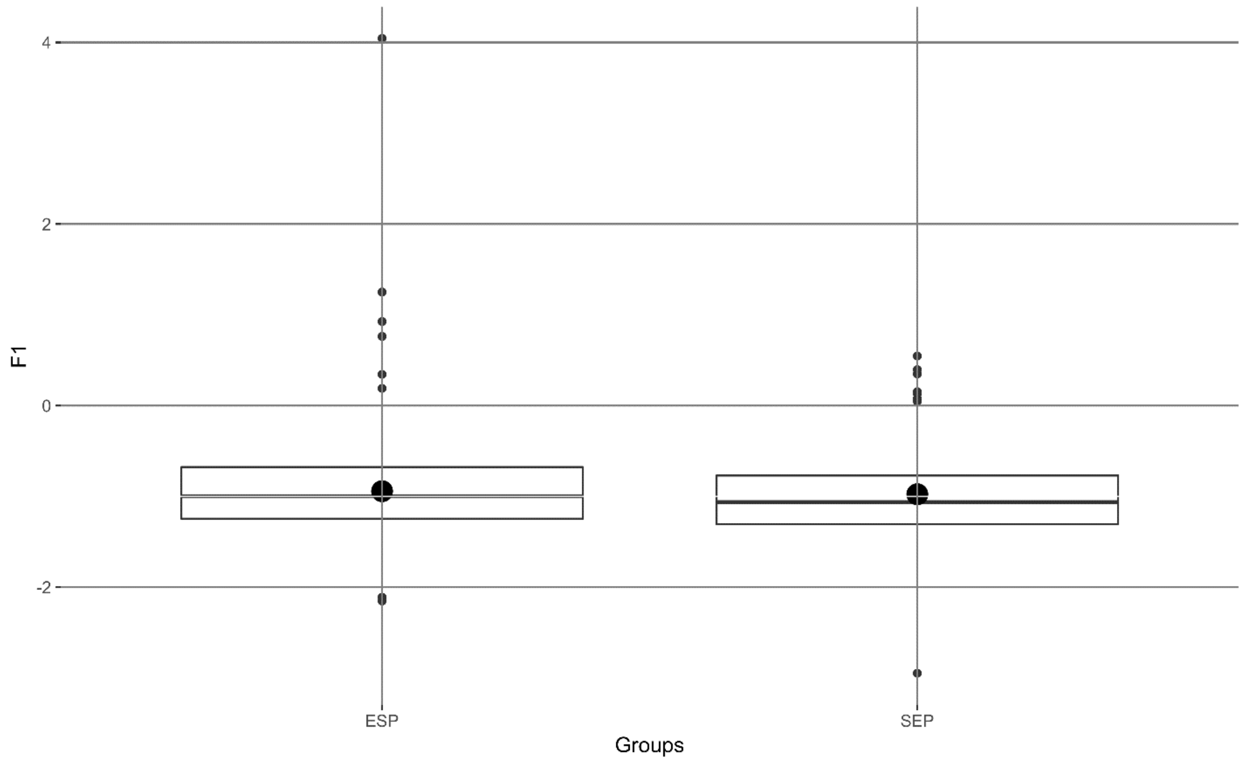


Figure 15 Height (F1) of Unstressed Vowels by Group - PRT

For normalized F1 across groups, as seen in Table 10, the mean for SEP is higher than that of ESP. The negative values are a product of normalization. A smaller number denotes more reduction in BP.

Table 10 *Normalized F1 Across Groups*

Group	Mean	SD
ESP	-0.917	0.487
SEP	-0.830	0.438

The same principle applies when considering F1 across tasks, in Table 11.

Table 11 *Normalized F1 by Task*

Task	Mean	SD
Phrase	-0.857	0.436
Paragraph	-0.956	0.528

4.5.2 Height (F1) in CPT

The Height in CPT model evaluated the impact of Group and Exposure on normalized F1values of unstressed vowels, using Group, Exposure, and Group by Exposure as fixed effects Table 12). This model evaluated these variables for the Carrier Phrase Task. The random effects included participant and item as random intercepts.

Table 12 *Fixed Effects – Unstressed Normalized F1 in Carrier Phrase*

Parameter	*β*	SE	*df*	*t*	*p*
(Intercept)	-0.92	0.13	8.31	-6.86	< .001
Language Order Classification (SEP)	0.23	0.26	6.36	0.90	.403
Length of Exposure to Portuguese	0.01	0.05	6.70	0.25	.812
Language Order Classification: Length of Exposure to Portuguese	-0.03	0.06	6.52	-0.60	.569

Significant difference was not found for any of the fixed effects in the Height (F1) in CPT model. No significance was found in duration ratio between Groups (β = 0.234, SE = 0.26, $t(6.36) = 0.90$, $p = .40$). The effect of Exposure on duration ratio was not significant (β = 0.01, SE = 0.05, $t(6.70) = 0.25$, $p = .81$). No significant difference was found in the interaction between Group and Exposure (β = -0.035, SE = 0.06, $t(6.52) = -0.60$, $p = .57$). These data are visually represented in Figure 16 for reference.

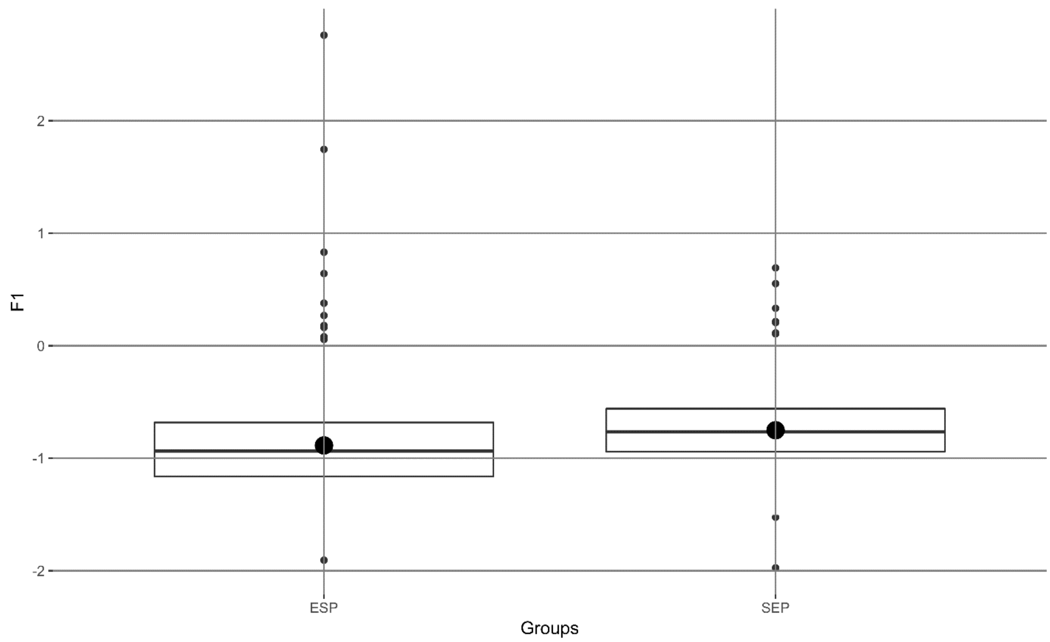


Figure 16 Height (F1) by Group – CPT

4.6 Summary of Results

Results from the carrier phrase task (CPT) and paragraph reading task (PRT) were presented in this chapter. In addition, results yielded by six different statistical models which examined the significance of the variables under examination in this dissertation were also shown. These results address the Research Questions that attend this dissertation.

Concerning Research Question 1, which seeks to shed light on whether a native speaker of a vowel reducing L1 and a non-vowel reducing L2 display more or less vowel reduction in a vowel reducing L3 than a native speaker of a non-vowel reducing L1 and vowel reducing L2, data from the first statistical model can be used to answer this query. Group SEP displays more vowel reduction than Group ESP when intensity ratio is considered in the PRT. For the CPT, SEP reduced less, although the analysis only approached significance (p = .08). No significance was present for duration ratio or F1 (Height) as dependent variables.

Research question 2 focused on how exposure to an L3 affects phonological production, and if exposure would affect these results. Only in the models regarding intensity ratio was statistical significance present in terms of exposure. Overall, as exposure increased there was less reduction being that as exposure increased, the intensity ratio increased. However, specifically in Group SEP, as exposure increased, there was more reduction (that is, intensity ratio decreased).

In the following chapter, further discussion of how the findings of this chapter answer the Research Questions and their attendant hypotheses will be presented. Chapter 5 also elaborates on how this study contributes to the discussion of L3 Multilingual Models. Finally, pedagogical implications are considered. In Chapter 6, concluding remarks are submitted, and limitations and further directions of this study will be examined.

CHAPTER 5. DISCUSSION

In chapter 4, results from the carrier phrase task (CPT) and paragraph reading task (PRT) were presented, containing the features analyzed for vowels: duration ratio, intensity ratio, and height (F1, i.e., first formant). In this chapter, we will discuss these findings in light of the Research Questions articulated in chapter 2. A general discussion section will follow, articulating the findings in the context of previous research. Lastly, pedagogical implications of this study are examined.

The chapter will be organized as follows: Research Question 1 Discussion (5.1), Research Question 2 Discussion (5.2), General Discussion (5.3), Pedagogical Implications (5.4). Chapter 6 presents a conclusion, limitations, and further directions.

5.1 Research Question 1 Discussion

Research Question 1: Does a native speaker of a vowel reducing L1 (first language) and a non-vowel reducing L2 (second language) display more or less vowel reduction in a vowel reducing L3 (third language) than a native speaker of a non-vowel reducing L1 and vowel reducing L2?

Research Question (RQ) 1 sought to determine whether an L1 speaker of a vowel reducing language and a non-vowel reducing L2 (ESP) displays more or less vowel reduction in a vowel reducing L3 than a native speaker of a non-vowel reducing L1 and vowel reducing L2 (SEP). Its attendant hypothesis was that the speaker of a vowel reducing L2 (SEP) would display more vowel reduction in the L3 than the non-vowel reducing L2 speaker (ESP) in accordance with the postulations of the L2 status factor (Hypothesis 1).

RQ1 was prompted by the ongoing debate in the literature regarding TPM (Typological Primacy Model) and L2 status factor. In chapter 2, it was established that at present, it has not yet been conclusively determined whether L2 status or typology is a stronger predictor when selecting a language for phonological acquisition in L3 (Llama et al., 2010; Cabrelli Amaro 2017). TPM posits that L3 transfer is determined by the structural proximity between L1 and/or the L2 and L3 (Rothman, 2015). On the other hand, L2 status factor proposes that the L2 can supersede the L1 as a source of transfer, given the presence of a higher degree of cognitive similarity between L2 and L3, than that which is present between L1 and L3 (Falk & Bardel, 2011). In this study, it was originally hypothesized that the L2 status factor would be a stronger predictor for how vowel reduction would occur between the SEP and ESP Groups. This hypothesis was driven by the notion that L2 would have a greater influence on L3 production for learners at the initial stages of acquisition as occurred in studies such as Hammarberg and Hammarberg (1993), Leung (2005), Bardel and Falk (2007), and Wrembel (2010). Participants in the present study were also at the initial stages of L3 acquisition.

The data presented in the results suggests that specifically considering intensity ratio in the PRT, Group SEP reduces more than Group ESP. For intensity ratio, there seems to be greater influence based on the L2 status factor over Typology (that is, typological similarity between L1 English and L3 BP). These results support the L2 status in that the SEP group has English as an L2, which is also a reducing language in this case. Thus, given the primacy of the L2 there would be a greater chance of reduction.

It is, however, important to note that for the CPT task, near significance (p = .08) was observed in the analysis of intensity ratio, and in that case, SEP displayed a higher intensity ratio than ESP. And also, that the results for both duration ratio and height (F1) were not significant, and therefore inconclusive. While it would be expected that vowel reduction in terms of duration ratio would mirror the findings for vowel reduction when considering relative intensity (intensity ratio), there is not enough evidence in the present study to make such a claim. It is worth noting that, interestingly, as can be seen in Table 4, the duration ratio mean is higher for SEP (0.911) than ESP (0.746) overall, and also specifically in the PRT, as seen in Figure 7 in the Results chapter.

Even though the means are slightly different, the distribution is rather similar among groups (including the skew on the top end), and as noted, there is no significant effect. This difference in means must therefore be dismissed when considering other similarities.

First formant (F1) is a well-established correlate of (vowel) height (e.g., Herrick, 2003; Ladefoged, 2006; Ogden, 2009). In this study, formant values were normalized using Lobanov's (1971) normalization method (see section 3.5.1). As such, the normalized values should be interpreted in this manner: a smaller normalized F1 value represents a higher vowel, and thus signifies more reduction. This is the case as in Portuguese vowel raising is a form of reduction.
Since the results pertaining to Height (F1) did not achieve statistical significance, it is only possible to make note of the slight trend of SEP potentially denoting SEP having more reduction (see Table

10). This suggestion, although only verifiable if given a larger sample size, is consistent with the significant findings of the intensity models in this study.

The difference in terms of mean of intensity ratio (at midpoint) is also not large (0.915 in ESP vs. 0.922 in SEP). Group SEP also coincides with the high exposure group (higher exposure to BP). The sample is not large given the constraints of language sequence, and there are more ESP participants than SEP participants which could potentially have driven the exposure effect. If that were the case, one would expect that the group with highest exposure to the vowel reducing L3 (here, SEP) would be the one reducing the most, which is the case here. These results necessitate the consideration that exposure itself could be driving the effect between groups. Especially given that the results showed that as exposure increases, intensity ratio in Group SEP decreases, that is, it displays more reduction. A natural line of questioning follows: whether the effect of exposure differs based on the typological differences of L1/L2 between the two groups if the groups were more evenly balanced for L3 exposure. Such a study would have to regulate for exposure, ensuring that both groups had an equal representation of participants in terms of exposure, not only in terms of length of time, but also in terms of amount of exposure in percentage of time. Language activation would have to be taken into account, and it would be important to have learners with similar proficiency in L3, as is the case for the present study. Finding a group of such homogenous language learners might prove challenging, as it is often the case in the recruitment of L3 participants, though, given time, not impossible. Indeed, an ever-present reality of investigating L3 production, especially when considering specific set of languages in a specific set of order of acquisition, while accounting for comparable proficiencies and language activation, is that it becomes difficult to find a large number of such participants. A reasonable line of questioning might be the intensity ratio results were the only ones that achieved statistical significance. In 2016, Kenstowicz and Sandalo investigated vowel duration, intensity, and timbre differences in BP vowels in two sets of vowels in five native speakers of BP. The authors used nouns, one set of proparoxytones and the other, paroxytones. They compared the variables above in unstressed syllables to the stressed syllable in tonic, pretonic, posttonic and word-final position (Kenstowicz & Sandalo, 2016). The authors found that “the reduction to a binary height contrast in the final syllable is better attributed to a difference in intensity rather than duration” (p.2, 2016). In fact, intensity performed better than duration in every position as a way to differentiate among positions. This was specially the case when considering the differences between posttonic and final positions (Kenstowicz & Sandalo, 2016). The words used in the present study were all structured to be paroxytone, and all were disyllabic, as opposed to trisyllabic for the Kenstowick & Sandalo 2016 study. Their finding of intensity being a better discriminator of position is relevant for the current study, as it is possible that that trend could explain in part the presence of significance for the intensity models vs. those of duration.

Overall, the results show preliminary support for the L2 status factor as proposed in Hypothesis 1, but only when considering intensity ratio. Further research accounting for the discussed limitations will be necessary for more robust conclusions. In the following section, we will further discuss the findings specifically as they apply to Research Question 2.

5.2 Research Question 2 Discussion

Research Question 2: Does longer exposure to an L3 affect phonological production in such a way as to modify the results?

RQ2 sought to determine how exposure to an L3 affects phonological production, and if a participant's overall exposure to L3 over their lifetime would affect these results.

RQ2 was prompted by the call for more research at the very early stages of L3 processing (González Alonso et al., 2020) and specifically in terms of exposure, the notion that the more a participant would be exposed to a particular language, the more their phonological production would approximate that language. There is still much left to discover about what effect this exposure would have on CLI (cross-linguistic influence), especially over time (De Angelis, 2007), and this RQ sought to add to that effort.

RQ2's hypothesis suggested that participants would reduce more in the L3 the longer they are exposed to the language. Since BP (Brazilian Portuguese) is a vowel reducing language, it would be predicted that the longer the participants were exposed BP, the more they would reduce their vowels. Contrary to the RQ2's attendant hypothesis, overall (for both groups), as exposure increases, so does the intensity ratio. The same results are present for both tasks. In the PRT, as exposure increases, the intensity ratio also increases. Therefore, less vowel reduction is occurring in the L3 as exposure increases. This same trend was present in the CPT, with the effect of exposure on intensity ratio approaching significance (p = .05). However, and notably, when it comes to the SEP group specifically, as exposure increases, the intensity ratio decreases, which suggests that more reduction is present, and supports the original hypothesis. This was true both in the PRT and the CPT. The overall trend of exposure when considering both groups combined and that of the SEP alone are opposite of each other. It is appropriate to suggest then, that the ESP group trend is driving the overall trend. This is especially likely since the ESP group had a greater number of participants.

Greater exposure to the L3 showing more vowel reduction for the SEP group is worth noting, especially as all participants are at the beginning stages of learning the L3. This finding suggests that even at the same level of formal instruction, overall length of exposure to the L3 is a determinant of a learner producing more native-like suprasegmentals. These results must be contextualized in the acknowledgment that the SEP group had fewer participants, and that it is also possible that other factors could be contributing. Cenoz (2013) points out the possible distinction between learners who were exposed to the language within the context of school or everyday life. All participants in this study had at least one court of BP, but their level of current exposure differed, and group SEP coincided with the most current exposure to L3 BP. All participants reported interactions with friends as the highest contributor to their learning (when compared to radio, TV, self-instruction, reading or interaction with family). It is possible, then, that the SEP group displayed more reduction not only because of their greater level of overall exposure, but also because of their greater level of current exposure to L3 BP.

Another aspect to consider is the level of formality of each task. Major (1994) indicates that as formality of style increases, so does the frequency of presence of target-like forms, and that generally, a decreased level of L1 transfer occurs. Zampini (1994) suggests that within formal tasks various tasks are used, such as reading of word lists, reciting of previously learned material or, as is the case for the current study, reading a paragraph. Conversations and spontaneous speech are commonly considered informal tasks. In the present study, both tasks are reading tasks, but there are still possible trends to identify, at least in terms of the artificiality of the language. As one moves from the more fluid speech of a paragraph into the more rigid context of a carrier phrase task, the participants could simply be producing vowels with lower intensity ratio (thus, more reduction) given the formality of the task (see Table 8). Reading the paragraph aloud could have been perceived as a more naturalistic situation by the participants over than the repetition of the carrier phrase task. The carrier phrase, in being shorter and more explicit, might have allowed the participant to have a degree of focus on the production of the nonce word, as juxtaposed to the reading of a whole paragraph, which in its implicit nature, might better conceal the purpose of the task. However, for F1 the trend seems to be the opposite: higher vowels (higher F1) are present in the PRT as its normalized F1 value is smaller, as seen in Table 11. While vowel reduction is often thought of as centralization, note that in BP, vowel reduction occurs with the raising of the vowel.

This could possibly trend towards more vowel reduction being present, though given that we are not comparing the formant values here, but rather just observing the unstressed F1 trend, it is impossible to ascertain that conclusion with certainty.

The lower F1 values in the CPT could be posited to be a byproduct of the environment surrounding the utterance in context; in carrier phrases, the lexical environment is controlled (see chapter 3), in the PRT each nonce word is randomized in its placement. Therefore, the influence of coarticulation should be more consistent in the CPT, since the phrase is always the same. The neighboring sounds could be ascertained to have caused the lowering of the unstressed vowel in terms of F1 in the CPT.

5.3 General Discussion

Six linear mixed-effects models (LMEMs) were used to analyze the data presented in the previous Results chapter. Each model addressed one of the dependent variables under consideration: duration ratio, intensity ratio, and F1 (height) for each task – CPT and PRT. In this section, general observations yielded from the models not addressed under the purview of the RQs will be presented.

Generally, when it comes to vowel reduction, the present study provides some support of the postulations of the L2 status factor, since, specifically considering intensity ratio, SEP reduces more than ESP. English, as the SEP group's L2, being a vowel reducing language is suggested to have had influence in the phonological production of L3 BP vowels (L1→L3). Even so, these findings further support the idea that these questions may not be answered in a binary manner (that is, of TPM vs L2 status factor) alone. SEP participants have English, a vowel reducing language, as an L2, and this group that generally displays more vowel reduction in terms of intensity. If L2 status is the most important factor for predicting their L2 performance in terms of vowel reduction, then one would precisely expect this finding: more reduction in L3 BP, influenced by the reducing nature of their L2 English (L2→L3). As for Group ESP, it is still true that their L2 Spanish non-reducing nature could be affecting the presence of less reduction in their L3 BP. Nevertheless, as discussed in chapter 2, L2 Spanish is also typologically more similar to L3 BP, and therefore, for Group ESP that assertion is not absolutely verified by these results.

It is reasonable to propose, then, that L3 production may happen in hybrid fashion, depending on the nature of the feature analyzed; what is, even so, evidenced by the results is that typological similarity between languages (here, L1 and L3) is a definite contributor in vowel reduction in an L3. A mixed model approach could benefit the determination of which linguistics factors are strong determinants of performance in an L3. On a lexical level, and certainly semantic, the TPM has proven a good predictor, but on a suprasegmental level, perhaps a combined or more dynamic model might be more telling. Certainly, as research continues to surface in TLA, more generalizable models may be possible, but given the relative dearth of research of L3 acquisition, it becomes difficult to make truly generalizable statements. That is precisely one of the criticisms of the TPM: Cabrelli Amaro, Flynn, & Rothman (2012) admit that "criticism of the TPM involves its generalizability on the one hand and its apparent inexactitude of spelling out what linguistic factors key learners into typological proximity on the other" (p. 41). Rothman (2015) calls for a continued effort to create models that increasingly better explicate the complex nature of multilingualism. Rothman (2015) posits that

> (g)iven the sheer number of multilingual speakers in the world, it is important that generative linguistics attempt to model the dynamic nature of multilingual acquisition. If one wishes to claim that all humans are born with the same genetic blueprint for language, and given that multilingualism prevails as the default natural state of linguistic knowledge, then the genetic linguistic endowment must be able to account for multilingualism as well (p. 189)

It is advisable that research continue, both qualitatively, but also in quantitative setups as the present study. Considering a suprasegmental process like vowel reduction can be informative, as it is produced subconsciously it largely removes the possibility of biased production. This is especially important given the multidirectional and complex nature of language transfer. More importantly, investigating suprasegmentals in the context of L3 can further be revealing as pronunciation receives less focused instructional attention than other features (Derwing & Munro, 2005; Olson, 2014; Sturm, 2019). Since students are not explicitly taught pronunciation as much as other aspects of language, they are likely to focus less on suprasegmental processes, thus making the continued study of such processes of great pertinence for the research L3 acquisition.

Taking into account the practical and direct applications of the type of research present in this study, the next section explores possible pedagogical implications.

5.4 Pedagogical Implications Discussion

While the present study was not directly pedagogical in nature, as discussed in the first chapter, most people in the world are multilingual, and we live in an increasingly multilingual society. Research in L3 acquisition should be able to have a practical impact in informing how language learning occurs. The L2 learning process is an important and determining aspect of language learning, being a strong predictor of effective learning. From a pedagogical perspective, it could therefore be beneficial to create a pathway model for language learning based on these considerations. One should not only take typological similarity into account, but also consider the subconscious functions of language. The more languages an individual speaks, the harder it is to retrieve a phonological form in any given language, simply by virtue of their inventory being larger. Indeed, as De Angelis (2007) points out, "when an individual engages in a cognitive task as demanding as language learning, it is reasonable to presume that prior linguistic knowledge and prior learning experience will play a role in the learning task" (p. 41). This is also true of word categorization, as it is more cognitively taxing to pick among a greater number of options. From a typological standpoint, within phonological retrieval, a learner may retrieve from their L1 without ever having to consider L2 phonology given the lexical similarity. If a language learner internalizes a particular skill on a phonological level in their L2 that an L3 also possesses (such as vowel reduction seen here), this will aid in their L3 learning. Having a robust L2 learning process then becomes an obvious focus. If the neurological pathway to learn a language is well solidified, then independent of typological similarity, the learner should be more successful in their L3 acquisition process.

This chapter provided further discussion of the results in light of the Research Questions, as well as a general discussion on the findings of the linear mixed-effects models (LMEMs). In the following chapter, a conclusion will be presented, and limitations and further directions of this study will be discussed.

CHAPTER 6. CONCLUSION

6.1 General Conclusion

This study documented the findings of an experiment designed to determine whether a native speaker of a vowel reducing L1 (first language) and a non-vowel reducing L2 (second language) (SEP group) displays more or less vowel reduction in a vowel reducing L3 (third language) than a native speaker of a non-vowel reducing L1 and vowel reducing L2 (ESP group), and how length of exposure over time to an L3 affects phonological production. To do so, data from two tasks (Carrier Phrase Task and Paragraph Reading Task) were analyzed through six linear mixed-effects (LMEMs) models featuring duration ratio, intensity ratio, and height (F1). Group SEP (L2 English is a vowel reducing language, as is L3 BP (Brazilian Portuguese) displayed more vowel reduction than Group ESP when intensity ratio is considered, in PRT (Paragraph Reading Task). No significance was present for duration ratio or F1 (Height) as dependent variables. While these findings broadly do not support the original hypotheses, as no significant difference between the two groups was found for either duration ratio or vowel height (F1), the intensity ratio results show some preliminary support for the postulations of the L2 status factor.

Overall, as exposure to L3 BP increased less vowel reduction was present; as exposure increased, the intensity ratio increased. However, in Group SEP, as exposure increased, more reduction was present. In the following (and last) section, limitations and further directions are discussed.

6.2 Limitations and Further Directions

The current study was limited in its number of participants. The SEP group had only 3 participants. The very nature of TLA (Third Language Acquisition) studies restricts the ease of finding suitable participants for its research. This study targeted very specific language pairings and order of acquisition, and thus a natural limitation is the number of participants analyzed. To address this limitation, this study should be replicated with a higher number of participants. Given the growth that the use of Video/Web Conferencing has undergone in the recent past, it is possible that this type of medium could be used to allow for more expansive recruitment of multilingual participants.

The stimuli design was also a limitation. Specifically, the same vowel was not utilized in both stressed and unstressed positions, which prohibited direct comparison of like vowels in these positions. Although previous research has shown that duration is affected by vowel height (Flemming, 2009), this issue is relevant for comparisons of vowel height considering F1.

For measurement of intensity and duration, a ratio was calculated, whereas for height, only the normalized F1 was utilized. While allowing for comparisons among groups, this limits the ability to establish robust conclusions between vowels in the same speaker. In future, a relative measurement of the first formant could be utilized for comparison.

The way in which exposure was calculated is also a limiting factor. Exposure was measured in length of years in this study. It was a metric by which all participants could be uniformly compared, and one that has been used in other TLA studies (e.g., Cabrelli Amaro & Rothman, 2015). This measurement, however, does not differentiate between participants' level of exposure over the years, so it is possible that some learners would have had a higher level of exposure during specific periods over their overall length of exposure, and/or that their current level of exposure to the language also differs. Some learners could have had a higher level of incidental exposure as children, in comparison to others who might never have been exposed until their adult years. While this would be somewhat reflected in the metric of length of exposure in years (i.e., an adult person with exposure to the L3 as a child would have a higher number of overall exposure in years), it does not account for the developmental stages of language learning and how this could affect acquisition of the L3. It would be informative to repeat the same type of study but take a different metric for exposure, such as current exposure or even exposure to different skills, such as reading, writing, or speaking.

Taking this type of experiment in a neurolinguistics direction could yield results that would allow us to better understand how TLA occurs. Examining how production of different phonetic aspects is manifested in brain activity would be useful in informing how these processes are occurring on a phonological level. González Alonso et al. (2020) use event-related potentials (ERPs) and artificial mini-grammars to examine the predictions of L2 Status Factor, the TPM (Typological Primacy Model) and the CEM (Cumulative-Enhancement Model). While the results in González Alonso et al. (2020) did not confirm any of the predictions proposed by these models, the direction of using neurolinguistic measures in TLA research is still important. Language learning has been shown to improve brain connective function in elderly individuals (Bubbico et al., 2019), and research proposes that bilingualism delays dementia both for younger and older people (Kim et al., 2019). Still within the field of neurolinguistics, then, it could be productive to explore how the neurological pathways of a third language learner in a subconscious phonological function would inform this vein of neurodegenerative research.

APPENDIX A – ADAPTED LEAP-Q


PURDUE UNIVERSITY

First Name

Last Name

E-mail

Age

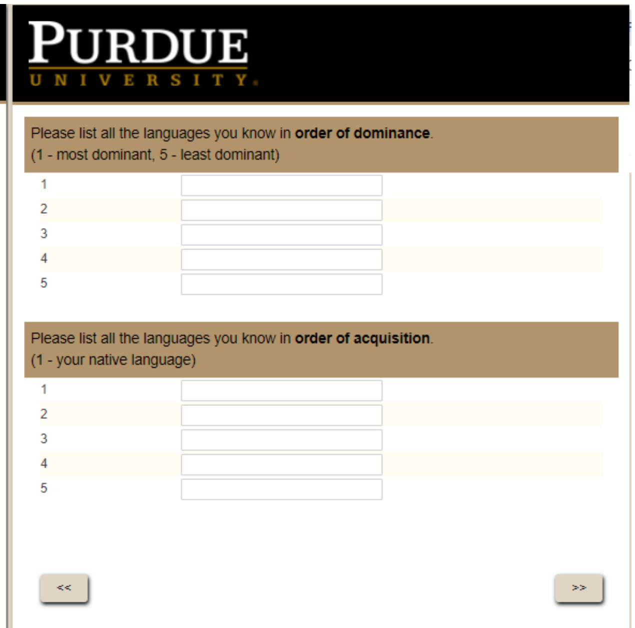
Gender

- Male
- Female
- Other

Please select your highest education level.

What is your current class denomination.

>>


PURDUE UNIVERSITY

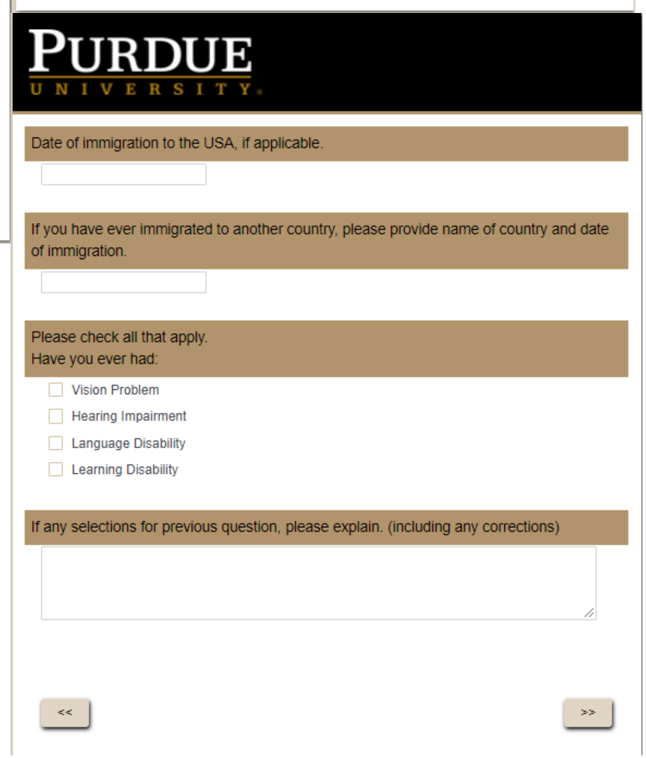
Please list all the languages you know in **order of dominance**.
(1 - most dominant, 5 - least dominant)

1
2
3
4
5

Please list all the languages you know in **order of acquisition**.
(1 - your native language)

1
2
3
4
5

<< >>


PURDUE UNIVERSITY

Date of immigration to the USA, if applicable.

If you have ever immigrated to another country, please provide name of country and date of immigration.

Please check all that apply.
Have you ever had:

- Vision Problem
- Hearing Impairment
- Language Disability
- Learning Disability

If any selections for previous question, please explain. (including any corrections)

<< >>

PURDUE
UNIVERSITY

Please list the age when you...

	began acquiring	became fluent in	began reading in	became fluent reading in

Language Environment

Please list the number of years and months you spent in **country** where the language is spoken.

years months

Please list the number of years and months you spent with a **family** where the language is spoken.

years months

Please list the number of years and months you spent in a **school/work environment** where the language is spoken.

years months

On a scale from 0 - 10, please insert your level of **proficiency** in each skill.

	Speaking	Understanding Spoken Language	Reading

On a scale from 0 - 10, please indicate how much the following factors contributed to your learning.
(0 - not a contributor, 1 - minimal contributor, 5 - moderate contributor, 10 - most important contributor)

	Interacting with Friends	Interacting with Family	Reading	Self-instruction	Watching Television	Listening to the Radio/Music

On a scale from 0 - 10, please indicate to what extent you're currently exposed to each language in the following contexts.
(0 - never, 1 - rarely, 5 - half of the time, 10 - always)

	Interacting with Friends	Interacting with Family	Reading	Self-instruction	Watching Television	Listening to the Radio/Music

<< >>

PURDUE
UNIVERSITY

In your perception, how much of a foreign accent do you have in each language?

Please indicate how frequently others identify you as a non-native speaker based on your **accent**.

<< >>

PURDUE
UNIVERSITY

Thank you for participating in this survey! The researcher Daniela, will contact you soon should you be eligible for further participation.

APPENDIX B – FIXED EFFECTS TABLES

Raw Duration Across Groups

Group	Mean	SD
ESP	0.116	0.0448
SEP	0.121	0.0474

Duration Ratio Across Groups

Group	Mean	SD
ESP	0.746	0.332
SEP	0.911	0.571

Intensity at Midpoint Across Groups

Group	Mean (dB)	SD (dB)
ESP	64.6	5.85
SEP	63.6	4.15

Intensity Ratio at Midpoint Across Groups

Group	Mean	SD
ESP	0.915	0.0614
SEP	0.922	0.0712

Non-Normalized F1 Across Groups

Group	Mean (Hz)	SD (Hz)
ESP	472	120
SEP	486	97.4

Normalized F1 Across Groups

Group	Mean	SD
ESP	-0.917	0.487
SEP	-0.830	0.438

Raw Duration By Task

Task	Mean	SD
Phrase	0.121	0.0444
Paragraph	0.111	0.0465

Duration Ratio By Task

Task	Mean	SD
Phrase	0.789	0.352
Paragraph	0.779	0.482

Intensity at Midpoint By Task

Task	Mean (dB)	SD (dB)
Phrase	63.7	5.32
Paragraph	65.5	5.62

Intensity Ratio at Midpoint By Task

Task	Mean	SD
Phrase	0.914	0.0661
Paragraph	0.921	0.0601

Non-Normalized F1 By Task

Task	Mean (Hz)	SD (Hz)
Phrase	481	111
Paragraph	468	122

Normalized F1 By Task

Task	Mean	SD
Phrase	-0.857	0.436
Paragraph	-0.956	0.528

Raw Duration By Portuguese Exposure

Exposure	Mean	SD
1	0.119	0.0428
2	0.125	0.0512
3	0.122	0.0465
4	0.0970	0.0383
7	0.0750	0.0218
11	0.136	0.0326

Duration Ratio By Portuguese Exposure

Exposure	Mean	SD
1	0.826	0.361
2	0.784	0.314
3	1.07	0.621
4	0.573	0.257
7	0.456	0.131
11	0.747	0.173

Intensity at Midpoint By Portuguese Exposure

Exposure	Mean (dB)	SD (dB)
1	65.9	4.97
2	62.6	7.24
3	62.5	2.98
4	66.3	4.54
7	57.8	4.60
11	66.2	2.90

Intensity Ratio at Midpoint By Portuguese Exposure

Exposure (years)	Mean	SD
1	0.890	0.0581
2	0.908	0.0612
3	0.956	0.0591
4	0.951	0.0452
7	0.843	0.0640
11	0.897	0.0498

Non-Normalized F1 By Portuguese Exposure

Exposure	Mean (Hz)	SD (Hz)
1	473	124
2	451	145
3	520	72.9
4	486	87.1
7	381	94.6
11	477	96.7

Normalized F1 By Portuguese Exposure

Exposure	Mean	SD
1	-0.917	0.485
2	-0.960	0.535
3	-0.762	0.450
4	-0.884	0.453
7	-1.13	0.337
11	-0.863	0.384

APPENDIX C – RANDOM EFFECTS TABLES

Random Effects – Unstressed/Stressed Vowel Duration Ratio in Paragraph

Parameter	Variance	Standard Deviation
Word (Intercept)	0.01	0.08
Subject Number (Intercept)	0.08	0.28
Residual	0.14	0.38

Random Effects – Unstressed/Stressed Vowel Duration Ratio in Carrier Phrase

Parameter	Variance	Standard Deviation
Word (Intercept)	0.003	0.05
Subject Number (Intercept)	0.07	0.26
Residual	0.07	0.26

Random Effects – Unstressed/Stressed Intensity Ratio Without Vowel Fixed Effect in Paragraph

Parameter	Variance	Standard Deviation
Word (Intercept)	.00004	0.01
Subject Number (Intercept)	.0002	0.01
Residual	.003	0.05

Random Effects – Unstressed/Stressed Intensity Ratio Without Vowel Fixed Effect in Carrier Phrase

Parameter	Variance	Standard Deviation
Word (Intercept)	0.0001	0.01
Subject Number (Intercept)	0.002	0.05
Residual	0.002	0.04

Random Effects – Unstressed Normalized F1 in Paragraph

Parameter	Variance	Standard Deviation
Word (Intercept)	0.03	0.18
Subject Number (Intercept)	0.01	0.09
Residual	0.24	0.49

Random Effects – Unstressed Normalized F1 in Carrier Phrase

Parameter	Variance	Standard Deviation
Word (Intercept)	0.04	0.19
Subject Number (Intercept)	0.03	0.16
Residual	0.14	0.37

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Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, *9*(2, Pt.2), 1–27.

VITA

DANIELA MARINHO RIBEIRO BEARD

EDUCATION

May 2021 **Ph.D**., Spanish Linguistics, Purdue University
Specialization in Applied Linguistics, Second/Third Language Acquisition, Acquisition of Phonetics/Phonology, Psycholinguistics
Dissertation: "Third Language Acquisition: a Study of Unstressed Vowel Reduction"
Committee: Jessica L. Sturm (Director), Daniel J. Olson, Lori Czerwionka, and Colleen Neary-Sundquist

2012 **M.A**., Spanish Language and Literature, University of Wyoming, GPA: 4.0
Thesis: "Ortega y Gasset: Considerations on Translation and Silence"

2009 **B.A**., Spanish, University of Wyoming

RESEARCH AND TEACHING INTERESTS

Second/Third Language Acquisition, Phonetics/Phonology, Pedagogy, Psycholinguistics, Spanish Linguistics, Portuguese Linguistics, Spanish, Portuguese, Materials Development, Curriculum Development

RESEARCH EXPERIENCE

Indigenous and Endangered Languages Lab (IELLab), Purdue University
Bilingualism Lab, Purdue University

TEACHING EXPERIENCE

Purdue University
Portuguese III
Portuguese IV
Spanish I
Spanish II
Spanish III
Spanish IV
University of Wyoming
Spanish I
Spanish II
Spanish III
Spanish IV

Shorter University
Spanish I
Spanish II
Spanish III
Spanish IV
Advanced Grammar and Composition
Advanced Conversation
Spanish Selected Readings
Spanish and Latin American Literature
Freshman Foundations of College Success
Foundations of Academic Success

Tutoring (Student Success Services) – University of Wyoming
Spanish
Biology

PRESENTATIONS

"L2 Learning Methodologies". Presented at Shorter University, Undergraduate Course. September 1, 2020.
"Foreign Languages and Our Brains" 2019 International Education Week. September 18, 2019. Rome, Georgia.
"English Language Learners – Pedagogical Resources" - 2019 Data Review – School of Education, Shorter University. May 8, 2019.

TRANSLATION EXPERIENCE

University of Wyoming/Health Department
Translated a variety of health and medical documents
Hospice – Laramie, Wyoming
Translated for patients and their families
Sweeney Zone – Atlanta, Georgia
Translated Business/Marketing materials

PROFESSIONAL AND UNIVERSITY SERVICE

Safety Committee, Shorter University
Abstract Reviewer, Purdue Languages and Cultures Conference
Recruitment Committee, Purdue School of Languages and Cultures
Treasurer, Graduate Student Committee, SLC, Purdue
Secretary, Graduate Student Committee, SLC, Purdue
Recruitment Officer, Graduate Student Committee, SLC, Purdue
Student Senate, College of Arts and Sciences, University of Wyoming

GRANTS, AWARDS, AND HONORS

2016 College of Liberal Arts PROMISE (Promoting Research Opportunities to Maximize Innovation and Scholarly Excellence) Award ($1500)
2015 Synergistic Launch – Lilly Endowment Inc. ($100,000)

2011 John P. Ellbogen Outstanding Graduate Assistant Teaching Award, University of Wyoming ($4000)
2007 President' Honor Roll, University of Wyoming

PROFESSIONAL MEMBERSHIPS AND CERTIFICATIONS

Institutional Review Board – CITI Program Certification
American Heart Association for the BLS for Healthcare Providers (CPR & AED) Program Certification
National Conservatory of Music in Portugal - Vocal Performance, Flute and Piano
Sigma Delta Pi National Collegiate Hispanic Honor Society
The Honor Society of Phi Kappa Phi

COMMUNITY INVOLVEMENT AND OUTREACH

Purdue Collegiate Ministry – Grad Intern, Purdue University
International Campus Ministry – President, Purdue University
Read Naturally, Inc. – Volunteer, Copperopolis, California
Journey Girls – Group Leader/Teacher, Lafayette, Indiana
Purdue University Generation: Justice - Member
Disaster Relief Certification – Lafayette, Indiana
University of Wyoming Student Radio – DJ, Laramie, Wyoming
Hospice – Volunteer – Laramie, Wyoming

GRADUATE COURSES

Language Acquisition
Acquisition of L2 Phonology
Complexity, Accuracy, and Fluency in Second Language Acquisition
Theories of Second Language Acquisition
Teaching College Spanish
Second Language Teaching Materials
Phonology & Phonetics
Phonology I: Descriptive Analysis
Structure of Spanish I: Phonetics & Phonology
Teaching L2 Pronunciation
Heritage Speakers
Heritage Language In Schools
Morphosyntax
Structure of Spanish II: Morphosyntax
Syntax I: Syntactical Analysis

Historical Linguistics
Historical Linguistics and Language Change
History of Spanish Language
Sociolinguistics

Sociolinguistics
Psycholinguistics & Networks
Networks & Linguistic Analysis

COMPUTER SKILLS

BlackBoard
Canvas
Microsoft Office
PRAAT
Futurekids, Inc Software and Hardware Program (Visual Basic, Adobe Flash, CorelDRAW)
Python/PsychoPy
Web Conferencing

LANGUAGE PROFIENCY

Portuguese – native	German (heritage)– intermediate -high
English – native-like	Italian – intermediate-high
Spanish – native-like	French – intermediate-high
Latin – intermediate	