PHONETIC CONSTRAINTS AND L1 TRANSFER OF AN ENGLISH PHONOLOGICAL RULE IN SPANISH L2 PRONUNCIATION

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One particular area of concern for L2 Spanish students whose L1 is English is the pronunciation of Spanish rhotics. This study investigates L2 Spanish rhotic production in beginning learners, specifically addressing the possible effects that the different ways to produce [ɹ] in English (retroflex and bunched) have on the acquisition of Spanish tap [ɾ] and trill [r]. It also addresses the influence that a phonological rule involving [ɾ] in English has on the acquisition of the same phone in Spanish. Results from multiple linear regressions involving forty-eight students enrolled in beginning Spanish foreign language classes show that English rhotic articulation alone is a significant predictor of trill accuracy and is a predictor of tap accuracy when controlling for amount of Spanish exposure. Concerning the effect of an L1 phonological rule on the production of Spanish rhotics, results from a paired samples t-test show that a significantly high percentage of accurately produced taps were found in words that follow the same phonological rule that produces taps in English. These results suggest that a theory of the second language acquisition of phonology should consider both phonological and physiological factors.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 INTERLANGUAGE PHONOLOLGY SYSTEM 6

2.1 ENGLISH RHOTIC PHONOLOGICAL STRUCTURE 6

2.2 SPANISH RHOTIC PHONOLOGICAL STRUCTURE 8

2.3 INTERLANGUAGE RHOTIC PHONOLOGICAL STRUCTURE 9

3.0 RESEARCH IN INTERLANGUAGE PHONOLOGY 12

3.1 L2 PHONOLOGICAL REPRESENTATION 12

3.1.1 Single Representation 13

3.1.2 Separate Representation 14

3.2 L2 PHONOLOGICAL ACQUISITION 15

3.2.1 Phonetic Explanation 15

3.2.2 Phonological Explanation 16

3.2.3 Eclectic Explanation 17

3.2.4 Current L2 Phonology Acquisition Models 18

4.0 CURRENT STUDY 22

4.1 PHONETIC CONSTRAINTS 22

4.2 PHONOLOGICAL RULE 23

4.3 PARTICIPANTS AND PROCEDURES 25

4.4 RESULTS 29

5.0 DISCUSSION AND IMPLICATIONS 40

6.0 CONCLUSION........ 45

APPENDIX........ 47

BIBLIOGRAPHY 49

LIST OF FIGURES

Figure 1. Phonological structure of English tap 8

Figure 2. Phonological structure of English tap and Spanish rhotics 10

Figure 3. Phonological restructuring of English tap and Spanish rhotics 10

Figure 4. Interlanguage phonological structure of rhotics 11

Figure 5. Example of accurate tap articulation 27

Figure 6. Example of accurate trill articulation 28

Figure 7. Measurement of [ɹ] articulations 28

Figure 8. Distribution of perception accuracy rates 30

Figure 9. Distribution of exposure to Spanish prior to enrollment 31

Figure 10**.** Distribution of the perception rate means by prior exposure to Spanish 32

Figure 11. Correlation between tap accuracy and English rhotic articulation 33

Figure 12. Correlation between tap accuracy and English rhotic articulation by exposure group 35

Figure 13. Means of accuracy rates of taps in different environments 36

Figure 14. Correlation between tap accuracy and perception accuracy 37

Figure 15. Correlation between trill accuracy and English rhotic articulation 38

Figure 16. Correlation between trill accuracy and perception accuracy 39

PREFACE

This thesis is a presentation of a research project that I carried out as graduate student at the University of Pittsburgh en route to a PhD. A previous version of this work was presented at the Current Approaches to Spanish and Portuguese Second Language Phonology conference in Gainsville, Florida on February 6, 2010.

I am extremely grateful to my wife and children for their support and understanding. I would also like to thank the people on my committee for their great feedback and help as well as Jeff Lingwall for his statistical advice.

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1.0 INTRODUCTION

One important aspect of learning to communicate in a second language (L2) is acquiring the phonology of the target language. This is one of the most difficult features of language for L2 learners to acquire because most phonological rules are nontransparent to native speakers. In other words, it is difficult to change something that is below the level of perception. That the acquisition of L2 phonology is difficult can be frustrating for students from a perception and production standpoint. Such frustration stems from student expectations of being able to accurately produce and recognize target strings of phones that encode meaning after a short time of language study. The task that learners have when acquiring an L2 phonology can be described using three main scenarios of how phonological rules between the learner's first language (L1) and L2 interact.

One scenario is that an L1 phonological rule is the same as the L2 phonological rule. An example of this scenario is nasal assimilation which exists in English (Padgett, 1994) and Spanish (Harris, 1968). Examples of nasal assimilation can be seen the pairs of words in each language. The nasals in the words [ɪntʰɹ̩əpt] *interrupt* and [ɪmpʰɹ̩fɪkt] *imperfect* assimilate to the voiceless stop that follows them. Nasal assimilation is also evident in the equivalent Spanish words [in̪t̪erumpe] *interrumpe* 'interrupt (3rd person singular)' and [imperfekto] *imperfecto* 'imperfect'. A second scenario is that an L1 phonological rule is different than an L2 rule, but the segments involved exist in both languages. This scenario is evident in the production of

Spanish alveolar taps. Although alveolar taps exist in English, different phonological rules govern the realization of taps in English than in Spanish. A more detailed discussion of this type of interaction is provided in section 4.2. A third scenario is that a phone in the L2 does not exist in the L1 and learners must acquire the sound and any phonological rules that govern its distribution. An example of this scenario is the acquisition of alveolar trills found in Spanish by L1 English speakers who do not have trills in their phonological inventory.

For the most part, researchers agree that the phones that fall into the first scenario are positively transferred and are not difficult for L2 learners to acquire. Phones that fall into the second scenario are more difficult to acquire because phones that are different may be, at least at first, perceived to be the same as L1 phones (Best, 1995). There has been some controversy over phones that fall into the third scenario. Some researchers (Best, 1995; Brown, 2000; Carlisle, 1988) assert that phones that are not found in the L1 inventory of L2 learners will never be acquired or that they will at least be extremely difficult to acquire. Archibald (1998) disputes such an assertion and shows that improvement can be made on these types of phones. Flege (1995) goes further to say that L2 phones that are not part of the L1 inventory are easier to acquire. Although this may be the case, Face (2006) mentions that physiological factors also play a role in acquiring L2 phones that do not exist in the L1.

The first scenario mentioned is not necessarily addressed in this study. Results do support the idea that L1 phones that are close to target phones which do not follow the same phonological rules affect the acquisition of the L2 phonology. As for the third scenario, the current study maintains the claims made by Face (2006) and Archibald (1998) that L2 phones that do not exist in the L1 are acquirable and that physiological factors also influence acquisition.

As mentioned, L1 phonological rules and physiological articulatory conventions affect the accuracy of learners' L2 pronunciation. When these L1 phonological rules are adversely different from the target language rules and when L1 articulatory conventions are adversely different from target conventions, learners find difficulty in acquiring accurate L2 pronunciation skills particular to certain strings or segments. Because L2 phonological rules that differ from L1 rules are difficult to acquire (Eckman, Elreyes, & Iverson, 2003), a better understanding of interlanguage phonology can inform L2 students and teachers on what to expect when acquiring target language phonology.

Studies on L2 phonology acquisition have mainly focused on hypotheses of cross-linguistic markedness, language typology, and perceptual similarity (see Eckman, 2008). Colantoni and Steele (2008) discussed the need to incorporate phonetic constraints into hypotheses regarding L2 phonology acquisition. Their study showed that the current phonological and phonetic models did not adequately predict the variation and acquisition sequences they found in rhotic pronunciation by L1 English speakers learning L2 French and Spanish. They showed that phonetic factors evident in L2 speech such as word-position and manner are not included in the theories they tested and proposed that phonetic factors should be considered in L2 phonological acquisition. Because of this, it is important to carry out studies on L2 phonetic phenomena that may influence the acquisition of L2 phonological systems. Therefore, the hypothesis that this study tests is that both phonological and phonetic factors contribute to the acquisition of an L2 phonology.

The hypothesis tested herein is similar to Colantoni and Steele's (2008) proposal to incorporate constraints on speech production in theories regarding phonological acquisition, but differs in regards to the specific constraints on which it focuses. Colantoni and Steele mentioned aerodynamic constraints and investigated contextual differences of rhotic pronunciation in L2 Spanish and French learners. This study shows that specific L1 articulatory conventions that are not necessarily predisposed by aerodynamics (i.e., tongue shape in English rhotic articulation) also influence L2 speech production. The present study also differs in regards to the subjects tested. Whereas Colantoni and Steele observed intermediate and advanced students, the participants in this study are all beginners. This study therefore contributes to L2 phonological acquisition by providing additional support for Colantoni and Steele's proposal by studying beginners and a different type of phonetic constraint.

One particular phenomenon that can be used to test the hypothesis is that of native English speakers learning to pronounce Spanish rhotics. The L2 acquisition of Spanish rhotics by English speakers is revelatory regarding the current thesis because distinct predictions (see section 4) can be made regarding both phonetic and phonological influence due to the phonetic and phonological differences in rhotics between these two languages. This phenomenon is also interesting because it is a salient phonological difference in the minds of students and causes student anxiety (noticed from personal experience in learning and teaching Spanish). Surprisingly, because of the differences in rhotic pronunciation between English and Spanish, there have not been many studies focusing on the L2 acquisition of Spanish rhotics.[1] Most studies have focused on other aspects of Spanish phonology such as other types of phones, mainly voiceless stops, or pronunciation in general without specifying particular sounds (Face, 2006). Face investigated intervocalic rhotics among intermediate and advanced L2 Spanish learners whose L1 was English and noted the developmental trajectory of rhotic accuracy among

[1] The variety of English in this study is Standard American English spoken in the mid-Atlantic United States. All instances of the word English from here on refer to this dialect. The variety of Spanish in this study is a Standard Spanish that L2 learners are taught in the United States.

his participants. However, his study did not look at students at the beginning stages of L2 development.

The present study investigates L2 Spanish rhotic production in beginning learners, the possible effect L1 phonetic constraints have on Spanish rhotic production, and the effect that an English L1 phonological rule has on accurate L2 pronunciation in an attempt to test the hypothesis that both phonology and phonetic factors contribute to L2 phonology acquisition. This will also provide a better understanding of English-Spanish interlanguage phonology regarding rhotic acquisition of beginning learners. The sequence of the remainder of this paper is the following: In section 2, I present the phonological systems of English and Spanish rhotics and the processes that occur in L2 phonological acquisition. Section 3 is a discussion of the relevant research in interlanguage phonology and L2 Spanish acquisition. Section 4 is a description of the present study that investigates the effect of L1 phonological rules and phonetic constraints on L2 Spanish rhotic production in beginning learners by analyzing speech data from recordings of a read aloud task. Section 5 is a discussion of the results and their implications in interlanguage phonology for students and teachers of L2 Spanish. Finally, section 6 is a discussion of the conclusions drawn from the current study.

2.0 INTERLANGUAGE PHONOLOLGY SYSTEM

To understand the task that L1 English speakers have when acquiring Spanish rhotics, an understanding of each phonological system involving rhotics is necessary. Although interlanguage cannot be solely described by L1 transfer, it is reasonable to assume that with phonology, learners start with full transfer from their L1 phonology (Ellis, 2008). In this section, I describe the English and Spanish phonological structure of rhotics as well as a proposed interlanguage rhotic structure (at least for this level of proficiency).

2.1 ENGLISH RHOTIC PHONOLOGICAL STRUCTURE

Before discussing the structure of the English-Spanish interlanguage phonological system, a description of English rhotics is needed. English has one phonemic rhotic /ɹ/ which can be produced utilizing two maximally distinctive articulations. One is known as the "retroflex" [ɹ] and the other as the "bunched" [ɹ] (Zhou et al., 2008). These descriptions depict the shape of the tongue when producing [ɹ]. Speakers who employ a retroflex [ɹ] lift the apex of their tongue up and curl it back towards the dorsum. Speakers who employ a bunched [ɹ] contract their tongue back into a tight bunch near the rear of their oral cavity.

Although these two distinct ways of producing [ɹ] in English do differ in some acoustic ways, these differences are extremely minimal. Zhou et al. showed that there is a greater difference between formants four and five (F4 and F5 respectively) in retroflex productions than in bunched productions. These differences in distance between F4 and F5 are acoustic measures that correlate with the size and ratio between anterior and posterior (relative to the tongue) resonating cavities. In basic (and somewhat simplified terms), the bigger the posterior cavity is (which correlates with retroflex articulations), the greater the distance between F4 and F5. This is a minimal distinction regarding perception, however, because perception more readily relies on distinct patterns in the lower formants to decode relevant acoustic information. Whether or not the two different ways of producing English rhotics have an acoustic effect is not as important for acquisition as the physiological aspect of the differing articulations and the way to measure such articulations (F5-F4 distance). The implications of the difference between the two English rhotic articulations and Spanish rhotic articulations are further discussed in section 5.

Although taps are not usually associated with rhotics in English, because they occur as allophones of coronal stop consonants /t/ and /d/ as in the word *matter* [mæɾɹ̩], they are important to this study because of their rhotic status in Spanish. Speakers produce taps by raising the apex of the tongue towards the alveolar ridge and making a very brief closure. Figure 1 shows the phonological structure relating to taps in English. Figure 1 only shows the relevant structure of the phonemic relationship between the allophonic tap and the phonemes to which it belongs. Although a complete phonological structure would include other allophones of /t/ and /d/, only the phonological structure as it relates to taps is relevant for this study. The significance of this structure will be discussed below.

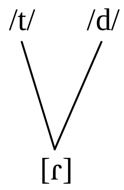

Figure 1. Phonological structure of English tap

2.2 SPANISH RHOTIC PHONOLOGICAL STRUCTURE

Spanish, unlike English, has two distinct phonemic rhotics –a tap /ɾ/ and a trill /r/. Although the full phonemic status of each rhotic has been the topic of some debate (see Hualde, 2005),[2] I maintain the analysis that there are two separate phonemes. This is evidenced in minimal pairs such as *foro* [foɾo] 'forum'-*forro* [foro] 'lining'. Spanish speakers produce taps in the same way as the allophonic tap in English. Trills are produced by raising the apex of the tongue toward the alveolar ridge and making a short sequence of a few brief closures. In a study on aerodynamic factors in trill production, Solé (2002) showed that trills usually entailed a succession of four, and sometimes five or six quick taps. However, she also cites Barry (1997) and Blecua (1999) who suggest that subjects often hyperarticulate in laboratory conditions, and that less taps are more common in speech that is more casual.

Aside from intrapersonal variation, there are also dialectal variations on trills (Bradley, 2004, Willis, 2006). Although variation in articulatory gestures assigned to /r/ that L2 learners might encounter exists, rhotics that L2 learners are exposed to in classroom learning in the United States can be described simply as alveolar taps and alveolar trills (Face, 2006).

[2] Harris (2001) argues that [r] is an allophone of /ɾ/.

2.3 INTERLANGUAGE RHOTIC PHONOLOGICAL STRUCTURE

In the case of L1 English speakers learning Spanish as an L2, learners must acquire a new speech sound, the trill /r/, and must reassign an English allophone of coronal stops [ɾ] to become its own phoneme /ɾ/. Because English speakers do not use trills in speech production, they are more easily acquired (from a perception point of view) than taps (Flege, 1995). This is because speakers do not need to reassign an existing phone in their L1, and are able to construct a new phoneme. However, this does not mean that learners accurately produce trills before taps. Due to the articulatory difficulty of trills, they actually show up later in rhotic development than taps (Face, 2006). Figure 2 shows the native structure of English taps and Spanish taps. The tap is found in complementary distribution of coronal stops /t/ and /d/. The connecting lines between the phonemes and the [ɾ] indicate this relationship. Because both Spanish rhotics hold phonemic status (Hualde, 2005), the lines show the Spanish phonemes connecting directly to their corresponding phones. Figure 3 shows the process that native English speakers must undergo to acquire a target-like phonological system regarding rhotics. The broken lines indicate the process of disassociation from coronal stops in the L2 and the arrow indicates the phonemicization process that [ɾ] must undergo. Learners must also acquire the other Spanish rhotic which does not exist in English. This process occurs as learners notice (subconsciously) that the environmental distribution of taps is no longer predictable and a separate phoneme must be posited.

Figure 2. Phonological structure of English tap and Spanish rhotics

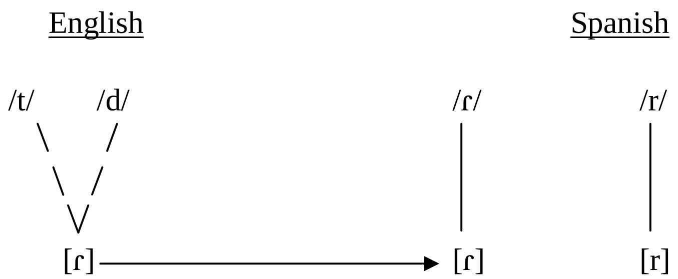

Figure 3. Phonological restructuring of English tap and Spanish rhotics

Although this process seems somewhat straightforward, there are other confounding factors. Orthography is one factor that can have a negative influence on the acquisition of Spanish rhotics (Koda, 1989; Munro & Derwing, 1994; Zampini, 1994). Because taps and trills are represented orthographically as <r> (trills are represented as <rr> intervocalically), classroom learners' (with no prior experience) immediate response is to refer to the same orthographic representation in English that represents the rhotic /ɹ/. Instead of activating the tap already existent in their phonological representation, the alveolar approximant /ɹ/ is activated. This is another obstacle for L2 Spanish learners to overcome. Therefore, a proposed interlanguage phonological system regarding rhotics (after a contrast between all rhotics is perceived) consists of the two phonemes /ɾ/ and /r/. The former phoneme is realized as the allophones [ɾ] and [ɹ] and the latter phoneme is realized as [r] and [ɹ]. Figure 4 shows the proposed interlanguage structure of beginning L2 Spanish learners.

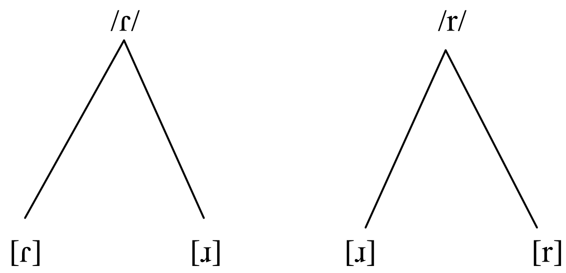

Figure 4. Interlanguage phonological structure of rhotics

3.0 RESEARCH IN INTERLANGUAGE PHONOLOGY

Although learners go through a process of learning phonology starting with their L1 and moving towards an L2 (Ellis, 2008), the language phenomena evident in this processes sometimes does not resemble the L1 or the L2. Because of this, learners' interlanguage system has become an object of study. In attempting to explain interlanguage phonology, researchers have investigated how the interlanguage is represented in the minds of learners as well as the process of acquiring an L2 phonology which involves (perhaps entirely) an interlanguage stage. These two focuses of interlanguage phonology research are discussed below.

3.1 L2 PHONOLOGICAL REPRESENTATION

One important question regarding interlanguage phonology is how L2 learners represent the target phonology in terms of their L1. Do learners create a different representation altogether or do they have a single phonological representation of their L1 upon which they add new phonological information? Some researchers posit a single phonological representation for all languages while others argue that separate phonological representations are created for each language.

3.1.1 Single Representation

Roelofs and Verhoef (2006) believe that phonological representations of different languages are not separate in bilinguals. Based on results from computer simulations that assume the WEAVER++ model of speech production, they claim that there would be no proficiency deficiency of phonological forms in L2 learners if forms were separated into different phonological representations because there would be no reason for the L1 phonology to interfere with L2 phonology. However, L1 phonology does have an influence on L2 speech production. The fact that most L2 learners of all levels of proficiency have, in common terms, a "foreign accent" is suggestive of this influence.

The act of distinguishing between phones in an L2 is further confounded when word structures of each language are similar. Various Spanish words with English equivalents exemplify this phenomenon. For instance, the word for *different* in Spanish is *diferente*. Although these words communicate equivalent meanings and very similar pronunciation, there are a few distinct differences. *Different* is phonetically transcribed as [ˈdɪfɹənt] while *diferente* is transcribed as [d̪ifeˈɾen̪t̪e]. Roelofs and Verhoef's (2006) hypothesis predicts that an L2 learner would pronounce these words using phones that are closer to those found in their L1 than phones used with other words in the different languages because learners are using the phonology they already have to interpret and produce such similar words.

3.1.2 Separate Representation

Opposed to claims that phonological representations are unitary in bilinguals, Goldstein, Fabiano, and Washington (2005) posit that each language in bilinguals' repertoires maintains its own phonological representation. They studied the phonological skills of bilingual children by analyzing output in picture naming tasks. Their results supported the idea that, although there were a few instances of cross-linguistic influence on phonetic qualities of the output, bilinguals' phonological representations are separate for each of their languages.

Llama, Cardoso, and Collins (2008) carried out another study that lends strength to the concept of two separate phonological representations. They investigated whether typology or L2 status was a stronger predictor of third language (L3) phonology by analyzing voice onset time differences among English, French, and Spanish L3 learners. The results of this study show that L2 phonology influenced L3 phonology more than L1 phonology. This suggests that, because a learned phonological system (i.e, L2 system) is affecting a target phonological system more than one that is mostly subconscious (i.e, L1 system), each phonology is represented as a distinct entity. Otherwise, we would not see one set of sounds dominate another in the acquisition of a third phonology because these sounds would be represented in one discrete set.

A synthesis of these opposing ideas about phonological representation suggests that perhaps there is a process in acquisition where, in the first stages of acquisition, a single phonological representation forms. Over time, with more experience and more opportunities for input and production, representations branch to become more like the different targets. Longitudinal studies should be conducted to test the possibility of such a developmental process.

3.2 L2 PHONOLOGICAL ACQUISITION

Describing the process of constructing the interlanguage system used to store phonological information in languages beyond the L1 is also important when describing interlanguage phonology. Researchers have also attempted to describe this process in various ways. Here I discuss three explanations that have been used to describe this process and three current models that attempt to explain this process and make predictions about interlanguage phenomena.

3.2.1 Phonetic Explanation

Other research that has sought to explain phenomena in interlanguage phonology has tried to predict the processes of acquiring an L2 phonology. One hypothesis that attempts to explain this process is the Intralingual Markedness Hypothesis (IMH) (Carlisle, 1988); it states:

> If structures in the target language differ from those in the native language, and if those structures in the target language are in a markedness relationship, then the more marked structure will be more difficult to acquire than will the less marked structure. (p. 17)

Markedness here refers to the relative cross-linguistic frequency of a speech sound. The less frequent the sound is, the more marked it is. Carlisle (1988) based his hypothesis on the fact that when Spanish speakers learning English as an L2, they tend to epenthesize /e/ before word-initial /s/ (e.g., [esˈmaɹt] for [ˈsmaɹt] *smart*). Spanish speakers do this because the features in the target language are more marked (less-frequent cross-linguistically) than those in the L1 and thus follow L1 phonological rules. In other words, L1 Spanish speakers have more difficulty acquiring word-initial consonant clusters involving /s/ followed by another consonant, found in words like *speak* [spik], than other word-initial phones (e.g., /t͡ʃ/ in words like *church* [t͡ʃɹ̩t͡ʃ]) because these clusters do not occur in Spanish and are more marked than other word-initial phone combinations. Because of this markedness relationship, L1 Spanish speakers initially revert to the L1 phonological epenthetic rule which produces [espik] rather than follow the L2 phonological rule (or lack of such a rule) which produces [spik].

Another example that illustrates the predictions of the IMH, which has direct relevance to the current study, is shown by the acquisition of taps and trills found in Spanish by English L1 speakers. Face (2006) investigated high intermediate and advanced learners and showed that they acquired trills later than taps. This is exactly what the IMH would predict because trills are more marked than taps. The IMH relies on phonetic constraints to explain how L2 learners acquire a new set of phonological representations (or the lack thereof).

3.2.2 Phonological Explanation

Other researchers dispute the idea that interlanguage phonology should rely on phonetics or typology. Archibald (1998) states that "there are a number of reasons that [he] maintain[s] that an abstract mental representation solution is preferable to more concrete phonetic or typological arguments" (pg. 190). He founds his claim on the fact that languages like Japanese and Korean make a phonetic distinction between [l] and [ɹ] yet still have difficulty in native like production of [l] and [ɹ] in when speaking English.[3] This is not because they do not have the phones in their

[3] I distinguish between phonemic transcription and phonetic transcription with / / and [ ] respectively unless otherwise indicated.

phonological inventory, but because they have to learn the different representations and phonological rules and constraints that drive the distribution of these phones in English.

Similarly, English speakers learning Spanish as an L2 have difficulty reassigning [ɾ] to a different phonemic representation (i.e., full phonemic status). Although this phone exists as a homophonous allophone of /t/ and /d/ in English, as found in the words [læɾɹ̩] *ladder* and [fæɾɹ̩] *fatter,* it is not an allophone of /ɹ/. Spanish students must therefore reassign a tap [ɾ] to phoneme status and add a trill [r] to /r/ (assuming a single phonological representation in the mind) to their phonological inventory when learning Spanish. Eventually, /ɹ/ is replaced as the L2 learner approaches native-like proficiency in the target language by the two separate phonemes /ɾ/ and /r/.

3.2.3 Eclectic Explanation

Because both phonological and phonetic positions argue valid points for explaining interlanguage phonology acquisition, both should be considered when explaining and predicting interlanguage phonology phenomena. Some research has appealed to a more comprehensive account for the acquisition of new speech sounds. Escudero and Boersma (2004), for example, investigated L2 speech perception in Spanish speakers learning English. They tested learners' perception of /i/ and /ɪ/ distinctions with relationship to different target dialects of English. They found that learners whose target dialect was Scottish Standard English performed like native speakers and learners whose target dialect was Southern British English did not perform like native speakers. The latter learners not only deviated from their native speaker counterparts, but also did not perform in a predictable way considering their L1 phonology. This is problematic for phonetic accounts of interlanguage phonology because pure acoustic cues were not enough for the second group of learners. If this were the case, both groups of learners would perform in a similar fashion—either similar to native performance of the L2 or similar to L1 phonological performance. Therefore, purely phonetic accounts are problematic.

Although phonetics cannot fully explain interlanguage phonology phenomena, other researchers have demonstrated that purely phonological accounts are also problematic. Colantoni and Steele (2008) studied the production of rhotics by English-speaking L2 learners of French and Spanish. They looked at the variability found in L2 rhotic production among these speakers. The results of their study suggest that phonological theories of L2 phonology acquisition fall short in their ability to predict the variability found in L2 speakers because they do not account for complexity involved in articulation and perception. Colantoni and Steele posit that phonetic constraints on speech production can explain such variability. They propose that phonological theory should include phonetic constraints for a better overall explanation of interlanguage phonology.

3.2.4 Current L2 Phonology Acquisition Models

There are currently three major models that have been proposed to explain how learners acquire an L2 phonological system through perception—The Perceptual Assimilation Model (PAM, Best, 1995), The Speech Learning Model (SLM, Flege, 1995), and The Native Language Magnet Model (NLM, Iverson & Kuhl, 1996). The PAM posits that what Best calls "gestural constellations" encode phonological segments. Gestural constellations are the positions and movements of the articulators in the vocal tract that produce speech sounds.[4] Learners perceive target language segments in terms of similarities and differences in articulatory gestures compared to native language segments. This means that if a target language segment is similar to a native language segment, L2 learners will perceive it to be the same as the native segment. If a target language segment is different than any native segment, but still falls within native phonological space (e.g., [ɪ] for native Spanish speakers who only contrast [i] and [e]), L2 learners will perceive it as a speech sound that is different than segments in their native phonological system. Finally, for a target language segment that is extremely different from any native language segment, L2 learners will not perceive it as a speech sound and will not assimilate it.

Flege's (1995) SLM takes a more dynamic approach to explaining how L2 learners acquire target sounds. According to the SLM, L2 learners perceive all L2 sounds in terms of established L1 segments in their phonological system from the onset of L2 exposure. Through experience, L2 learners notice phonetic differences between target segments and L1 segments and are able to create a different phonetic category for the target language segment. This means that native English speakers would, at first interpret the voiced interdental fricative [ð] found in the word [kaða] *cada* 'each' as a voiced alveolar stop [d]. Over time speakers would recognize a difference and form a separate segment in their phonological system. The SLM also predicts that separating L2 segments from L1 segments that are phonetically closer to those L1 segments (e.g., [t] and [t^h]) will be more difficult than separating L2 segments from L1 segments that have more phonetic distance between them (e.g., [ɹ] and [ɾ]). Because L2 segments that are more

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[4] Gestural constellations are based on gestural phonology proposed by Browman and Goldstein (1986).

distant from L1 segments are more easily separated, the SLM also predicts that L2 learners more easily produce them.

Similar to the SLM, the NLM also predicts that L1-like phones will be harder to distinguish than phones that less like the L1. The basic tenet of the NLM model is that the ability to distinguish between two phones diminishes as the phonetic space approximates native prototypical segments and expands closer to the boundaries between prototypical segments. Applied to L2 phonology acquisition, this means that the ability of L2 learners to distinguish differences between segments diminishes the closer the new segments are to native segments and that the closer to the boundaries between L1 prototypes the new segments are, the easier they will be to distinguish and, therefore, acquire.

These models attempt to explain the acquisition of phonology in slightly different ways; however, they also share commonalities. Each model claims that L2 segments that are closer to native segments are harder to perceive and produce correctly than segments that are more unlike L1 segments. Although these models have been employed in explaining L2 phonology acquisition, they only explain how L2 learners perceive target sounds and do not incorporate the influence that production has on L2 phonology acquisition, specifically the physiological factors that facilitate or hamper acquisition.

In assessing the information provided here, a theory of L2 phonology acquisition that combines phonology and phonetics in perceptive and productive realms is superior to a theory that is blind to either phonology or phonetics and that only describes perception or production. An evaluation of the research provided here can also allow us to see how phonetics and phonology may contribute to L2 phonology acquisition. For the most part, articulatory factors (i.e., motor control) restrict the ability to produce native-like segments. This is because the learner must consciously change physiological habits while speaking in order to produce target-like utterances.

As the L2 phonological models predict, L1 phonology can contribute to L2 acquisition in positive and negative ways depending on the similarity of the L1 to the L2. When representations are similar, as we see with English and Spanish /n/ which both have allophones that assimilate in place with following obstruents (e.g., Eng.: [ten̪θ] 'tenth', Spn.: [βen̪θeɾ] 'to defeat',[5] Eng.: [piano] 'piano', Spn.: [uno] 'one', Eng.: [eɪŋkɹ̩] 'anchor', Spn.: [riŋkon] 'corner'), L1 phonology contributes positively to acquiring an L2 phonology. When representations are dissimilar, however, as with English and Spanish /r/ as seen in Figure 2, L1 phonology makes a negative contribution to acquisition. Another example of negative L1 phonological influence is when certain Spanish phones do not exist in English such as [γ] as in [aγua] 'water' or [x] as in [enoxo] 'anger'. Beginning Spanish learners usually pronounce these phones as [g] and [h] respectively since they are the closest phones that exist in the English phonological system. Orthography probably also influences the non-target-like production of these phones (Koda, 1989; Munro & Derwing, 1994; Zampini, 1994).

[5] This example is taken from a Spanish dialect spoken in Madrid, Spain; although nasal place assimilation occurs in all Spanish dialects.

4.0 CURRENT STUDY

Because phonetic constraints and phonological representations both influence the acquisition of an L2 phonology, the current study looks at one possible phonetic constraint and L1 phonological influence that English speakers learning Spanish as an L2 have in learning Spanish rhotics. Specifically, this study addresses the possible effects of the maximally different ways to produce [ɹ] in English—retroflex and bunched. It also addresses the influence that a phonological rule involving [ɾ] in English has on the acquisition of the same phone in Spanish. The remainder of this paper consists of a brief discussion on the physiological nature of the English and Spanish rhotics and the phonological rule in question, a description of the participants and the procedures used in the study, analytical results, a discussion on what the results indicate, and a brief conclusion.

4.1 PHONETIC CONSTRAINTS

Before discussing the possible implications of different physiological ways of producing [ɹ], a description of the production of Spanish rhotics is needed. There are two phonemic rhotics in standard Spanish, which surface in different allophones across dialects. These two phonemes are realized as a tap [ɾ] and a trill [r]. Dialectal variation and individual variation do exist in the actual phones pronounced in Spanish rhotics, usually occurring as fricatives or approximants (Lindau, 1985; Blecua, 2001; Hammond, 1999); however, apical taps and trills are generally what English-speaking learners of Spanish confront in a classroom setting (Face, 2006). Speakers produce taps by raising the apex of tongue towards the alveolar ridge and making a very brief closure. The important point is that in both rhotics of standard Spanish, speakers raise the apex of the tongue toward the alveolar ridge (Blecua, 2001).

The potential implication of physiological differences between English rhotics is that speakers who employ retroflex articulations may have an advantage over speakers who employ bunched rhotic articulations. Because retroflex rhotics raise the apex of the tongue towards the alveolar ridge, it follows that production of taps and trills would be facilitated when they are represented in the phonology as allophones of /r/. On the other hand, production of taps would be impeded when English speakers employ a bunched [ɹ] because they are used to the opposite direction of movement in producing rhotics.

4.2 PHONOLOGICAL RULE

Aside from the potential phonetic constraints influencing L2 Spanish rhotics, L1 phonological rules may also contribute to Spanish rhotic accuracy. One potential English rule that may have an influence on the accuracy of Spanish rhotics is the English tap rule, which converts the alveolar stops /t/ and /d/ to [ɾ]. Ladefoged (2006, pg. 74) formulates this rule stating, "alveolar stops become voiced taps when they occur between two vowels the second of which is unstressed". Alternations in *atomic* and *atom* exemplify this rule. The word *atomic* [æˈtʰamɪk] shows that when stress falls on the syllable containing /t/ in its onset, it is realized as [tʰ]. The word *atom* [ˈæɾəm] shows that [ɾ] alternates with [tʰ] when stress falls on a syllable that does not contain /t/ in its onset, leaving the vowel unstressed.

A phonological rule (the English tap rule mentioned above) is needed to explain the distribution of taps with respect to the phoneme they represent in production because taps are only allophonic in English. Spanish taps are phonemic and a discrete rule is not needed to explain their distribution. Taps can be realized in both stressed and unstressed environments as exemplified in the words *mejoro* [meˈxoɾo] 'improve (first person singular)' and *mejoró* [mexoˈɾo] 'third person singular improved'. Stress does not influence tap distribution in Spanish as it does in English.

Because taps do exist in their native language, English speakers learning Spanish should be able to produce them. If the English phonological rule has an influence on production of Spanish taps, learners of Spanish should be able to produce taps more accurately when the environment in which taps exist in Spanish are similar to the predictable environments in which they exist in English (following a stressed syllable). Because trills do not exist in Standard American English, there is no prediction on how phonological rules would affect their acquisition. The lack of the existence of trills in American English, however, could impede, as predicted by Face (2006), or facilitate, as predicted by Carlisle (1988) the acquisition of Spanish trills.

This discussion leads to the research questions addressed in this study. These questions are: (1) Does manner of American English rhotic articulation (i.e., retroflex or bunched) affect the facilitation of Spanish rhotic production?, and (2) Does the phonological rule that governs taps in English affect accuracy in Spanish rhotic production?

4.3 PARTICIPANTS AND PROCEDURES

Fifty-five native English-speaking adults from three beginning Spanish as a foreign language classes at the university level were involved in this study. Five native Spanish-speakers (three females and two males) representing dialects from a variety of South American countries and Spain also participated to provide a control group of rhotic accuracy rates. The data from three of the native English-speaking participants are not included in this study because either an instrument malfunction or user error occurred causing their audio recordings to not contain any sound. Four more participants were removed because their perception data were unclassifiable and hence no determination whether they perceived difference between [r] and [ɾ] could be made. For example, one participant did not write anything for the perception task while the other three participants wrote words that did not contain either target phone like *paso* for the word *carro*. Other answers provided by these three participants that were deemed unclassifiable were not words in Spanish nor did they contain the target phones as in *kayo* and *calow* for *caro* and *carro* respectively. Therefore, the data elicited from a total of number of forty-eight participants were included in the analyses. Participants filled out a questionnaire that asked them to indicate if English was their native language and to rate their exposure to Spanish before taking the Spanish class in which they were currently enrolled on a Likert scale from one to seven where one equaled no exposure and seven equaled extensive exposure. All L2 Spanish learners indicated that they were native English speakers.

Participants then recorded themselves reading a text in Spanish (see Apendix A) adapted from a reading found in *Mosaicos 4th edition* (Castells, Guzmán, Lapuerta & García, 2006) designed to elicit the same number of possible tap and trill articulations from each participant in order to calculate accuracy rates. They accomplished this task on Macintosh computers equipped with headsets using Audio Recorder 3.2. The Spanish text contained a total of thirty-two taps in the intervocalic position. Nineteen taps occurred in the onsets of unstressed syllables where the preceding syllable was stressed (the same environment in which alveolar stops become taps in English), as in the word [ˈpeɾo] *pero* ‘but’. Thirteen taps occurred in other intervocalic environments (i.e., occurring after an unstressed syllable and comprising the onset of either a stressed or unstressed syllable), as in the words [difeˈɾente] *diferente* ‘different’ or [ˈnumeɾo] *numero* ‘number’. The text also contained four intervocalic trills as in the words [ˈsjeran] *cierran* ‘3rd person plural close’ or [koˈreos] *correos* ‘mail (plural)’. In order to determine the type of English rhotic articulation employed, participants also recorded themselves pronouncing four English words containing [ɹ] –*arrow*, *car*, *proud*, and *heart* along with a prolonged [ɹ] pronunciation. They were asked to pronounce each word twice and to hold out the [ɹ] for a few seconds.

Upon completion of the recordings, participants completed a simple perception task that combined identification and discrimination of taps and trills. The discrimination part of the task was similar to Brown’s (1998) AX task where participants are presented stimuli and respond with “same” or “different”. This task differed in the fact that participants were asked to also identify (like identification tasks mentioned in Strange and Shafer, 2008) the words that were spoken to make it simple and to mimic possible tasks they might encounter in a classroom setting. Because this study is primarily concerned with production, a simple, combined version of these perception tasks was used.

A female native Spanish speaker from Madrid, Spain recorded 10 words containing minimal pairs involving taps and trills including: [kaɾo] *caro* ‘expensive’, [karo] *carro* ‘car’, [koɾo] *coro* ‘choir’, [koro] *corro* ‘I run’, [paɾa] *para* ‘for’, [para] *parra* ‘vine’, [peɾa] *pera* ‘pear’, [pera] *perra* ‘female dog’, [peɾo] *pero* ‘but’, and [pero] *perro* ‘male dog’. Participants listened to these words which were played back over speakers installed in the room so that all participants were able to hear. Each word was played three times in the order listed above and participants were asked to write down the word that they heard and the definition in English. They were also instructed that if they did not know the definition, to not write one. Participants were only told that this study was investigating learner pronunciation of Spanish at the beginning level so that they did not purposefully alter their normal pronunciation with regards to the rhotics involved in the elicitation.

All recordings were analyzed using *Praat* (Boersma & Weenink, 2009). Successful taps were counted when there was a clear closure of the vocal tract indicated in the spectrogram by a brief break in the simultaneous formant structures. Successful trills were counted following Solé (2002), Barry (1997), and Blecua (1999); when there were at least two successive closures of the vocal tract were evident. Figure 5 shows an example of an accurate tap articulation and Figure 6 is an example of an accurate trill articulation.

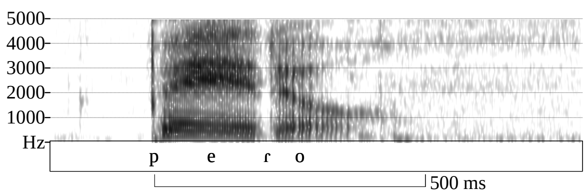

Figure 5. Example of accurate tap articulation

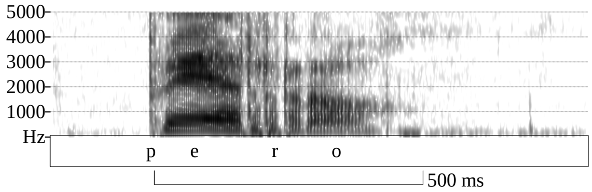

Figure 6. Example of accurate trill articulation

Manner of articulation of English [ɹ] in each participant was calculated by averaging the distances between F4 and F5 taken from each of the pronounced English words and the prolonged [ɹ]. As mentioned previously, a greater distance between F4 and F5 indicates a more retroflex articulation whereas a lower distance between F4 and F5 indicates a more bunched articulation. The distance between F4 and F5 of each [ɹ] articulation was produced by averaging all of the F4s and F5s measured throughout each pronunciation, taking care not to include surrounding sounds, and subtracting the F4 average from the F5 average. Figure 7 shows how each measurement was taken.

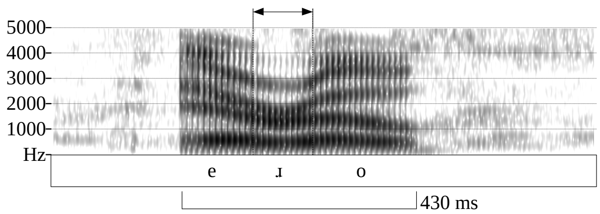

Figure 7. Measurement of [ɹ] articulations

Zhou et al. (2008) found that differences between F4 and F5 in their participants (males with similar vocal tract length) for speakers employing retroflex articulations were around 1400 Hz, while differences for speakers employing bunched articulations were around 700 Hz.

Because the average distance between F4 and F5 varied among speakers in the present study, ranging from 525 Hz and 1603 Hz with a mean of 1057 Hz and a standard deviation of 219 Hz, determining strictly retroflex and strictly bunched articulations proved to be arbitrary. Because English rhotic articulations in this study fell along a continuum of rhoticity, they where analyzed as such.

Tap accuracy rates were calculated for each student by dividing the total number of accurate taps by the total number of possible taps. Tap accuracy rates were also calculated for taps in phonological environments that produce taps in English as well as those taps that were in other environments in order to test for the possible influence that the English tap rule has on accuracy of the production of Spanish taps. Trill accuracy rates were calculated in the same manner.

4.4 RESULTS

Perception accuracy rates were calculated to examine whether participants were able to distinguish between [ɾ] and [r]. These perception accuracy rates were then separated by the amount of prior Spanish exposure to see whether participants improved over time. Figure 8 shows the distribution of results of the perception task. The majority of the participants (*n*=34, 70.8%) scored 80% or above on the perception task while the rest of the participants' scores were distributed fairly evenly across the other possible accuracy rates.

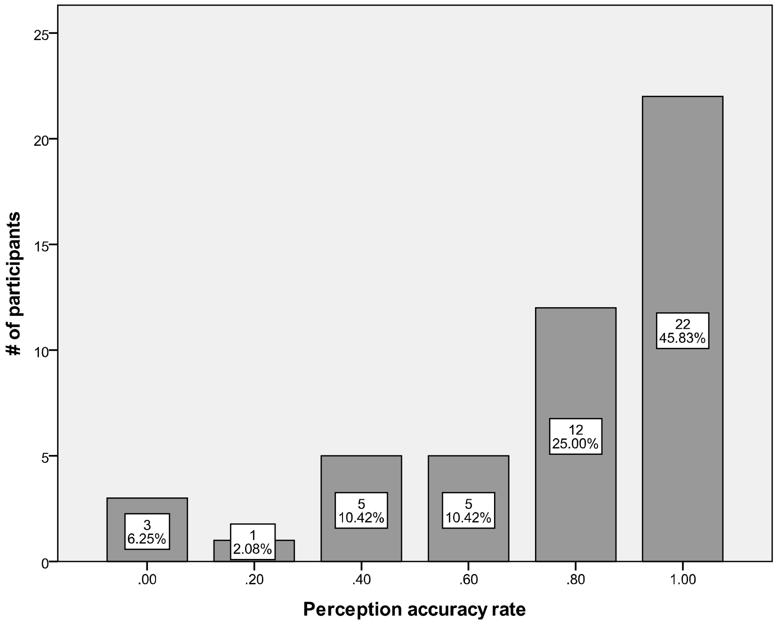

Figure 8. Distribution of perception accuracy rates

Figure 9 shows the distribution of participant responses to the Likert scale ranking task which asked them to rank themselves according to the amount of exposure to Spanish prior to enrolling in their Spanish class. The participant responses to prior Spanish exposure created a normal distribution with a peak around the second ranking (little exposure). The percentage of participants that indicated having little exposure was 37.5% (*n*=18). Two participants indicated that they previously had a fair amount of exposure to Spanish (Likert ranking of 5), and no participants indicated that they had undergone considerable (Likert ranking of 6) or extensive (Likert ranking of 7) exposure to Spanish prior to enrolling in this course.

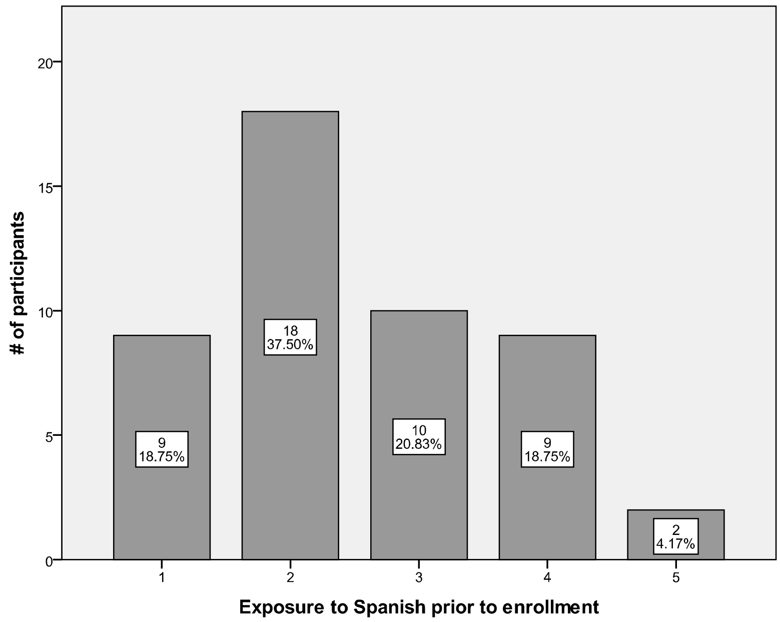

Figure 9. Distribution of exposure to Spanish prior to enrollment

The mean perception rates of each prior Spanish exposure group show an overall rise in the perceptual accuracy as Spanish exposure increases. Because there were no participants that ranked themselves a six or seven for amount of prior exposure to Spanish, there was no mean calculated. The distribution of the means of the perception accuracy rates by the amount of Spanish exposure prior to enrollment is shown in Figure 10. As can be seen, there is also a notable jump in perception rate means between the participants that ranked themselves as having no prior exposure (Likert ranking of 1) and the participants that ranked themselves as having little prior exposure to Spanish (Likert ranking of 2).

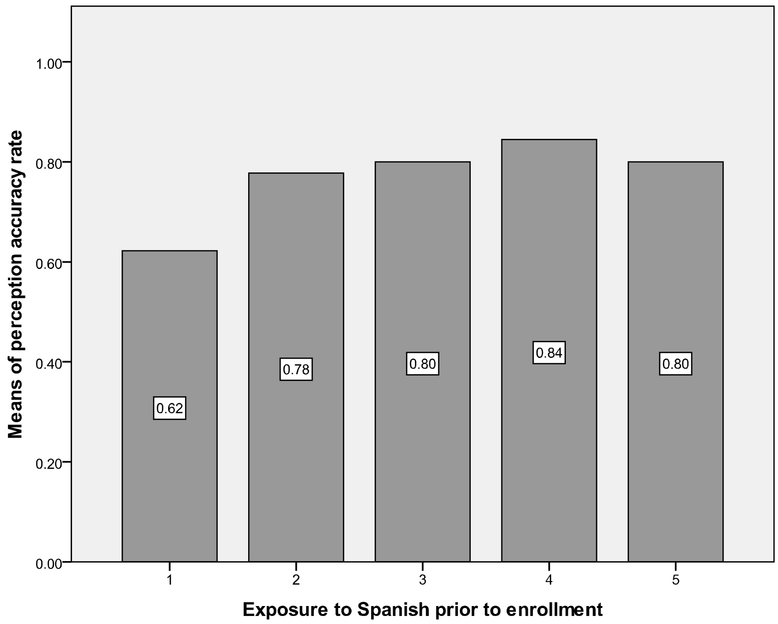

Figure 10. Distribution of the perception rate means by prior exposure to Spanish

As for tap accuracy rates, thirty-one English-speaking participants (64.6%) were able to produce at least one tap accurately (as judged by the investigator using spectrograms as seen in Figures 5 and 6). Successful taps consisted of a clear closure the vocal tract and successful trills consisted of at least two successive closures. Of the accurately produced taps, accuracy rates ranged from 3.1% (1/32) to 100% (32/32) with a mean of 56.3%. Tap accuracy rates for the native Spanish-speaking participants ranged from 96.9% (31/32) to 100% (32/32) with a mean of 97.5% accurate tap production. An independent-samples t-test was performed to test the significance of the difference between the means of Spanish tap accuracy rates between the participant groups. The difference between English-speaking participants' tap accuracy rates (M=36.3, SD=36.1) and Spanish-speaking participants' tap accuracy rates (M=97.5, SD=1.4) was significant; $t(51)=11.661$, $p < .001$.

A linear regression was performed (alpha level was set at the .05 level) to test whether English rhotic articulation was a predictor for tap accuracy. For tap accuracy, rhotic articulation (R^2=.057) alone was not a significant predictor (β=.239, p=.102). Figure 11 is a scatter plot of the relationship between tap accuracy rates and English rhotic articulation. A multiple linear regression was then performed to test whether English rhotic articulation was a predictor of tap accuracy, this time controlling for participants amount of exposure to Spanish. This test showed a significant effect for English rhotic articulation (β=.320, p=.010) as well as amount of exposure to Spanish (β=.564, p< .001) which combined accounted for 37% of the variance (R^2=.369).

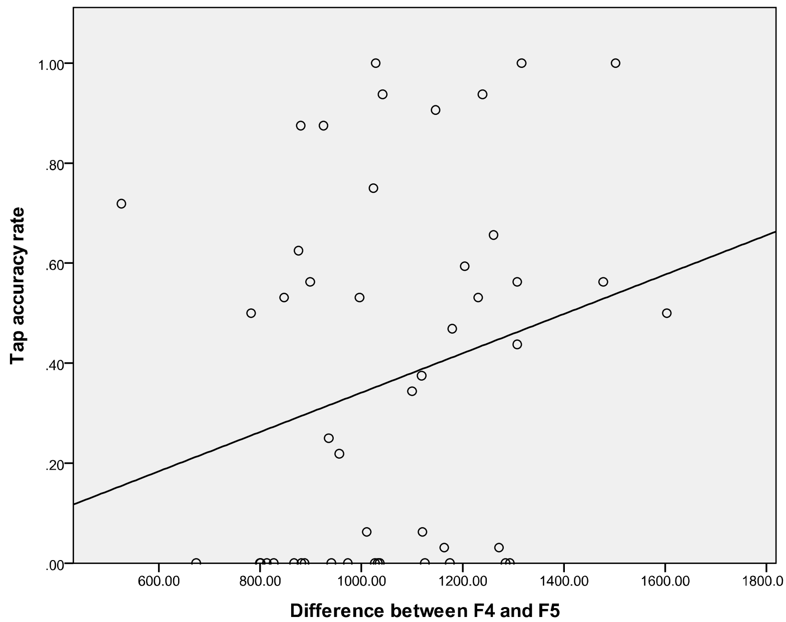

Figure 11. Correlation between tap accuracy and English rhotic articulation

Because English rhotic articulation was only a significant predictor when controlling for amount of exposure to Spanish, participants were split into groups according to the amount of exposure to Spanish they had indicated and separate regressions were performed on each group.

English rhotic articulation (R^2=.235) alone proved to be a significant predictor (β=.484, p=.042) for the participants who ranked themselves as having little prior exposure to Spanish (a ranking of 2 on the Likert scale). For participants who reported having some prior exposure to Spanish (a ranking of 3 on the Likert scale), English rhotic articulation (R^2=.321) approached significance as a predictor of tap accuracy (β=.567, p=.088). For all other participants, English rhotic articulation was not a significant predictor of tap accuracy (R^2=.215, β=.464, p=.209 for group 1; R^2=.161, β=.401, p=.285 for group 4).[6] Figure 12 shows the relationship between tap accuracy rates and English rhotic articulation separated by Spanish exposure group. The data points in the second group line up better with the regression line, showing a significant correlation. The data points in the third group also show a relative relationship to the regression line, indicating a weak relationship. The other groups do not show strong correlations.

[6] Because only two participants indicated that they had a fair amount (Likert ranking of 5) of exposure to Spanish prior to enrolling in the beginning Spanish course a multiple linear regression could not be performed on this group.

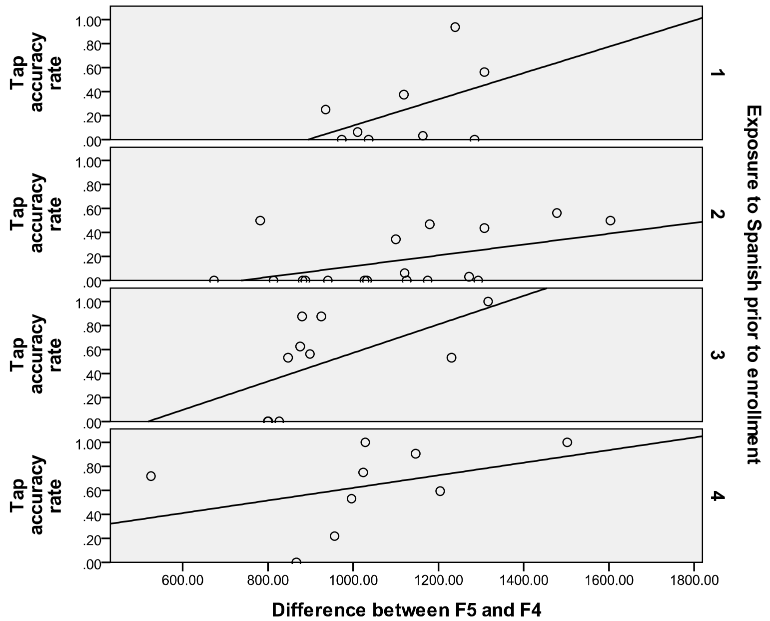

Figure 12. Correlation between tap accuracy and English rhotic articulation by exposure group

To see whether the English tap phonological rule affected Spanish tap accuracy, a paired-samples t-test was performed. This test compared the means of the accuracy rates of taps (including only the participants that produced accurate taps, *N*=31) found in phonological environments that pattern like the English tap rule (M=61.6, SD=31.4) and taps found in other environments (M=45.4, SD=30.9). A significant difference was found between these means; $t(30)=4.845$, $p< .001$. Figure 13 shows the means of the accurate taps in the English tap rule environment compared to the accurate taps in other environments. As the error bars indicate, the mean accuracy of taps in English tap rule environments is significantly higher than the mean accuracy of taps on other environments.

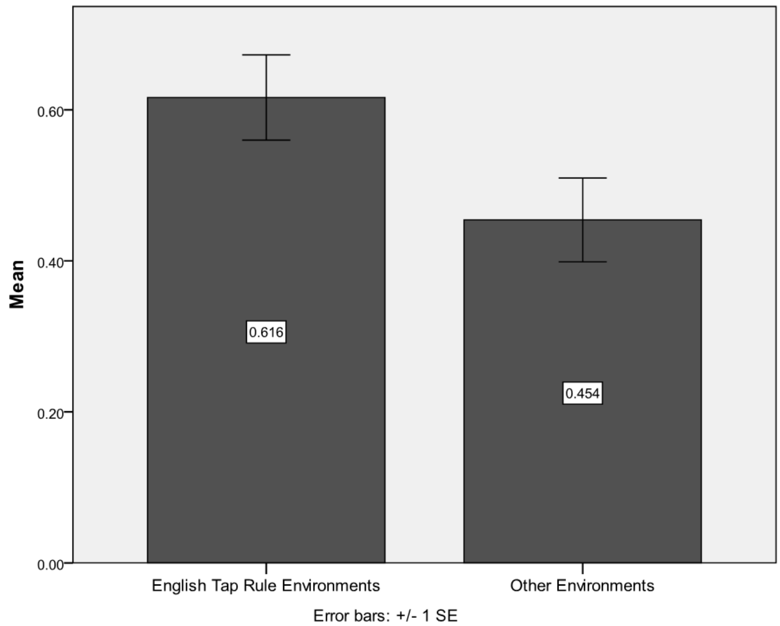

Figure 13. Means of accuracy rates of taps in different environments

A linear regression was also performed (alpha level was set at the .05 level) to see whether perception accuracy rate was a significant predictor of tap accuracy. Perception accuracy rate (R^2=.180) was a significant predictor of tap accuracy (β=.517, p=.003). Figure 14 shows the relationship between these two variables. Although this correlation between these variables is significant, a wide range of tap accuracy rates can be seen in the upper levels of perception accuracy rates.

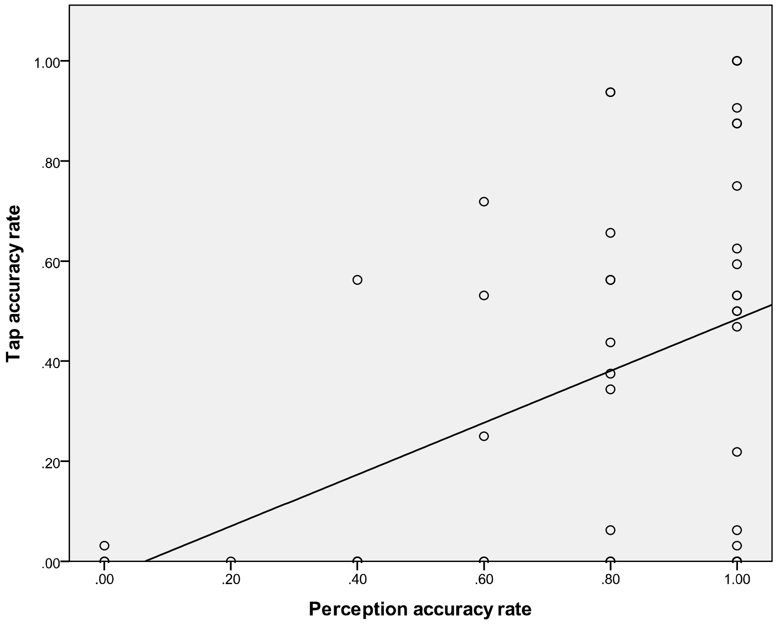

Figure 14. Correlation between tap accuracy and perception accuracy

As for trill accuracy rates, seven English-speaking participants out of the forty-eight (14.6%) were able to produce at least one accurate trill (multiple brief closures evidenced in the spectrogram). Of the accurately produced trills, accuracy rates ranged from 25% (1/4) to 50% (2/4) with a mean of 35.7% accurate trill production. Trill accuracy rates among the native Spanish-speaking participants ranged from 50% (2/4) to 100% (4/4) with a mean of 85% accurate trill production. An independent-samples t-test was performed to test the significance of the difference between the means of Spanish trill accuracy rates between the participant groups. The test showed a significant difference, $t(51)=11.724$, $p< .001$, between the English-speaking participants' trill accuracy rates ($n=48$, M=5.2, SD=13.6) and Spanish-speaking participants' trill accuracy rates ($n=5$, M=85.0, SD=22.4).

A linear regression was performed (alpha level was set at the .05 level) to test whether English rhotic articulation was a predictor for trill accuracy. For trill accuracy, rhotic articulation alone (R^2=.110) was a significant predictor (β=.332, p=.021). A multiple linear regression was also performed to account for exposure to Spanish in trill accuracy rates. This test showed that English rhotic articulation (β=.364, p=.012) was also a significant factor controlling for exposure to Spanish (β=.218, p=.122) which combined accounted for 16% of the variance (R^2=.157). Figure 15 shows the correlation between trill accuracy rates and English rhotic articulation.

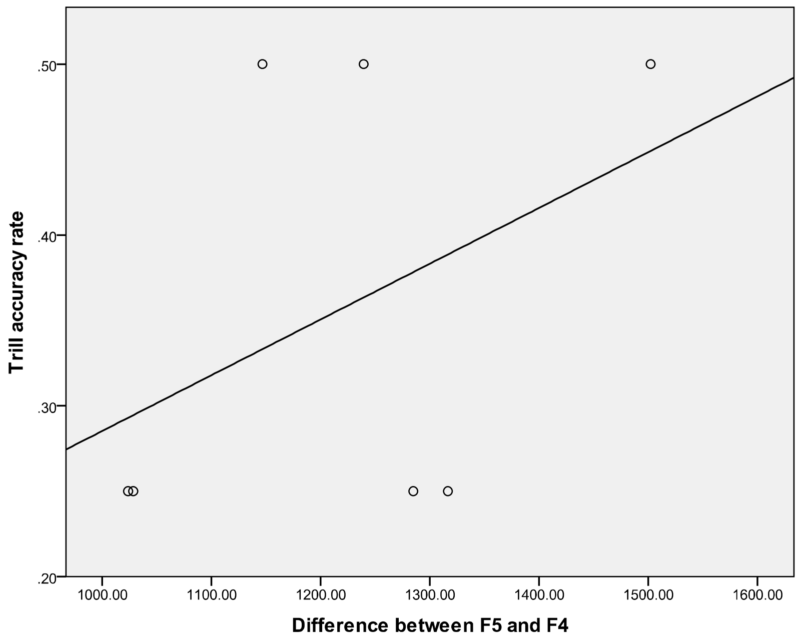

Figure 15. Correlation between trill accuracy and English rhotic articulation

A linear regression was also performed (alpha level was set at the .05 level) to see whether perception accuracy rate was a significant predictor of trill accuracy. Unlike with tap accuracy rate, perception accuracy rate (R^2=.065) was not a significant predictor of trill accuracy (β=.118, p=.079). Figure 16 shows the relationship between these two variables. The only participants that were able to produce accurate trills showed above 80% accuracy on the perception task.

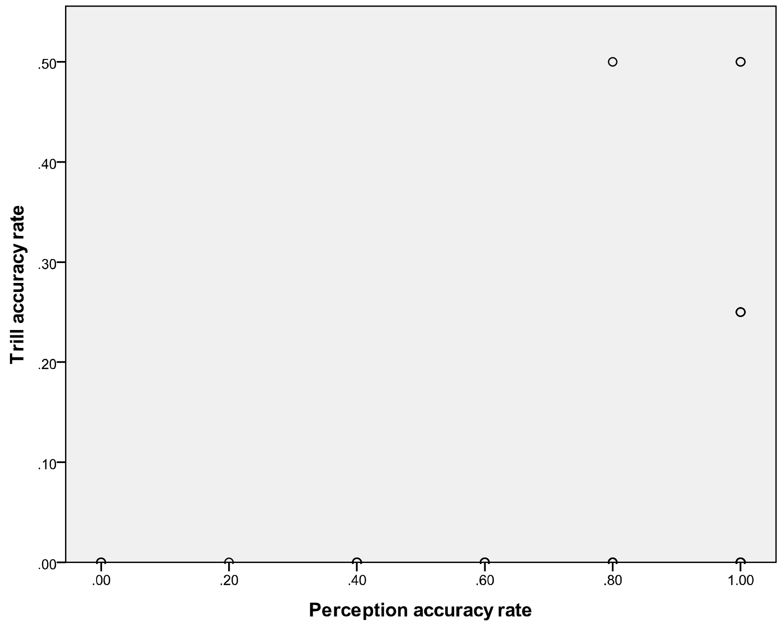

Figure 16. Correlation between trill accuracy and perception accuracy

5.0 DISCUSSION AND IMPLICATIONS

The overall accuracy rates of Spanish rhotics for native English-speaking participants were quite low compared to the native Spanish-speaking participants. This finding is not surprising because the native English-speaking participants were at the beginning levels of learning Spanish. However, even at this level, some participants did have a high tap accuracy rate and were able to produce trills in the process of reading the text. One explanation of this low accuracy rate in Spanish rhotic production is that these learners have not received enough input and practice for their production to be reliable. These learners are at a developmental stage where rhotics are just beginning to emerge which would explain the wide range of accuracy rates across different participants.

The results found in this study do provide answers to the research questions. English rhotic articulation is a predictor of accurate trill production at the beginning levels of L2 Spanish phonology acquisition. That is to say, those learners who employ more retroflex articulations in English will initially be able to produce trills with a higher accuracy rate than those who employ more bunched articulations. However, when considering the importance of the results regarding trill accuracy, the small number of trills produced by participants should be taken into consideration.

Although results were positive for trill production both alone and accounting for prior exposure to Spanish, results of this study showed that there was no significant relationship between tap accuracy rates and English rhotic articulation alone. When taking amount of prior exposure to Spanish into consideration, however, English rhotic articulation did correlate with tap accuracy rate. This result is in line with what Face (2006) found in his study on the development of Spanish rhotics –that with more experience, rhotic accuracy rates improve. These results also extend the idea that experience is one of the main factors in the acquisition of Spanish rhotics even within the beginning level. When controlling for amount of exposure to Spanish, English rhotic articulation did have an effect on tap accuracy rates. From this, we can posit that although experience is the main factor in accurate tap production in Spanish, English rhotic articulation does influence the development of tap acquisition.

Because the English rhotic articulation became a predictor of tap accuracy only after controlling for exposure, self-ranked groups were split to further examine the effect of English rhotic influence on each individual group. Results showed an effect for the second and third self-ranked groups (only the second group was statistically significant at the 95% confidence level). These results along with the progression in perception accuracy through different exposure groups can be interpreted to show a developmental sequence involving perception, physiological factors (e.g., English rhotic articulation), and production as Spanish exposure increases. At first, perception rates are the lowest and therefore, tap accuracy rates are also low. Although perception rates do predict tap accuracy rates, this does not minimize the influence of rhotic articulation and should not be a surprise. When split by amount of exposure to Spanish, the perception accuracy rates show a notable difference between participants that indicated having no prior exposure to Spanish (Likert ranking of 1) and participants that indicated having a little exposure to Spanish (Likert ranking of 2). This difference indicates the next phase of the developmental sequence.

In the second phase (shown by the results in groups two and three), perception increases, and as learners begin to perceive the difference between English and Spanish rhotics (onset of segmental acquisition), English rhotic articulation becomes a factor in tap accuracy rates. Retroflex-type articulations facilitate accurate tap production as opposed to bunched-like articulations. The lack of a relationship between high perception rate and trill accuracy strengthens this argument. The fact that only participants with high perception rates were able to accurately produce trills and that retroflex articulation was a significant predictor of trill accuracy provides evidence for this phase in the developmental sequence of Spanish rhotic acquisition. After more experience with Spanish, physiological factors become less important. In the last stage, learners who employ bunched-like articulations also learn to produce accurate taps. Further research employing longitudinal design and a higher number of elicited trills would be able to test the reality of such a developmental process.

Concerning the effect of an L1 phonological rule on the production of Spanish rhotics, results show that out of the accurately produced taps, a significantly high percentage of them were in words that have stress patterns equal to those found in English words that create tapped realizations of /t/ and /d/. These results provide an answer to the second research question and are interesting for two reasons. First, the correlation of similar stress patterns across languages and effective production of taps indicate that the subconscious phonological English tap rule interacts with Spanish utterances in a way that facilitates the similar phonetic effects. That participants more accurately produced taps in environments that also produce taps in their L1 shows an L1 influence of phonological rules. Second, that a phonological rule associated with /t/ and /d/ (both of which are also phonemes in Spanish) facilitates the production of taps only in environments that are similar to English provides evidence that these participants have not yet correctly phonemicized [ɾ] in Spanish. Although this process is underway, indicated by instances of accurate tap productions in environments unlike English, learners at beginning levels have not yet reallocated taps in their phonemic inventories from an English allophone of /t/ and /d/ to a separate Spanish phoneme. The phonological structure of learners in this study is in an interlingual state as seen in Figure 4 above.

The influence of an L1 phonological rule on L2 Spanish pronunciation is also in line with Roelefs and Verhoef's (2006) claim that bilinguals have only one phonological representation for both languages. The results of this study support this claim at least for learners at the beginning level. Otherwise there would be no phonological influence on the Spanish pronunciation of the participants in this study.

The current study has implications for interlanguage phonological theory and for English speaking students and teachers of L2 Spanish. As proposed by Colantoni and Steele (2008), theories that explain and predict interlanguage phonology should consist of both phonological and phonetic constraints. The results obtained by this study provide evidence for this proposal. That both phonological factors (the English tap rule) and phonetic factors (English rhotic articulation) have an effect on the accuracy rates of Spanish rhotics by L2 learners lends support for the hypothesis tested in this study. Because results showed that both types of factors did influence how target-like learners' pronunciation was, both phonological and phonetic factors do contribute to the acquisition of an L2 phonology and should be considered in theories that attempt to explain such acquisition.

The results of this study show that there is more to phonological acquisition than perception. However, the current theories used to explain the acquisition of an L2 phonology mentioned herein (Best, 1995; Flege, 1995; and Iverson & Kuhl, 1996) only account for how learners acquire a target language phonology through perceptive means. Therefore, these theories should be revised or new theories should be formulated which take the physiological aspect of production into consideration to explain the phonological acquisition in a holistic manner. Although results suggest that phonological rules and representations have greater bearing on the accuracy and sequence of acquisition than phonetic constraints, such constraints can account for some of the variability among speakers in interlanguage phonology.

Other implications of this study deal with L2 Spanish learner and teacher expectations. This study has indicated that rhotics are emerging at the beginning levels of L2 Spanish education in a classroom setting. Therefore, teachers should inform students who are often frustrated about the difficulty of pronunciation of the normal developmental process of an L2 phonology involving rhotics. Teachers should also be aware of the amount of input and practice needed to produce accurate Spanish rhotics reliably. Metalinguistic discussions that focus on issues regarding L2 phonology acquisition such as those studied here incorporated into instruction could help students set personal expectations and goals for learning pronunciation.

6.0 CONCLUSION

This study has presented some issues in interlanguage phonology of native English speakers learning Spanish. Results from the study of phonetic and phonological factors in Spanish rhotic production show that learners first transfer L1 phonological rules to their interlanguage phonologies and, over time, reassign allophonic variations to their proper phonemes in the target language. Results also show that learners employing a bunched articulation for English rhotics are at a slight disadvantage in producing accurate Spanish rhotics than other learners who employ retroflex articulations at the initial point when learners begin noticing a difference between English and Spanish rhotics. Theories dealing with L2 phonology acquisition should incorporate both phonological and phonetic considerations to account for the full range of phenomena involved in interlanguage phonologies. Second and foreign language teachers should also be aware of students’ tendencies when acquiring an L2 phonology to be able to address students’ frustrations regarding pronunciation efforts.

Future research should be carried out to test the possibility of a developmental sequence involving perception, physiological, and production factors using a longitudinal design and also to explore physiological factors at higher levels of proficiency. The investigation of other phones where cross-linguistic phonetic constraints may contribute to acquisition, such as in differences between articulations of /l/ and /s/ in English and Spanish in coda position, and other phonological rules, such as rules governing the distribution of interdental fricatives, could also provide more evidence of L1 phonetic and phonological influence on L2 phonological acquisition. Because of the low number of trills in this study, another future endeavor will be to elicit a higher number of trills so that the results found herein can be confirmed with a larger sample size.

APPENDIX

SPANISH TEXT

La Casa inteligente del futuro

Las casas inteligentes ya existen en el presente. Los expertos las describen con un gran número de aparatos eléctricos y electrónicos –controlados por una computadora—que se comunican entre ellos. Pero, muchos se preguntan, ¿Cuáles son las diferencias entre una casa tradicional y una inteligente?

Realmente, la casa inteligente incorpora los últimos avances en beneficio de las personas que viven en ella. A través de sensores, estas casas facilitan el trabajo de sus dueños: abren y cierran cortinas y puertas, hacen funcionar electrodomésticos como cafeteras, microondas, ventiladores, computadoras, refrigeradores, el aire acondicionado y la calefacción, por ejemplo.

La casa inteligente también ofrece un uso más eficiente de los aparatos eléctricos y electrónicos en su interior. Un microondas se puede usar para calentar comida y para ver televisión. De la misma manera, un refrigerador puede conectarse a Internet y permitir a una persona navegar por la red o enviar correos electrónicos.

Si a la familia le gusta escuchar música mientras descansa o a mirar películas en su tiempo libre, basta conectar dispositivos de red para distribuir música y películas a lugares diferentes dentro y fuera de la casa.

En resumen, la casa del futuro es una versión reformulada de la casa del presente. Es difícil predecir cómo vamos a vivir en cuarenta años. Sin embargo, muchos se preguntan si esta abundancia de tecnología va a afectar nuestra vida. (adapted from a reading in Castells, Guzmán, Lapuerta, & García, 2006)

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