

THE PRODUCTION OF RHOTIC SOUNDS BY BRAZILIAN SPEAKERS OF ENGLISH

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This study investigates how three Brazilians surface the rhotic sounds in free speech when speaking English, taking into consideration the phonological environment, the frequency, and the occurrence of patterns. Attempts are made to relate the differences in pronunciation to possible theoretical explanations (the Markedness Differential Hypothesis (MDH) [Eckman, 1977], the Structural Conformity Hypothesis (SCH) [Eckman, 1991], and the Speech Learning Model (SLM) [Flege, 1995]). The data shows that the SLM appears to explain much of the participants' difficulty, since L2 learners are not able to separate their L1 and L2 phonetic subsystems. In two-member onsets, for example, participants recognize the English rhotic, but fail to surface it phonetically accurately (e.g., central [sɛntɾaw]). The MDH might explain the great number of two-member onsets/codas and the very few three-member onsets/codas, since the former are less marked. It might also partially account for the variability of retroflex liquids in syllable-final (e.g., York [i ɔXki]), since the retroflex is the most marked sound among the rhotic sounds analyzed (Maddieson, 1984). However, the MDH cannot encompass all the complexities found in the participants' interlanguage phonological processes. The SCH also appears to fail to provide an explanation of the participants' interlanguage processes, since generalizations found in children's acquisition of the retroflex diverge from the processes identified in the participants' interlanguage.

INTRODUCTION

Although the difficulties in perceiving and producing the English rhotic by Brazilian Portuguese (BP) speakers of English has been reported in the literature (e.g., Major, 1999; Osborne, 2008), it is still an open area of

investigation since, to my knowledge, no study focusing solely on the acquisition of English rhotic sound by BP speakers has been conducted. This study, therefore, can be considered the first step toward a better understanding of this interlanguage phonological process.

In this research project, I study how Brazilians surface the rhotic sounds in free speech when speaking English, focusing especially on the sounds that deviate from standard American English. I verify the environment in which the sounds occur and the occurrence (or absence) of patterns, as well as the frequency in which such deviations occur in relation to their environment. In addition, attempts are made to relate the differences in pronunciation to possible theoretical explanations (e.g., the Markedness Differential Hypothesis [Eckman, 1977], the Structural FFC conformity Hypothesis [Eckman, 1991], and the Speech Learning Model [Flege, 1995]).

The study begins with a brief review of the literature, followed by a description of the rhotic sounds in BP and English, the methodology employed in the investigation, results, and discussion. The paper concludes with some suggestions for future studies.

LITERATURE REVIEW

There has been a growing interest in studying the interlanguage phonology of Brazilian speakers of English, especially in Brazil. A comprehensive study of it and of dissertations in Brazil written between 1987 and 2004, shows that 65% of the research produced in this area during that period is concentrated between the years 2001 and 2004 (Silveira & Baptista, 2007). Topics vary between perception and production of vowels and consonants, and the role of instruction in pronunciation, among others. More specifically, the production of initial English clusters (e.g., Rebello & Baptista, 2006) and the production of coda (e.g., Delatorre & Koerich, 2004), as well as the orthographic influence in the pronunciation of Brazilian Portuguese (BP) learners of English (e.g., Silveira, 2007), are examples of recently-conducted studies in the interlanguage phonology of BP speakers.

Regarding the study of the acquisition of the English rhotic sound by BP speakers, many researchers have pointed out that Brazilian learners of English deviate from standard American English regarding the production of rhotic sounds. For instance, Brazilians may produce the retroflex liquid as a velar fricative or as a glottal fricative (Cristófaró Silva, 2007). Other researchers have shown that the retroflex liquid and the glottal fricative tend to be realized as a velar sound among BP speakers (Zimmer, Silveira, & Alves, 2009).

Although the difficulties of BP speakers of English regarding the English rhotic have been reported in the literature, a study focusing solely on rhotic sounds has yet to be conducted, as mentioned before. However, studies involving the acquisition of the rhotic sound by other second language (L2) learners have been conducted. The study of the acquisition of the French rhotic sounds, for example, has shown that there is asymmetry between the

production of voiced uvular fricatives in onsets and codas (Colantoni & Steele, 2007). Other studies have focused on the acquisition of Spanish rhotic sounds by second language learners. Such studies have shown, for example, that advanced learners overgeneralize the tap and use it where a trill should be produced (Face, 2006). The acquisition of rhotic sounds by English learners of Arabic has also been investigated (Leather, 1999). Regarding the study of acquisition of English rhotic sounds, much of the research has been done focusing on Japanese learners of English due to their well-known difficulty in distinguishing the liquids /l/ and /r/ (e.g., Shimizu & Dantsuji, 1987).

The cause of variability in the pronunciation of sounds may have different sources. It can occur due to perception, articulation, or grapho-phonetic-phonological transfer; that is, the influence of orthography (Zimmer et al., 2009). There are other factors that may influence the learners' pronunciation and accent, such as the learners' age of learning, length of residence in a country where the target language is spoken; gender; formal instruction; motivation; aptitude; and amount of native language (L1) use (Piske, MacKay, & Flege, 2001).

Other approaches, such as the markedness theory, have shown that there are some sounds that are less common and less universal in languages, and, consequently, they are more difficult to acquire, whereas other sounds are more neutral and more common and are acquired earlier. The Markedness Differential Hypothesis (MDH), conceptualized by Eckman (1977), is the application of the markedness theory in second language phonology. Markedness is defined by frequency (e.g., the most frequent sound is the less marked), and by implicational hierarchy (e.g., if the presence of X implies the presence of Y, then X is more marked). The MDH claims that less marked structures will be acquired earlier by second language learners (e.g., Carlisle, 1994). The MDH predicts that there are structures more difficult to acquire in L2 (e.g., areas that differ from L1 and are more marked will be more difficult to acquire). According to this hypothesis, differences between L1 and L2 are not enough to explain learners' difficulties; typological markedness has to be incorporated as well (Eckman, 2008). Evidence for the MDH has been reported by many studies (e.g., Anderson, 1987; Benson, 1988).

The MDH takes into consideration areas that differ between L1 and L2, and marked and unmarked structures are involved. In other areas, for example, structures that are present in L1 and L2 and still pose difficulties for learners, "the hypothesis made [makes] no prediction at all" (Eckman, 2008, p. 101). Hungarian learners of English, for example, devoiced final obstruents, even though they have voiced and voiceless final obstruents in their L1. In this case, according to the MDH, learners would not have problems because both structures are present in L1 and L2. The MDH cannot explain this error pattern.

Eckman (1991) conceptualized another hypothesis in which typological markedness is involved: the Structure Conformity Hypothesis (SCH), which states that "universal generalizations that hold for primary languages hold also for interlanguages" (p. 24). This hypothesis states that

both primary languages and interlanguages obey universal generalizations. The SCH can account for the fact that Hungarians devoice final obstruents, since voiced obstruents in final position are more marked than their voiceless counterparts. The SCH has been supported by a number of research studies (e.g., Eckman & Iverson, 1994; Carlisle, 1997).

On the other hand, many researchers have considered cross-linguistic influence an important factor in second language acquisition (Odlin, xi, 1989). The L1 may influence the target language in different ways. Carlisle (e.g., 1994), has shown evidence of L1 transfer among Spanish-speaking learners of English. In producing the sequence /sC-/ onsets in English, Spanish speakers insert an /e/ sound because they do not have /sC-/ in the L1; by contrast, they have a large number of words that start with /esC/ (e.g., *escuela*). In this case, the universal preference for the CV syllable does not apply (e.g., 'snow' was never pronounced as [seno], which might have happened if the CV syllable was preferred). L1 knowledge can also be an influence in avoidance, in the perception of similarities, and in the notice of features that are distinguishable from the L2 (Lightbown & Spada, 2006).

Perception seems to play an important role in L2 acquisition. According to Flege (2003), "the perception of L2 phonetic segments is influenced by L1 phonological system" (p. 322). Studies have shown, for example, that BP learners of English fail to perceive English coda nasals accurately, which is related to the fact that Brazilians do not fully realize /n/ and /m/ in final-position in Portuguese (Kluge, Reis, Rauber, & Bion, 2007). Other studies have shown that there is a positive relationship between perception and production; that is, the better the production, the better the perception of the target phones (e.g., Kluge et al., 2007). However, this relationship is not a straightforward one. Some studies have shown that perception and production are closely related but are not exactly mirror-images (Major, 1998).

One of the most influential models that accounts for non-native perception is the Speech Learning Model (SLM) (Flege, 1995). This model claims that perceptual problems occur because L2 segments are assimilated by L1 category. The SLM states that new L2 phones will be acquired, whereas L2 phones that are similar to L1 categories will be more difficult to acquire. In other words, the perceived phonetic dissimilarity between L2 phones and the closest L1 sound will be mastered, while other sounds that are perceived as similar will pose difficulties for the learner. The SLM also predicts that accurately perceived phonetic differences will lead to correct production of the differences. The SLM focuses on the idea of achieving native-like pronunciation and assumes that accurate perception occurs before accurate production. Therefore, a period between accurate perception and inaccurate production can occur during the acquisition of the new soundsⁱⁱ.

According to the perception model described above, it can be assumed that Brazilians will have perceptual difficulty in distinguishing the rhotic sounds in English, since some rhotic sounds are used in free variation in BP, but not in English. Although this study is not designed to test assimilation

models, the discussion of the results takes the SLM into consideration. This study also considers the framework of markedness theory and cross-linguistic influences in the analysis of the production of rhotic sounds by BP speakers of English.

THE RHOTIC SOUNDS IN BP AND IN ENGLISH

Brazilian Portuguese (BP) has a wide range of possible realizations of r-sounds and all are related to the orthographic <r>, which can be pronounced as glottal fricatives [h, h̥], velar fricatives [X, ɣ], a trill [ʀ], a retroflex liquid [ɻ]iii, and a flap [ɾ]. The standard rhotic sounds in BP are the glottal fricative /h, h̥/ and the velar fricative /X, ɣ/. They are used interchangeably and replacing one sound with the other does not change the meaning of the word.

The variation is related both to linguistic factors (the position of the rhotic sound in the word) (Cristófaró Silva, 2005) and to extralinguistic factors (e.g., regional dialect and age) (Silva & Albano, 1999). Some studies have also shown that paralinguistic factors can account for certain variations (e.g., the use of the alveolar trill by soccer play-by-play announcers in Brazil in order to give an eloquent style to their speech [Rocha Filho, 1989]).

Although both glottal fricatives and velar fricatives are considered standard Portuguese, velar fricatives are more characteristic of Rio de Janeiro. The trill, on the other hand, is only pronounced in certain areas in the south of Brazil. The retroflex liquid occurs in some regions of Brazil (e.g., certain areas in the state of Minas Gerais) and is called *r caipira* ('hillbilly r', my translation). (It is a stigmatized pronunciation which native speakers relate to less-educated speakers [Taylor & Eddington, 2006]). These sounds are called 'the strong 'R', whereas the flap is called the weak 'r' (Cristófaró Silva, 2005). The strong 'R' and the weak 'r' occur in contrastive distribution (e.g., they can form minimal pairs) only in intervocalic position; that is, in replacing one phoneme with the other, the meaning of the word changes (e.g., *coro* 'leather' surfaces as [ˈkorɔ], and *corro* 'I run' surfaces as [ˈkohɔ]). The weak 'r', that is, the flap sound, occurs in intervocalic position, as mentioned before, and it can also occur after a consonant in the same syllable, resulting in a consonant cluster (e.g., *prato* 'plate' surfaces as [p ratɔ]). In this environment, the only rhotic sound possible is the flap.

In intervocalic position, word-initial, and syllable-initial preceded by a consonant, the orthographic <r> can be pronounced as [h, X, ʀ]. In syllable-final and word-final, the rhotic sound can surface as [h, h̥, X, ɣ, ɾ, ɻ]iv. These sounds occur in free variation; that is, changing one sound for the other does not change the meaning of the word (Cristófaró Silva, 2005). Therefore, the loss of the contrast between the flap and the strong 'R' occurs word-final and syllable-final because neutralization takes place (e.g., *mar* 'sea' can surface as [maX], [mah], [maɻ], [maɾ]). (See Appendix A for a summary of the BP rhotic sounds and the environment in which they occur.)

In Standard American English, the rhotic is realized as a retroflex. While in BP the glottal sound is a rhotic sound and it is associated with the orthographic <r>, in American English this sound does not function in the same way. It is difficult for BP learners of English to perceive such cross-linguistic phonological differences and mispronunciation can therefore occur (Zimmer et al., 2009).

Although some linguists might consider the flap sound and the trill to be the same (e.g., if you hold the flap and repeat it many times, it turns into a trill [H. Williams, personal communication, October 13, 2009]), trills and flaps involve different movements, even when the trill is very short, involving only a single contact with the roof of the mouth. According to Ladefoged (2006), in a trill “the tip of the tongue is set in motion by the current of air,” while in a flap, there is a “single contraction of the muscles so that one articulator is thrown against another” (p. 170). In this paper, I consider the flap and the trill to be distinguished phones.

The flap is sometimes called a tap. Some linguists distinguish them: a tap occurs when the tip of the tongue produces a brief contact with the dental or alveolar region, whereas the flap occurs when the tip of the tongue is curled up and back and then touches the post-alveolar region (Ladefoged, 2006). In this paper, I use the term flap to refer to both processes, following the reasoning of other linguists (e.g., Celce-Murcia, Brinton, & Goodwin, 1996).

The next session begins with the methodology and procedures used in this study, followed by analysis and discussion of the data.

METHODOLOGY

Participants

The participants in the study were three native Brazilian speakers (Mila, Rod, and Ana^v) who were living in New York City at the time the study was conducted. Their ages ranged from 36 to 45. Rod and Ana are both from the state of Minas Gerais and Mila is from the state of Bahia. Their native language is Portuguese, and English is the only foreign language that they have learned. All participants reported having very little (or no) formal education in English in Brazil. As Table 1 shows, the length of formal education in the United States ranged from a minimum of 15 days to a maximum of 6 months ($m = 3.5$ months). The length of stay in the United States ranged from a minimum of 45 days to a maximum of 6 years ($m = 2.54$ years). All of them were studying English at the Community English Program (CEP) at Teachers College Columbia University (TC).

Table 1: Participants' Background Information

Participants	Gender	Length of stay in the	Length of formal	Level at CEP ^{vi}
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		USA	education in English in the USA	
Rod	Male	45 days	15 days	Beginner 4
Mila	Female	1,5 year	6 months	Intermediate 1
Ana	Female	6 years	4 months	Intermediate 1

Procedures

The data was collected at TC, in a quiet room, when it was most convenient for each participant. Before the data collection, the participants filled out a brief background information sheet and they signed a consent form. Each participant was asked to talk about any subject that he or she wished. The researcher gave them a list of possible topics, but they were free to talk about any other topic. The researcher was prepared to interact with them if any cue (e.g., a question) was necessary in order to keep them talking, which, in fact, occurred several times with Rod and Mila. The data was recorded on a digital voice recorder WS-321M (Mila spoke for 4m 51s; Rod, for 1m 21s; and Ana, for 7m 32s). The data was phonetically transcribed by the researcher and subsequently, checked by a more experienced researcher in the field. It is important to mention that the author of this study is Brazilian and that the second researcher was American and did not speak Portuguese. Having different linguistic backgrounds minimizes the influence that L1 might have on the perception of sounds and reduce potential bias in the transcription process. No acoustic analysis was conducted. In order to minimize the possibility of errors in the transcription of the rhotic sounds, only the part of the transcription that both researchers agreed upon was considered in this study.

DATA ANALYSIS AND DISCUSSION

A total of 229 words were analyzed. Their analysis and discussion took into consideration the phonological environment in which the rhotic sounds occurred. General systematic deviations and idiosyncratic phonological processes were examined.

/ɹ/ in onset and coda consonant clusters

As shown in Table 2, in onset consonant clusters the retroflex surfaced most of the time as a flap (71.69%) (e.g., [ˈsɛntrəw]vii *Central*) and a few times as a retroflex (26.41%) (e.g., [ˈtɹavow] *travel*). There was only one instance in which [ɹ] was dropped, [ˈkaũntə] *country*, produced by Mila. However, in other instances, Mila surfaced *country* accurately.

Table 2: /ɹ/ in Onset Consonant Cluster

/ɹ/ → [r]	38 (71.69%) ^{viii}
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/ɹ/ → [ɹ]	14 (26.41%)
Omission of /r/	1 (1.88%)
Total words	53

In onset clusters, the participants produced a total of 53 words, whereas in coda clusters they produced only three words. In coda consonant clusters (see Table 3), the retroflex liquids were produced accurately three times, each time by one participant. Ana pronounced *first* as [ˈfɪɹst], Rod pronounced *sisters* as [ˈsɪstəɹs], and Mila pronounced *work* as [wɔɹk]. All complex onsets and codas had two members, with the exception of the word *first*, which had three members.

Table 3: /ɹ/ in Coda Consonant Cluster

/ɹ/ → [any other sound]	0
/ɹ/ → [ɹ]	3 (100%)
Total words	3

In Brazilian Portuguese (BP), there are complex onsets and codas, although the rules are very restrictive. In onset clusters, BP allows a stop or the fricative /f/ followed by a liquid /l/ or a flap (e.g., [ˈrazi] *frase* “phrase”). Very few words with coda clusters exist in BP. When coda clusters occur, the first consonant is one of the archiphonemes /R/, /l/, or /N/, followed by /S/ (e.g., /solʃisio/ *solstício* “solstice”; and /peɾʃpek tiva/ *perspectiva* “perspective”) (Cristófaró Silva, 2007, p. 164). In a surface representation, the underlying /N/, however, undergoes a phonological alteration and is not realized in coda clusters (e.g., [trãʃˈpoh] *transpor* “get across”) (Azevedo, 1981).

English allows many more onset and coda clusters than Portuguese. English allows up to three consonants in onsets (e.g., [spɹɪŋ] *spring*) and up to four consonants in coda position (e.g., [tɛkstʃ] *texts*) (Celce-Murcia et al., 1996).

Studies of the acquisition of onsets and codas in consonant clusters by L2 learners have been conducted, especially within the framework of the markedness theory. According to this theory, the markedness of onsets and codas increases with length; that is, longer onsets and codas (e.g., three-member) are more marked than shorter onsets and codas (e.g., two-member). The presence of an onset or coda cluster of length *n* implies the presence of onset or coda of *n-1* in that language (e.g., Greenberg, 1976). Consequently, more marked onsets or codas are predicted to be more frequently modified (e.g., learners produce more errors).

According to the Markedness Differential Hypothesis (MDH) (Eckman, 1977), there is an order for the acquisition of onset/coda: learners acquire singletons first, then two-members, and later, three-member onset/coda clusters. In the participants' speech, only one three-member coda was produced, which seems to be in accordance with the predictions of the MDH. The assumption here is that the avoidance of three-member onset/coda is related to the complexity of the L2 structure (Gass & Selinker, 2001). However, in order to confirm this assumption, a more controlled study has to be conducted in which the researcher can control for cluster length. This study deals with free speech data and the absence of certain types of cluster might simply be due to the fact that they are less frequent in the language than others. Nevertheless, the evident asymmetry between the production of two-member and three-member consonant clusters should not be overlooked.

It seems that participants are much more comfortable in producing two-member onsets (53 words) than two-member coda (two words). Syllables with singleton onsets are preferred among languages as opposed to singleton codas; therefore, singleton onsets are less marked. We might think that complex onsets are less marked than complex codas and markedness might account for this asymmetry in production as between onsets and codas. However, cross-linguistically, there are languages that permit only complex onsets (e.g., Spanish), whereas there are languages that permit only complex codas (e.g., Finnish). Therefore, complex codas cannot be considered more marked than complex onsets and we might expect both structures to be acquired at the same time (Kirb & Demuth, 2003). The MDH, therefore, cannot account for the two-member onset/coda asymmetry found in the participants' interlanguage.

Phonological transfer from BP seemed to occur when participants produced flaps in onsets. In BP, the rhotic sounds in onset consonant clusters surface as a flap in all dialects. The participants seem to follow this phonological rule when speaking English. Onset clusters in BP and in English can occur in the same environment (e.g., a stop + a rhotic sound). This similarity might account for the great number of onsets in the participants' speech. However, when participants produced the onsets, they recognized the English /ɹ/ as phonologically equivalent to the Portuguese flap, despite the fact that both sounds are realized differently phonetically. BP speakers do not seem to notice the difference. The Speech Learning Model (SLM) (Flege, 1991) predicts that the greater the similarity between a sound in L2 and the closest sound in L1, the more difficult is its acquisition. The perception of similarity between the retroflex and the flap by BP speakers seems to make the acquisition of /ɹ/ much more difficult. On the other hand, SLM also assumes a period of accurate perception before accurate production, since SLM is focused more on achieving native-like production than on the idea of learning. The participants might be in this phase, in which the perception is accurate, but not the production.

We might conclude that the apparent perception of /ɹ/ as similar to /r/, as well as phonetic-phonological transfer from L1 (in BP, the rhotic is realized as a flap in onset clusters), seem to account for the production of two-member onsets surfaced with a flap. The MDH might account for the great number of two-member clusters and only one three-member cluster, assuming that avoidance is related to the complexity of this structure; this assumption, however, remains to be confirmed by future investigation. Markedness, on the other hand, does not contribute to the understanding of asymmetry in the production of two-member onsets and codas.

/ɹ/ in Intervocalic Position

In intervocalic position, the retroflex liquid sometimes surface as flap (51.72%) (e.g., [a'mɛrikā] *American*), and other times surfaced as a retroflex (48.27%) (e.g., [fri'endli] *friendly*) (see Table 4).

Table 4: /ɹ/ in intervocalic position

/ɹ/ → [r]	15 (51.72%)
/ɹ/ → [ɹ]	14 (48.27%)
Total words	29

In BP, the flap, called the weak ‘r’, occurs in intervocalic position and is associated with the orthographic single <r> (e.g., [ka rɔ] *caro* “expensive”). The strong ‘R’ (glottal fricative, velar fricative, and trill) can occur intervocalically as well, in contrastive distribution, and is associated with the orthographic double <rr> (e.g., [kah ɔ] *carro* “car”). A phonetic-phonological transfer from BP seems to occur when the participants produce a flap instead of a retroflex in intervocalic position. In all BP dialects, a rhotic sound (associated with a single orthographic <r>) in intervocalic position surface as a flap.

Moreover, the relationship between perception and production might also partially account for this interlanguage process. The /ɹ/ is recognized phonologically, but it does not seem to be recognized phonetically. According to the SLM (Flege, 1991), similar sounds between L1 and L2 are more difficult to acquire. BP learners of English have to acquire a new phonetic category in this environment. The problem in producing /ɹ/ intervocalic, therefore, seems to be related to phonetic-phonological transfer and learners’ perception of the target feature. Grapho-phon-phonological transfer (Zimmer et al., 2009); that is, orthographic transfer from the BP writing system, might also influence the participants’ pronunciation, since intervocalic flap is associated with a single <r> in Portuguese. Some studies have shown that the transfer of Portuguese sound-spelling correspondence to the production of English word-final consonants can be pervasive (e.g., Silveira, 2009).

/ɹ/ in Syllable-Final, Mid-Word and in Word-Final Position

More variation occurred when the retroflex appeared in syllable-final, mid-word position (see Table 5). Most of the time (57.57%), the [ɹ] surfaced as [h] (e.g., [ˈpɑhki] *park*). There were two instances in which [ɹ] surfaced as a velar fricative [X] ([ˈiɔXki] *York*), pronounced by the participants Ana and Rod (see section 4.6 for idiosyncratic processes). In only one instance [ɹ] surfaced as a flap ([ˈɔrkə] *York*), pronounced by the participant Mila. A few times, /ɹ/ surfaced as a retroflex (18.18%) (e.g., [ˈʃʌɹʃi] *church*).

All three participants produced the word *York* in at least two different ways. Mila produced the retroflex in *York* as [h] six times and as [ɹ] once. Rod realized the retroflex in *York* as [h] three times and as [X] once; and Ana realized it as [h] seven times and as [X] once. Although there is variation for the word *York*, the retroflex liquid was surfaced as a glottal by the participants in accordance with the participants' general preference for /h/ in this environment. There was also an omission of the retroflex when the participant Ana produced the word *understand*, which occurred five times in her speech. Ana surfaced *understand* as [əndʌ'tænd] (see section 4.6 for idiosyncratic processes).

Table 5: /ɹ/ in Syllable-Final, Mid-Word

/ɹ/ → [ɹ]	1 (3.03%)
/ɹ/ → [h]	19 (57.57%)
/ɹ/ → [X]	2 (6.06%)
/ɹ/ → [ɹ]	6 (18.18%)
Omission of /ɹ/	5 (15.15%)
Total words	33

The production of word-final /ɹ/ also showed great variation. The glottal fricative (15%) (e.g., [ə'nɔdəh] *another*), and the velar fricative (5%) (e.g., [fɑX] *far*), produced twice by Ana, surfaced replacing the retroflex (see Table 6). Most of the time, however, the retroflex liquid in word-final position was dropped or not pronounced (52.5%) (e.g., [bə'fɔ] *before*). A few times /ɹ/ surfaced as a retroflex (27.5%) (e.g., [ˈbrɔdəɹ] *brother*).

Table 6: /ɹ/ in word-final

/ɹ/ → [h]	6 (15%)
/ɹ/ → [X]	2 (5%)
Omission of /ɹ/	21 (52.5%) ^{ix}

/ɹ/ → [ɹ]	11 (27.5%)
Total words	40

In BP, in syllable-final and word-final position, the sounds [h, X, ɹ, ɹ] can occur in free variation. They are not perceived as distinctive sounds by native speakers. As Tables 5 and 6 indicate, all four BP rhotic sounds surfaced in this environment. The acquisition of specific phonetic features in this environment seems to be a challenge for BP speakers of English. Similarities between the sounds make the acquisition of retroflex more difficult. As mentioned before, the SLM predicts this type of difficulty, and this seems to be a major obstacle for BP speakers to overcome.

As noted before, according to the MDH, the more marked the sound, the more difficult it is to acquire. In order to analyze this hypothesis, it is important to investigate the relationship between the typology of rhotic sounds and markedness.

The cross-linguistic typology of rhotics is essential for the MDH. The literature, however, has not yet come up with a typology of rhotics. Notwithstanding this, Maddieson (1984), who reported a study on the rhotic sounds of 282 languages (out of 316)^x of the UCLA Phonological Segment Inventory Database, might provide some answers.^{xi} The most common r-sound in this report is the trill (46.1%), followed by taps and flaps (36.9%), which is then followed by a retroflex (9.9% are approximant rhotics, which include the retroflex). Proceeding from the most marked to the least marked, we have the following sequence:

/ɹ/ > /r/ > /r̥/

The glottal sound, which is considered a rhotic sound in BP, is analyzed separately. Around 63% of the languages have this segment. Another BP rhotic is the velar fricative, which was analyzed by Maddieson and his team among the fricatives (and not as an r-sound). In their research, 75 languages, or 23.7%, had /X/ in their inventory.

If we attempt to combine all these sounds, we will have the following sequence (proceeding from the most marked to the least marked):

/ɹ/ > /X/ > /r/ > /r̥/ > /h/

According to Maddieson (1984), /h/ is the most common sound among the ones noted above, followed by the trill. In BP, however, the trill is not so common. Its use is limited to certain regions in the south of the country. Moreover, trills tend to be replaced by glottal or velar fricatives, as Portuguese history has shown (Silva & Albano, 1999). They are considered the most conservative variant in BP.

Although the retroflex seems to be the most marked segment, which might partially account for the participants' difficulty in producing it, markedness does not seem to be able to encompass the complexity of the acquisition of different phonetic parameters. It seems to be too general (as was also observed in Colantoni & Steele, 2007).

The Structural Conformity Hypothesis (SCH) (Eckman, 1991) not only takes into consideration marked and unmarked features, but also generalizations from primary languages. The SCH states that generalizations valid for primary languages are also valid for interlanguages. In order to verify the SCH in the acquisition of English rhotic, it is important to understand the acquisition processes of the rhotic sounds by native speakers.

According to Khattab (2002), few studies have focused on the development of the English /ɹ/ by children. Khattab states that the acquisition of /ɹ/ emerges relatively late (around the age of 4; 5) and its mastery is around the age of 6. There is great variability in the production of /ɹ/. The retroflex is generally replaced by [w] or [v] in initial position, a process called Gliding of /ɹ/ (e.g., [ˈwæbet] for *rabbit*). /ɹ/ is often deleted in initial consonant clusters and in medial and final position (e.g., [ˈgema] for *grandma*). In initial clusters with alveolar stops, the stops are often affricated or fricated. Another common process in early production is stopping: the replacement of /ɹ/ with stops (e.g., [dæt] for *rat*) (p. 94).

Based on the information gathered by Khattab (2002), the generalizations that occur in the acquisition of English rhotic by children differ from the interlanguage processes described in this study, with the exception of the deletion of final /ɹ/ (this process, however, is also found among adult native English speakers). Therefore, the SCH cannot be considered a valid hypothesis for the acquisition of the English rhotic sounds among BP speakers, since generalizations from the acquisition of the English /ɹ/ do not seem to hold for interlanguages. It is important to state, however, that no strong conclusions can be made at this point, since much research has yet to be done on the English rhotic sound as well as on the interlanguage processes involving its acquisition.

As for the SLM, which is a model based on phonetic similarities, the more perceptually distinct the L2 sound is from the L1 segments, the easier the acquisition. If this model is correct, the acquisition of retroflex is a challenge for BP speakers, since, as mentioned before, different rhotic sounds are perceived by BP native speakers as the same sound. The SLM might account for the participants' difficulty in producing /ɹ/ in word-final and syllable-final.

52.5% of the /ɹ/ in word-final position was dropped or not pronounced. The dropping of the English postvocalic [ɹ] by native speakers has been reported in the literature (e.g., Labov, 1966), which indicates that this process is not unique for interlanguages. Moreover, in Portuguese, word-final rhotics may also be silent when the last syllable is stressed, especially in colloquial speech (e.g., /ko'mɛh/ can surface as [kómɛ] *comer* “to eat”). Some studies have shown that the dropping of the final rhotic sound in Portuguese occurs in postvocalic position, especially with verbs (e.g., Reis & Dias, 2006).

The acquisition of final rhotic might also be influenced by other factors. According to Lindblom’s (1989) hyper- and hypoarticulation, speakers adjust their pronunciation according to the context. In a more informal context, for example, speakers tend to hypoarticulate, whereas in a more formal context, the tendency is to hyperarticulate. Moreover, hyperarticulation occurs in strong position (e.g., word-initial and stressed syllables) and hypoarticulation in other environments (Colantoni & Steele, 2007).

The participants tended to drop the final /ɹ/, which can be considered a hypoarticulation. However, Lindblom’s (1989) theory does not seem to be suitable for the omission of word-final rhotic sounds in Portuguese, since hypoarticulation occurs in a strong position (in stressed syllables). Regarding the words produced by the participants, there is a mixture of omission of [ɹ] in weak and strong positions (e.g., [ˈbrɔdɐ] *brother*; [bəˈfɔ] *before*).

Although some of the omissions of /ɹ/ can be related to hypoarticulation (the majority of the omissions occurs in weak positions), Lindblom’s (1989) theory does not seem to encompass all cases in which the omission occurs. The SCH also does not seem to apply in this case, since the interlanguage processes applied by the participants in this research and the generalizations reported in the literature regarding the acquisition of the retroflex by children depart from one another. The MDH might account for the difficulty in acquiring /ɹ/ in general, since it is considered a marked sound. The difficulty in distinguishing the rhotic sounds seems to be related more to phonetic-phonological transfer from Portuguese. This difficulty seems also to be related to the perception of similarities among rhotic sounds by BP speakers, which, according to the SLM, makes the acquisition of these sounds more difficult.

The possible influence of the L1 orthographic knowledge in the production of rhotic sounds by BP speakers might also be taken into consideration, since the rhotic sounds are related to the orthographic <ɹ>. Studies have shown that orthography “can provide alternative explanations to findings that have been exclusively attributed to factors such as markedness, phonological environment, or inability to perceive L2 sounds” (Silveira, 2009, p. 24). Although this study does not control for the influence of orthography on learners’ production of the rhotic sounds, this possibility cannot be ignored.

/ɹ/ and /h/ in word-initial position

In the participants' speech, there were only four instances in which the retroflex liquid occurred word-initially (see Table 7). These four words were produced by Ana. In two instances, she replaced the retroflex with [h] ([ˈhilaks] *relax*). In one instance, she surfaced the retroflex as velar ([Xa ʃã] Russian) and in still another instance she surfaced the retroflex in a native-like fashion ([ˈɹilə] *really*).

Table 7: /ɹ/ in word-initial

/ɹ/ → [h]	2 (50%)
/ɹ/ → [X]	1 (25%)
/ɹ/ → [ɹ]	1 (25%)
Total words	4

The production of /h/ in word-initial position, on the other hand, was not a problem for the participants (see Table 8). All 43 words produced by the participants in which /h/ is word-initial were surfaced accurately (e.g., [hauzi] *house*).

Table 8: /h/ in word-initial

/h/ → [any other sound]	0
/h/ → [h]	43 (100%)
Total words	43

In BP, /ɹ/ never occurs in word-initial position. In this environment, three possible rhotic sounds can surface: [h, X, ɹ]. All of them occur in free variation. As mentioned before, [h] and [X] are considered standard BP, [X] being more common in the dialect of Rio de Janeiro. Participants produced the [h] initially, which can indicate a positive phonetic-phonological transfer from Portuguese (see Table 8).

Whereas the production of initial /h/ was prominent (43 words), the number of /ɹ/ in word-initial position was very low (4 words). Apparently the participants seemed to recognize the rhotic English sound as phonologically equivalent to the Portuguese rhotic [h] or [X]. If this is the case, we can say that sounds that are similar in the L2 and the L1 are more difficult to acquire because learners do not notice the subtle phonetic differences, as SLM states.

The accurate production of initial /h/, therefore, can be a result of a positive phonetic-phonological transfer from Portuguese, which can also account for its noticeable production. The difficulty in surfacing the initial /ɹ/ seems to be related to the effects of the perception on participants' production. This assumption, however, remains to be confirmed (or refuted), for example,

through a perceptual experiment in which the variables can be controlled and the SLM can be tested.

/r/ intervocalic

Another environment in which a rhotic sound did not present a problem for the participants was the flap in intervocalic position (see Table 9). All 20 words in which the flap occurred in this environment were surfaced accurately (e.g., ['siri] *city*).

Table 9: */r/ intervocalic*^{xiii}

<i>/r/</i> → [any other sound]	0
<i>/r/</i> → <i>/r/</i>	20 (100%)
Total words	20

As mentioned before, intervocalic flaps occur in Portuguese as well (see section 4.2). In this environment, other rhotic sounds can occur in complementary distribution. In intervocalic position, it seems that BP speakers are more perceptive of phonetic features, and this might have helped them to acquire the flap in this environment. In the case of the intervocalic */r/*, similarities between the phones in English and Portuguese, as well as the environment in which the flap occurred, contributed to its acquisition. The acquisition of intervocalic flap by BP speakers seems to deviate from the SLM, since both sounds are similar. Moreover, the SLM does not consider the environment, which seems to be crucial for the accurate acquisition of intervocalic flap. It seems that, at least for some of the rhotic sounds, similarities or differences in sounds are crucial for their acquisition, as is the environment in which these sounds occur (e.g., glottal in word initial position and intervocalic flap).

It is important to state that, in order to confirm these assumptions, future studies have to investigate the influence of perception on production, since this study parts from production data to show the difficulties that BP learners have with rhotic sounds. Moreover, the SLM assumes that accurate perception precedes accurate production. The data in this research might display a possible phase of the process of acquisition of the rhotic sounds in which perception is accurate but production is inaccurate. Nevertheless, the SLM seems to provide an interesting explanation for much of the deviation in pronunciation by BP speakers.

Idiosyncratic Processes

In this last section, some idiosyncratic phonological processes are analyzed. They either occurred only a few times, or only with certain words. Although the number of their occurrences was limited, they should not be

ignored, since they might help in the understanding of the acquisition of the English rhotic by BP speakers.

There were two instances in which the participant Rod replaced the voiced interdental [ð] by a flap. These two words were: [ɔ' rəɹ] *other* and ['wɛɹə] *weather*. At first glance, the [r] and [ð] appear to be very different sounds. Regarding manner of articulation, for example, [ð] is fricative and [r] is considered a separate manner (the tongue makes a single tap). However, there are similarities between [ð] and [r]; for example, both are voiced. Regarding the place of articulation, flaps can be alveolar or dental. [ð] can be dental as well; it can also be interdental (Ladefoged, 2006). What is interesting is that Rod replaces [ð] with [d] throughout his speech (e.g., [ə' nɔðə' *another*]).

Rod's replacement of [ð] with [r] might be related to his perception of the voiced interdental, which does not belong to the Portuguese inventory. This replacement occurs intervocalically, an environment in which flaps occur in BP. It might also be partially articulatory. [ð] is considered a difficult sound to articulate. [r] can have the same place of articulation. Rod might produce the flap in an attempt to produce the sound that for him is similar to the interdental. What is interesting about this replacement is that it is unusual for BP speakers of English to replace [ð] with [r]. The literature has reported that Brazilians tend to replace interdentals with [d], [z], and sometimes [v] (Zimmer et al., 2009), but not with a flap.

Ana also has some idiosyncrasies in her speech. For example, the way she surfaces *sister-in-law* [sɪstən' lɔw], repeated twice, and the word *understand*, surfaced as [ʌndə' tɛnd], repeated five times in her speech. In both cases, the /ɹ/ is dropped and resyllabification occurs. It is not clear why Ana chose this process. It might be related to word length; dropping the number of syllables makes the words easier to pronounce.

There were also few instances in which the velar fricative [X] surfaced. From the 229 words analyzed [ɹ] surfaced as [X] in 5 words:

- ['iɔXki] *York* (produced by Rod once)
- ['iɔXki] *York* (produced by Ana once)
- ['faX] *far* (produced by Ana twice)
- ['Xaʃã] *Russian* (produced by Ana once)

Participants might be applying hyperarticulation (Lindbom, 1989) when pronouncing these words because [X] occurs in stressed syllable or word-initial (strong positions). This might also be a way to emphasize what they are saying, since paralinguistic factors have been reported as a possible cause of variation in the rhotic sounds in Portuguese (Rocha Filho, 1989). Any strong conclusion about the use of [X] in the participants' interlanguage, however, would be premature. More research on the rhotic variation, both in Portuguese and in interlanguages, has to be done in order to better understand this process.

CONCLUSION

The data in this study shows that the difficulty that BP speakers of English have in pronouncing the English rhotic sound seem to be related primarily to perception of the sound, and to the environment in which this sound occurs. To a certain extent, other factors, such as markedness and hyperarticulation, also seem to account for the deviations in pronunciation.

The SLM (Flege, 1991) appears to explain much of the participants' difficulty, since L2 learners appears not to be able to separate their L1 and L2 phonetic subsystems. However, this study shows that the participants display a phonetic sensitivity to the environment when surfacing the intervocalic flap and the initial glottal fricative. Since the data in this study parts from the production, and not from the perception, future studies focusing solely on the perception can help clarify assumptions made here. Moreover, a longitudinal study might help to understand if the deviations from standard American English are part of a phase of the acquisition process in which accurate perception and inaccurate production occurs, a possible process according to the SLM.

The MDH (Eckman, 1991) might explain the great number of two-member onsets/codas and the very few three-member onsets/codas, but the MDH does not provide any explanation for asymmetry in the production of two-member onsets and codas. Research in which the consonant cluster length is controlled will help confirm (or refute) assumptions about the MDH in this research. Markedness might also account for the difficult in acquiring the retroflex, since it is the most marked rhotic sound analyzed. The MDH, however, cannot encompass all the complexities found in the participants' interlanguage phonological processes.

The SCH (Eckman, 1991) also seems to fail to provide an explanation of the participants' interlanguage processes, since generalizations found in children acquiring /ɹ/ diverge from the processes identified in the participants' interlanguage.

The processes found in the participants' interlanguage might have been influenced by other factors as well, such as grapho-phonic-phonological transfer and paralinguistic factors. The investigation of the positive and negative effects of orthography on the acquisition of the rhotic sounds might also help understand the acquisition of these sounds. Future research might investigate these variables.

In addition, future studies might be interested in including an acoustic analysis of the rhotic sounds, which can provide other insights into the understanding of these processes. The acoustic analysis of the data and a perception experiment can measure the similarities or dissimilarities between the sounds as perceived by the learners. This might be considered the next step in the study of the acquisition of rhotic sounds by BP speakers of English.

The study of rhotic sounds in interlanguages is a difficult task, since "linguistic factors underlying different implementations of the rhotic

phonemes are not well understood” (Silva & Albano, 1999, p. 2214). It is important to state that no absolute conclusion can be made, since more research on the rhotic sounds in both primary languages and interlanguages must still be conducted. Although inconclusive, this study can be considered a first step in the understanding of the acquisition of the English rhotic sound by BP speakers.

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Appendix A

Distribution of the possible rhotic sounds in Brazilian Portuguese (based on Cristófaró Silva, 2007, p. 143).

	Environment	Example
/r/ fraco	Intervocalic	<i>caro</i> ‘expensive’ [‘kaɾʊ]
	After C in the same syllable	<i>triste</i> ‘sad’ [‘tristʃi]
/h, X, ř/	Intervocalic	<i>carro</i> ‘car’ [‘kahʊ], [‘kaXʊ], [‘kařʊ]
	Word-initial	<i>rio</i> ‘river’ [‘hiʊ], [‘Xiʊ], [‘řiʊ]
	Preceded by a C in another syllable	<i>Israel</i> [‘ishaɛʊ], [‘isXaɛʊ], [isřaɛʊ]
/h, f, X, ç, ɾ, ʎ/	Syllable-final before voiceless C	<i>perto</i> ‘close’ [‘pɛhtʊ], [‘pɛXtʊ], [‘pɛɾtʊ], [‘pɛɻtʊ]
	Syllable-final before voiced C	<i>gordo</i> ‘fat’ [‘gofɦdʊ], [‘goçɦdʊ], [‘gordʊ], [‘goɻdʊ]
	Word-final	<i>lar</i> ‘home’ [lah], [laX], [lar], [laɻ]

Endnotes

ⁱ C stands for consonant.

ⁱⁱ I am grateful to the editors for this comment.

ⁱⁱⁱ In a narrow transcription, the retroflex can be transcribed as [ɻ], an upside-down *r*. The symbol [ɻ] can also be used. In a broad transcription, the symbol /r/ can represent all possible *r*-sounds. Ladefoged (2006, p. 37) uses /r/ to refer to the retroflex, as do the major English dictionaries. However, because it is important to distinguish the different *r*-sounds in Portuguese, I use the symbol [ɻ] throughout this paper.

^{iv} The voiced velar fricative [ɣ] and voiced glottal fricative [ɦ] occur only when followed by voiced consonants. A process called voiced regressive assimilation occurs.

^v These are pseudonyms.

^{vi} The first level at CEP is called Beginner 4. It is followed by Intermediate 1. Each level takes around two and a half months to complete. Students have two-hour classes three times a week. Based on the researcher's experience as a teacher at CEP, these two levels can be grouped together for the purpose of this research, since between Beginner 4 and Intermediate 1, there is no great proficiency gap.

^{vii} In this study, only rhotic sounds are considered for analysis. Other deviations from standard American English will not be considered, unless it appears to be important for the analysis of the rhotic sounds.

^{viii} The number of words analyzed is followed by the percentage to the closest decimal point.

^{ix} The omission of final /ɹ/ can be considered native-like pronunciation, since the literature has reported that native speakers can reduce the /ɹ/ or drop it in word-final (e.g., Labov, 1966).

^x Portuguese is not among the 316 languages analyzed.

^{xi} I am following the rationale in Colantoni & Steele (2007), who studied the acquisition of French and Spanish rhotic sounds by American English speakers.

^{xii} In English, /r/ is an allophone of /t/ and /d/ in unstressed syllables preceded by a stressed syllable.