Perception and production of English initial /□/ clusters by Brazilian learners[1]

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No presente estudo foi investigada a relação percepção-produção na aquisição de encontros consonantais iniciados em /s/, em início de palavra, na interlíngua de brasileiros aprendendo inglês como língua estrangeira. Além da interface percepção-produção, foram analisados outros fatores que podem vir a influenciar os dois processos, e.g., percepção deficiente, interferência da língua materna ou uma combinação desses e outros fatores. Os resultados validam parcialmente outros estudos que propõem a influência da percepção sobre a produção. Constatou-se também a supremacia da influência da língua materna em detrimento de fatores como Marcação e Estrutura Silábica Canônica Universal. A estratégia de simplificação silábica usada por todos os sujeitos foi a inserção de uma vogal diante de todos os tipos de encontros consonantais testados. Houve uma certa variação na qualidade da vogal proclítica (/i/ e /I/), sugerindo que os sujeitos que utilizaram a vogal curta podem estar desenvolvendo uma categoria distinta para o padrão silábico testado.

The present study investigated the relationship between perception and production in the acquisition of word-initial /s/ clusters in the interlanguage of Brazilians learning English as a foreign language. In addition to the interface between perception and production, other factors that might influence both mental processes, e.g., faulty perception, L1 interference, or a combination of these factors, were taken into account. The results partially support studies which propose that perception influences production. There was also support for the power of L1 interference over Markedness and Universal Canonical Syllable Structure. Epenthesis was the strategy of syllable simplification present in all cluster types. Some subjects, though, resorted to a short epenthetic vowel (/I/), thus indicating that they might be developing a separate category for initial /s/ clusters.

[1] I would like to thank Professor Barbara O. Baptista and the two anonymous reviewers for the comments and suggestions.

Introduction

In his review of current trends in interlanguage phonology, Major (1994) observes that research in the area has moved from a single focus on transfer and contrastive analysis, to studies involving markedness, universal development factors and non-linear phonology. Among the issues that have been investigated in the area of interlanguage phonology, one that has been considerably studied is the second language (L2) learners' production of syllabic patterns absent from their first language (L1) inventory. (Silva Filho, 1998; Rebello, 1997; Fernandes, 1997; Abrahamsson, 1997; Carlisle, 1991, 1992, 1994, 1998; Eckman & Iverson, 1994; Abrahamsson, 1997; Koerich, forthcoming).

Research has indicated that the two most important strategies of syllable simplification found in L2 renditions of illicit syllabic patterns are consonant deletion and vowel epenthesis. The latter is subdivided into *prothesis*—inserting a vowel before the /♦/ segment (e.g., Brazilian learners may pronounce "sky" as [♓♦🕯&♋✋]), and *anaptysis*- inserting a vowel between /♦/ and the following consonant (e.g., Japanese learners may pronounce "sky" as [♦◆🕯&♋✋], (Abrahamsson, 1997)). In languages such as English, the deletion strategy is preferred, while in Brazilian Portuguese, epenthesis is more common. Thus, the word "hands" is likely to be pronounced as [♒✈■♦] by native speakers of English, but as [♒☜✂♎♑♓♦] by Brazilians learning English. The occurrence of epenthesis (prothesis) in the interlanguage of Brazilian learners before word-initial /♦/ clusters is attested by Rebello's study (1997). The present study sets out to investigate the relationship between perception and production in the acquisition of initial /♦/ clusters in the interlanguage of Brazilians learning English as a foreign language. In addition to the interface between perception and production, I shall take into account other factors that influence both mental processes, which have been discussed in the interphonology literature.

Factors Affecting the Learner's Interphonology

This section presents a review of possible factors affecting the acquisition of a L2 sound system. Among the factors discussed are L1 interference, amount of L1 use, universals, markedness, environment, perception, motor constraints, instruction, phonetic differences, and age.

According to Rebello (1997), word-initial /♦/ clusters cause difficulty due to the fact that they "involve a longer and different distribution of segments than that permissible in [Brazilian] Portuguese" (p.1). The difficulty posed by these clusters is attested in Rebello's study by the results which show that the subjects, no matter their level of proficiency, tended to resort to an epenthetic vowel to produce initial /♦/ clusters. In order to pronounce /♦/ clusters, Brazilians tend to make use of an epenthetic vowel (/♓/, or in some dialects /♏/, Istre, 1983) placed before /♦/.

As Carlisle (1994) points out, the occurrence of epenthesis in word-initial /♦/ clusters results in syllables of the VC type, which works as counter evidence to the claim that CV syllables are universally preferred[2]. Both Brazilian Portuguese and Spanish speakers' interlanguage are marked by the use of an epenthetic vowel before /♦/ to harmonise illicit word-initial /♦/ clusters, thus resulting in a VC syllable. This indicates that, in the case of Spanish and Brazilian Portuguese speakers, transfer factors play a more important role than universals in the selection of a strategy to help with the pronunciation of /♦/ clusters. In fact, the syllabic inventory of Brazilian Portuguese allows a limited number of consonant clusters both in onset and coda position: (C)(C)V(C)(C). Moreover, the occurrence of word-initial consonant clusters in Portuguese is restricted to some combinations of sounds: /□/, /♌/, /♐/, /v/, /♑/, /♍/ + /●/; /□/, /♌/, /♐/, /♦/, /♎/, /♑/, /♍/ + /☼/ (Cristófaro, 1999), and some other combinations of consonants + the glide /♦/ (Istre, 1983)[3].

Different from Brazilian Portuguese, English allows several types of consonant clusters: (C)(C)(C)V(C)(C)(C)(C) (Prator and Robinett, 1985). Therefore, it is no surprise that Brazilians resort to an epenthetic vowel, both in onset and coda positions[4] (Silva Filho, 1998), to make the syllabic structure of the target language closer to that of the native language. This can be regarded as a transfer strategy, since Brazilians also make use of epenthesis to harmonise syllabic anomalies in their L1. For instance, in words like "substituir" (/♦◆♌♓♦◆♠♓◆◆♗♓♒/) and "advogado" (/a<u>d♋♓</u>❖□♗♍♋♎◆/) an epenthetic vowel is inserted in the cluster /♌♦/ and in the consonant sequence /♎❖/.

Word-initial /♦/ clusters, they are not found in the syllabic inventory of Brazilian Portuguese. Nevertheless, Portuguese has many words beginning with "es", pronounced as [♓♦❁, [♏♦❁, [♓♠❁, [♏♠❁,[♓⌘], [♏⌘], [♓♋], [♏♋]. The consonants [♦] and [♠] are allophones of /♦/ when it is followed by voiceless consonants (e.g., "esta" [♗☜♦◆❶]), while [⌘] and [♋] are allophone of /♦/ when it is followed by voiced consonants (e.g., "esmo" [♗♏⌘❍◆]. Brazilian learners of English tend to transfer this voicing process to the word-initial /♦/ clusters that are followed by /●/ or /N/[5] (Rebello, 1997). Thus, loan words containing an initial /♦/ cluster are sometimes spelled with the closest Portuguese spelling pattern for that cluster, i.e., "es" (e.g., *stress*, becomes "estresse" /♓♦♗◆□☜♦♓/). Even

[2] In other words, it is more appropriate to say that least marked syllabic patterns are preferred to more marked ones. Thus, a VC syllable is preferred to the more marked CC(C)V.

[3] There are no words beginning with the cluster /❖☼/, but it can be found in mid-word position (e.g., "livre" [♗●♓<u>❖☼♓</u>]). The same is true for the cluster /◆●/ (e.g., "atleta" [♋♗<u>◆●☜</u>◆❶]). As for the cluster /❖●/, it can be found in proper names such as "Vladmir" [<u>❖●♋♎♓</u>♗❍♓☒] (Cristófaro, 1999).

[4] As observed by an anonymous reviser, words such as "pasta" do not trigger epenthesis [♗□♋♦◆♋]. The same is true for words such as "partir" [□♋☒♗◆♓☒]. In theory, Brazilian Portuguese allows only a few consonants in coda position: /❒/, /●/, /N/ and /s/. However, /❒/ tends to be pronounced as [❒] or [☒], while /N/ loses its consonantal feature and the preceding vowel assimilates its nasal feature. As to /●/, it is generally realised as /♦/, or, more rarely, as /♑/.

[5] /N/ stands for the nasal consonants /■/ and /❍/.

those loan words that do not go through spelling adaptations are pronounced according to the Brazilian sound system rules (e.g., *slogan* /♓⌘🕯●□♑♋✂/).

The issue of markedness of clusters has been discussed in the interphonology literature. Eckman and Iverson (1993) argue that typological markedness can account for the way L2 learners produce English clusters in syllable onsets. They predict the following markedness hierarchy of syllable difficulty:

> (a) voiced stop + liquid/glide is more difficult than voiceless stop + liquid/glide;
> (b) voiced fricative + liquid/glide is more difficult than voiceless fricative + liquid/glide
> (c) voiceless fricative + liquid/glide is more difficult than voiceless stop + liquid/glide. (Eckman & Iverson, 1993, p. 242)

According to Carlisle (1994), studies dealing with clusters should take into account the interaction between markedness and environment, for his study with Spanish speakers learning English showed that vowel epenthesis is less frequent after vowels than after consonants and less frequent before the less marked onsets than the more marked ones. He also found that less marked environments will induce a higher frequency of target variants than will more marked environments. Thus he claimed that less marked phonological structures should be presented before the more marked ones. In relation to this aspect, his study corroborated Eckman's (1991), which gives support to the hypothesis that two-member onsets are easier to learn than three-member ones. Carlisle (1994) also points out that some onsets are more marked than others (ex. /♦●/ > /♦❍/, /♦■/ > /♦♦/, /♦□/, /♦&/). Therefore, he proposes the following hierarchy of difficulty for two member onsets, which includes both markedness and environment factors (1=least difficult, 6=most difficult):

1. vocalic environment with /♦●/
2. vocalic environment with /♦❍/, /♦■/
3. vocalic environment with /♦♦/, /♦□/, and /♦&/
4. consonantal environment with /♦●/
5. consonantal environment with /♦❍/ and /♦■/
6. consonantal environment with /♦♦/, /♦□/, and /♦&/

Three-member onsets should abide by the same markedness hierarchy proposed for the two-member clusters, and should be more marked than two-member onsets.

Rebello (1997) tested Carlisle's hierarchy for consonant clusters. She carried out a cross-sectional study with Brazilian learners studying English as a foreign language, focusing on initial /♦/ clusters. Her results defied Carlisle's (1994) proposal, and she devised the following hierarchy of difficulty (1=least difficult, 8=most difficult):

1. tri-literal /spr, spl, str, skw, skr/ and bi-literal /st, sk, sp/ in the context of voiceless consonants

2. tri-literal /spr, spl, str, skw, skr/ and bi-literal /st, sk, sp/ in the context of voiced consonants

3. tri-literal /spr, spl, str, skw, skr/ and bi-literal /st, sk, sp/ in the context of vowels

4. tri-literal /spr, spl, str, skw, skr/ and bi-literal /st, sk, sp/ in the context of sentence-initial position

5. bi-literal /sm, sn, sl/ in the context of voiceless consonants

6. bi-literal /sm, sn, sl/ in the context of voiced consonants

7. bi-literal /sm, sn, sl/ in the context of vowels

8. bi-literal /sm, sn, sl/ in the context of sentence initial position

Rebello's hierarchy is totally contrary to the one proposed by Carlisle (1994). Her results show that L1 interference can overrule the effects of markedness as to cluster length (bi-literal clusters are more difficult than tri-literal ones), and as to clusters violating the Universal Canonical Syllable Structure (clusters in violation are easier than the ones not in violation). This study shows that the difficulties posed by word-initial /♦/ clusters vary across languages. Thus, any attempt to develop hierarchies of difficulties for such clusters should take into account the L1 factor.

Other studies such as Tropf (1987) and Carlisle (1991, 1994), propose that second language learners tend to modify more onsets that violate the Universal Canonical Syllable Structure UCSS. But as demonstrated by

Major (1987) and Rebello (1997), L1 transfer can be even stronger than the UCSS, given the fact that Portuguese speakers learning English tend to modify more /♦●/ clusters (which abide for the UCSS) than clusters that violate the UCSS. As Rebello (1997) points out, Brazilian learners voice the /♦/ of /♦●/ and /♦N/ clusters (not in violation of the UCSS) as a result of using a voicing process which is very active in the L1. The resulting voiced sibilant triggers epenthesis more frequently than the voiceless one, possibly because of markedness.

Flege (1988) observes that learners are better at detecting segmental errors than at avoiding them at the production stage. This assumption is corroborated by studies such as Rochet (1995) and Neufeld (1997). In the same study, Flege proposes 3 other factors affecting the acquisition of the phonetic inventory of an L2. First, Flege suggests that unaided second language experience only affects the acquisition of L2 pronunciation at the initial stages of language learning. After this initial stage, it seems that instruction is required in order to help learners to create or modify phonetic categories for the L2. Second, the author proposes that length of residence in a country where the target language is spoken has little effect on the acquisition of phonetic categories by adult learners. Third, he points out that pauses may have an effect on the degree of accentedness of English sentences spoken by L2 learners. Finally, Flege (1995) adds another factor affecting the acquisition of the L2 phonetic inventory: the constraints posed by the syllabic structure of a L1, which might cause motor difficulties and make it hard for the language learner to produce the target L2 sounds.

We could add to Flege's non-perceptual factors constraining the production of L2 sounds, the application of L1 phonological processes, spelling-oriented pronunciations, as well as the influence of cognates or loan words (Rochet, 1995). An example of a Brazilian Portuguese phonological process is the voicing of /♦/ in the contexts of /●/ (/♓⌘♗●♋❖◆/ "eslavo", *Slav*) or */N/ (/♓⌘♗❍❷●♋/ "esmola", alms*. Note that the voicing occurs even in the dialects in which /♦/ is pronounced as [⧫]. A phonological rule for this process could be:

/♦/ → [♦ ⧫] __ -voice,
/♦/ → [⌘ ☪]__ +voice

As for the influence of spelling, English teachers who work with Brazilians are well aware of the difficulty learners have to abandon the Portuguese pronunciation of words such as *route,* which tends to be pronounced as [❒☐⬥⧫☸ or [♒☐⬥⧫☸ or even [♒☐⬥⧫⧫♓☸, where the diphthong "ou" is pronounced the same way it is in Portuguese /☐⬥/, and the letter "r" is pronounced as /x/, as it is the case in most Brazilian Portuguese dialects. Finally, loan words could lead to accented pronunciations in words like *walkman*, which tends to be pronounced as [⬥♋◆♎♓♗❍♏✂☸ even when the learner is using it in a conversation in the L2.

It is important to point out the effects of age upon pronunciation achievements. According to Flege (1995), as the age of learning increases, the ability to discern and, therefore, acquire L2 sounds decreases. Many researchers have attempted to establish a threshold for the exact age where people start losing their ability to discriminate and produce sounds that are not present in their L1. The results so far are controversial, but as Patkowski (1994) observes, research focusing on long-term interphonology achievement indicates that younger learners (up to 12 or 15 years old), provided they have enough experience, appropriate environment and affective conditions, are likely to acquire native-like fluency. Such an achievement is not possible for post-puberty learners.

In light of the issues discussed in the literature, the present study investigates the acquisition of a L2 sound system by addressing the question: To what extent does perception influence production? I intend to test the relationship between the perception and production of initial /♦/ clusters[6] in the interphonology of Brazilian learners of English. While testing this relationship, I also hope to contribute to the controversial issue of the role of markedness and L1 interference on the production of word-initial /♦/ cluster. In addition, this study aims at testing Carlisle's (1994) and Rebello's (1997) hierarchies of difficulty for the acquisition of such clusters by l2 learners.

Method

Subjects

A group of 9 Brazilian Portuguese speakers attending an English course in the Extracurricular course of Universidade Federal de Santa Catarina (UFSC) were recruited for this study[7]. They were attending the fourth semester of the course and could be classified as being at a low-intermediate level of proficiency. The instructor of the course was the author of the present study.

Table 1 summarises the information about the subjects. Of the 9 subjects, 3 were female and 6 were male; 7 of them were undergraduate students of various areas at UFSC, and 2 had already graduated from the same university. Their age varied from 18 to 39 (m=22,6; SD=6,6). Most subjects reported they had started learning English when they entered the Extracurricular course or another private course, comprising 1.7 years of instruction. However, it is important to point out that all subjects received some sort of English instruction previous to these 1.7 years, since the Brazilian school system has adopted English as a compulsory subject. In some schools, English is taught from junior high up to secondary school,

[6] Mid-word /s/clusters such as [♌♓♦&●☜♦❶] "bicicleta" are not addressed in this paper.
[7] The initial number of subjects was 14, but 3 of them did not do one of the two tests used to collect the data, and 2 of them did not produce enough target words in the production test.

while other schools start offering English classes in primary or even pre-school. Only recently have students been able to opt for Spanish or English as the foreign language to be studied. Still, it is important to point out that the reason why students did not include the years they studied English at school in their calculation might have been the kind of foreign language instruction that is offered by most schools, which basically focuses on grammar and, sometimes, reading. Thus, the subjects seem to regard this kind of instruction as too restricted, for it does not involve the four language skills practised in their language course (i.e., speaking, listening, writing and reading). Only two subjects reported having spent some time in an English speaking country (2 and 3 weeks, respectively), but both did so as tourists.

	S2	S3	S4	S6	S7	S8	S11	S12	S13
Sex	F	M	M	M	M	F	M	F	M
Age	18	22	20	20	39	20	26	18	20
Time Studying English	4	1.7	1.7	1.7	4	1.7	1.7	.7	1.7
Time Spent in an English Speaking Country	-	-	3W	-	2W	-	-	-	-

Table 1. Subjects' information

Materials

Production test

The data for the production test were elicited through a task including 14 written sentences in Portuguese, which had to be translated into English. Each Portuguese sentence was intended to trigger at least one English word containing a word-initial /♦/ cluster. The activity was performed as a grammar review task for a written exam, and therefore the original sentences contain many grammatical structures that the subjects were studying in their English course. The criterion for the choice of words containing the /♦/ cluster was that the subjects would have no problems remembering them during the translation task, since the subjects were not allowed to use dictionaries. Such a criterion restricted the number of clusters being tested. The subjects were free to ask the instructor any questions on vocabulary. The words asked were written on the board, but were not pronounced, since I did not want the subjects to have external models for their pronunciation of the target words. Moreover, subjects were not allowed to write anything during the task, they could only record the sentences, as many times as they felt it was necessary. As a brief training

session, the instructor elicited possible translations for two sentences which did not include any target word.

Perception test

For the perception test, 26 sets of 3 sentences were recorded by a native speaker, of which 9 contained target contrasts (one of them was a catch trial, i.e., the target word was the same in the three sentences). In addition to the 9 target sets, the perception test included 12 distracters containing words dealing with other pronunciation problems Brazilians have while learning English, and 5 catch trials where the three sentences of the sets were identical. These extra sentences were included with the objective of not giving away the target sounds being tested and having some guarantee that the subjects were paying attention to the three sentences of each set. Each target set consisted of a carrier sentence (She is going to say ____ now) and one target word. The criterion for the selection of the target words was finding a minimal pair, i.e., two words that only differ as to the contrast between initial /♦/ cluster (/♦C(C)/) or initial /V♦C(C)/. An example would be the words *sleep* and *asleep*.

Before doing the perception test, the subjects answered some questions about their language background and personal information, and received a brief training in order to acquaint them with the task. The training session included varied pronunciation problems commonly found in English spoken by Brazilian Portuguese learners.

Data elicitation

Production test

The subjects were required to record the translation from Portuguese into English of 14 sentences, where the English version was expected to contain at least one word with an initial /♦/ cluster. The recording session took place in a Sony LLC-4500MKZ system laboratory, and the subjects who did not produce at least 10 target words were eliminated (2 subjects). The students only received a piece of paper containing the sentences to be translated and a cassette to record the sentences. They were not allowed to talk to each other during the task, but were free to ask the teacher any vocabulary question. The words asked by the subjects were written on the board and the instructor did not pronounce any of them. Even though the words chosen were expected to be part of the subjects' active vocabulary, most of the subjects had difficulty in remembering many of them. Maybe the type of task used to elicit data was too unusual, thus making the subjects feel insecure about the vocabulary.

The sentences resulting from the translation task were orthographically transcribed and the target words were transcribed

phonetically. The subjects were allowed to record the sentences as many times as they found necessary. Nevertheless, they could not erase any of the recorded versions, as the laboratory did not allow such procedure. For the data analysis, only the first version of each sentence containing a target word was taken into account.

Perception test

The perception test was carried out two weeks after the production test, at the same laboratory. The subjects wore headphones and received a short training provided by the instructor before the actual test. Immediately after the training, they listened to the tape containing the 26 sets of sentences recorded by an American native speaker, from which 9 had the target contrast, namely, /♦C(C)/ versus /V♦C(C)/ clusters. The subjects listened to the 26 sets containing 3 sentences and circled the odd one, i.e. the sentence that differed from the others, or circled "none", when they heard the 3 sentences as being the same. The answer sheets were collected and the results tabulated.

RESULTS

The study aimed at investigating the extent to which production is influenced by perception. This was tested by collecting data assessing subjects' perception and production of English initial /♦/ clusters in two different sessions. In this section the results yielded by both perception and production tests will be presented and discussed.

Another objective was to contribute to the controversy about the roles played by the L1 and markedness in the development of learner's interphonology. In order to do so, the study tested for the kind of strategy employed by Brazilian learners when they pronounce words containing initial /♦/ clusters. As has been pointed out by different researchers, epenthesis seems to be the strategy most commonly used. Moreover, the perception test was intended to investigate to what extent Brazilians actually hear a distinction between /♦C(C)/ and /V♦C(C)/ segments. The rationale for the perception test was that Brazilian learners of English might have their perception of initial /♦/ clusters hindered by the fact that such clusters do not exists in their L1, and, based on the L1 syllabic inventory, they are likely to perceive /♦/ clusters as /VsC(C).

The third aim was testing the hierarchies of difficulties for initial /♦/ clusters proposed by Carlisle (1994) and Rebello (1997). As the hierarchies proposed by both researchers only apply to production, I shall use the results of the production test to build a third hierarchy and compare it to Carlisle's and Rebello's in order to find out which one seems more appropriate to explain the phenomena of initial /♦/ clusters in the interphonology of Brazilian learners of English. Note, however, that test

design constraints of the production test prevented the assessment of all the kinds of /♦/ clusters that are present in Rebello's and Carlisle's study. The clusters assessed in the perception test were also limited by the research design (see section 2.2.2).

Perception test

Subjects' ability to discriminate between the syllabic patterns /♦C(C)/ and /V♦V(V)/ was tested with the use of a carrier sentence containing words with the two target patterns. As shown in Table 2, some subjects had problems discriminating between these two patterns with almost all clusters, while three other contrasts, 2 containing /sp/ and 1 with /♦&❒/ proved difficult for all subjects.

Target words	Clusters	KEY	S2	S3	S4	S6	S7	S8	S11	S12	S13	Correct Answers per cluster
Spy/espy	/♦□/	C	C	N	N	N	N	N	N	A	B	1
State/estate	/♦♦/	A	B	A	A	N	N	N	C	N	A	3
Spire/aspire	/♦□/	C	N	N	N	N	N	N	N	N	N	-
Sleep/asleep	/♦●/	C	C	N	C	C	B	N	N	C	A	4
Steam/esteem	/♦♦/	A	A	B	A	A	A	C	N	A	N	5
Stride/astride	/♦♦❒/	C	C	C	C	N	B	B	A	C	C	5
Spouse	/♦□/	N	N	A	N	N	A	N	N	N	A	6
Specially/ especially	/♦□/	C	N	N	N	N	N	N	N	N	N	-
Scribe/ascribe	/♦&❒/	B	N	N	N	N	N	N	N	N	N	-
Correct answers per subject		9	5	2	5	3	1	1	1	4	2	**24**

Table 2. Subjects' perception of minimal pair contrasts of initial /s/ clusters and clusters containing an initial /V♦C(C)/ syllable

The percentages of correct identification of the contrast /♦C(C)/ versus /V♦C(C)/ is presented in Figure 1. As can be seen, only 2 subjects were able to discriminate between more than 50% of the contrasts, and 3 of them were able to do so in only 11.1 % of the tokens. Note that four out of the five subjects who had the worst results were able to distinguish between pairs of words that contained the easiest clusters among the 5 tested, namely /♦♦/ and /♦♦❒/.

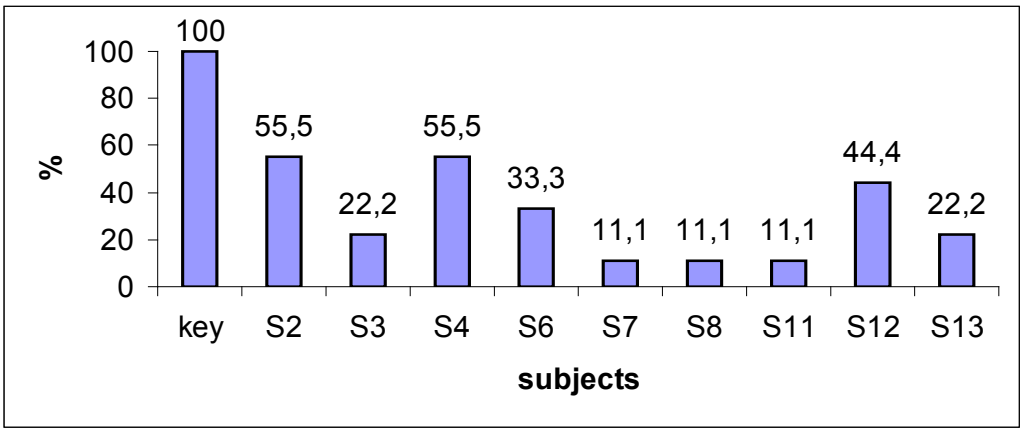

Figure 1. Frequency of subjects' perception of the target contrast: initial /♦/ clusters and words containing initial /V♦C(C).

The degree of difficulty of each type of cluster can be better visualised in Figure 2. The results indicate that the tri-literal cluster /♦&❒/ was the most difficult context for the subjects to detect the target contrast, followed by /♦❒/. On the other hand, the cluster /♦♦❒/, followed by /♦♦/ and /♦●/ seemed to offer less problems. The target words used in the perception test included cognates and English words that were part of the subjects' vocabulary, as well as words they probably had never heard of (see Table 2); but these classifications seem to be unrelated to the ease or difficulty of the cluster. The distinction between cognate words and their pairs was perceived by as many as 5 subjects (steam/esteem) and as few as 0 (specially/especially). The same pattern can be observed for unknown and known words. The distinction between the minimal pair stride/astride, which is not part of the subjects' vocabulary, was made by as many as 5 subjects, while another minimal pair containing new words (scribe/ascribe) proved difficult for all 9 subjects (see Table 2).

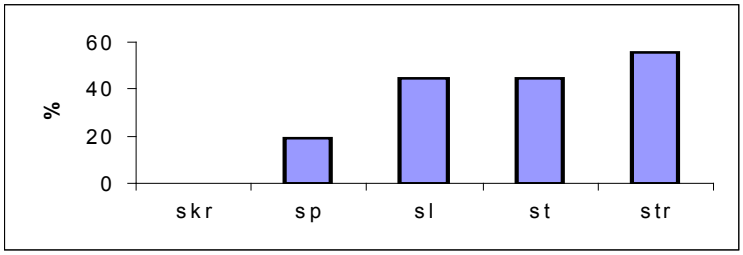

Figure 2. Percentage of correct perception of contrast between initial /♦/ clusters and initial /V♦C(C)/ by cluster type.

Although the number of subjects of the present study is rather small, a Pearson product-moment correlation was calculated to see if there was a

relationship between age and the subjects' ability to discriminate between the two syllabic patterns tested here. The test indicates a negative correlation between the two factors (r=-0.57). As can be observed in Figure 3, younger subjects tended to do better at the perception test than did the older subjects.

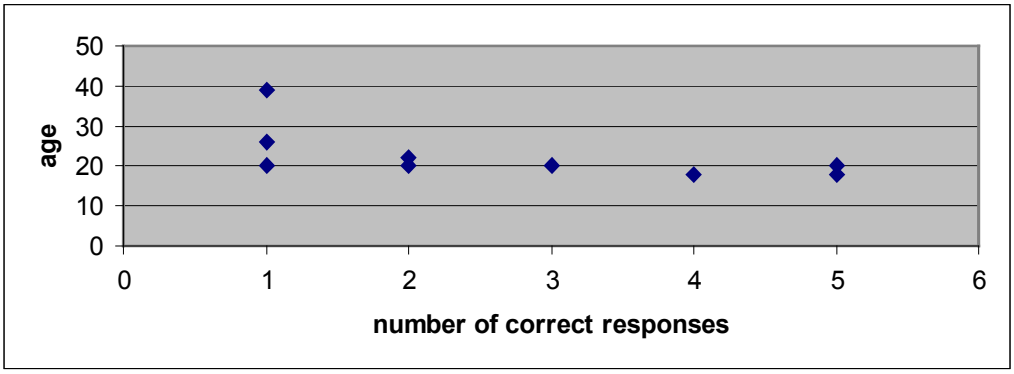

Figure 3. Relationship between age and subjects' ability to discriminate between initial /⋆/ clusters and /V⋆C(C)/.

Production Test

Table 3 shows the types of initial /⋆/ cluster that were produced by the subjects. As shown in this table, all the subjects used an epenthetic vowel to produce all initial /⋆/ clusters. There was some variation in the quality of the epenthetic vowel, for in certain environments some subjects used an epenthetic /ɨ/, while in others, they used /ʉ/.

	⋆●	⋆&	⋆◆	⋆□	⋆■	⋆◆↗	⋆□↗	⋆&↗	◆□◆ ♋●
S2	ɨ⋆● ɨ⌘● ʉ⌘●	ʉ⋆&(2) ɨ⋆&	ʉ⋆◆ ɨ⋆◆(2)	ɨ⋆□ ʉ⋆□	ɨ⋆■	ɨ⋆◆↗(3)	ɨ⋆□↗	ɨ⋆&↗	17
S3	ɨ⌘●(2)	ʉ⋆& ɨ⋆&	ɨ⋆◆(4)	ɨ●□ ɨ⋆□(2)	ɨ⌘■	ʉ⋆◆↗ (2)	ɨ⋆□↗	ʉ⋆&↗	16
S4	ɨ⌘● (2)	ɨ⋆&(3)	ɨ⋆◆(3)	ɨ⋆□(2)	ɨ⌘■	ɨ⋆◆↗(3)	ɨ⋆□↗	ɨ⋆&↗	16
S6	ɨ⌘● ɨ⋆●	ɨ⋆& (2)	ɨ⋆◆(4)	ɨ⋆□ (3)	ɨ⋆■	ɨ⋆◆↗(3)	ɨ⋆□↗	ɨ⋆&↗	17
S7	ɨ⌘● ɨ⋆▭	ɨ⋆& (3)	ɨ⋆◆(4)	ɨ⋆□(3)	ɨ⌘■	ɨ⋆◆↗ (2)	ɨ⋆□↗		16

S8	♓⌘● ✋⌘●	♓⬧&(2) ✋⬧&	♓⬧◆(3)	♓⬧◘(2) ♓●◘	♓⌘■	✋⬧◆↗(2) ♓⬧◆↗	✋⬧◘↗	✋⬧&↗	17
S11	♓⌘● ✋⌘●	♓⬧& (2)	♓⬧◆(3)	♓⬧◘(3)	♓⌘■(2)	♓⬧◆↗(3)	♓⬧◘↗	♓⬧&↗	17
S12	♓⬧●(2)	✋⬧&(2) ♓⬧&	♓⬧◆(3)	♓⬧◘		✋⬧◆↗ (2) ✋⬧◆↗	♓⬧◘↗	♓⬧&↗	14
S13	♓⬧● ♓⌘●	♓⬧&(2)	✋⬧◆ ♓⬧◆	♓⬧◘(3)	♓⌘■	✋⬧◆↗ ♓⬧◆↗(2)	✋⬧◘↗	♓⬧&↗	15
Total	19	23	29	23	9	25	9	8	**145**

Table 3 . Types of initial /⬧/ clusters generated by the subjects during the Production Test.

Figures 4 and 5 present more details about the quality of the epenthetic vowel used by the subjects. As can be seen in Figure 4, /♓/ was predominantly used, especially with the clusters /⬧■/, /⬧◘/, /⬧◆/ and /⬧●/. The epenthetic /✋/ was more frequent with the three tri-literal clusters /⬧◆❒/, /⬧&❒/, and /⬧◘❒/, as well as the bi-literal /⬧&/. Figure 5 shows the frequency of both epenthetic vowels per subject. Three subjects used an epenthetic /♓/ in 100% of the clusters. Subjects 8, 12 and 2 are the ones who alternated between /♓/ and /✋/ more frequently. Nevertheless, no subject used the epenthetic /✋/ more frequently than /♓/.

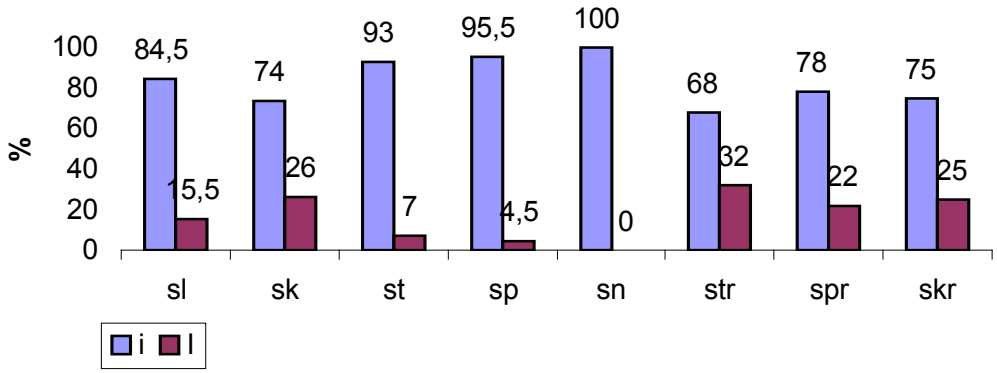

Figure 4. Frequency of different epenthetic vowels (/♓/ vs /✋/) occurring in the subjects' pronunciation of initial /⬧/ clusters.

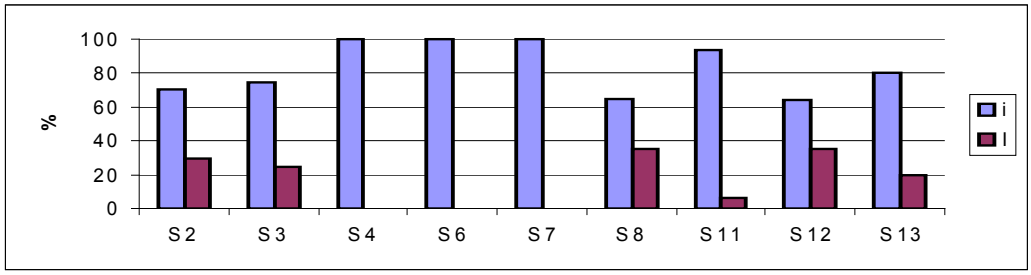

Figure 5. Percentage of use of the epenthetic vowels /ɪ/ and /ʉ/ per subject .

Also, as attested by Rebello's (1997) and Major's (1987) studies, the subjects tended to voice the segment /ɾ/ of initial /ɾ/ clusters sound when it was proceeded by /●/ and /■/. Two other subjects pronounced the sound /ɾ/ as [ɻ] when it was followed by /□/ (see Table 4). The two times this occurred, the target word was the cognate *special*. Note that the pronunciation of /ɾ/ as [ɻ] is typical of the dialect spoken in the city of Florianópolis, the place where the subjects were attending the course and where the data were collected, and which is the dialect spoken by the two subjects who used [ɻ] in place of /ɾ/.

/ɾ●/		/ɾ■/		/ɾ□/	
/ɾ/	/ɹ/	/ɾ/	/ɹ/	/ɾ/	/ɻ/
31,5	68,5	22,5	77,5	91,5	8,5

Table 4. Percentages of the different pronunciations of the phoneme /ɾ/.

The Interface Perception/Production

In order to test for a possible interaction between perception and production, the results of subjects' correct perception and approximate production of the word-initial /ɾ/ clusters yielded by both perception and production tests, respectively, were analysed. Figure 6 indicates that the subjects' ability to hear and produce initial /ɾ/ clusters are related, since the clusters that were better perceived were more accurately produced. The only cluster that does not follow this tendency is the tri-literal /ɾ&❒/, and this is probably responsible for the lack of correlation between perception and production in relation to cluster type (r = 0.1).

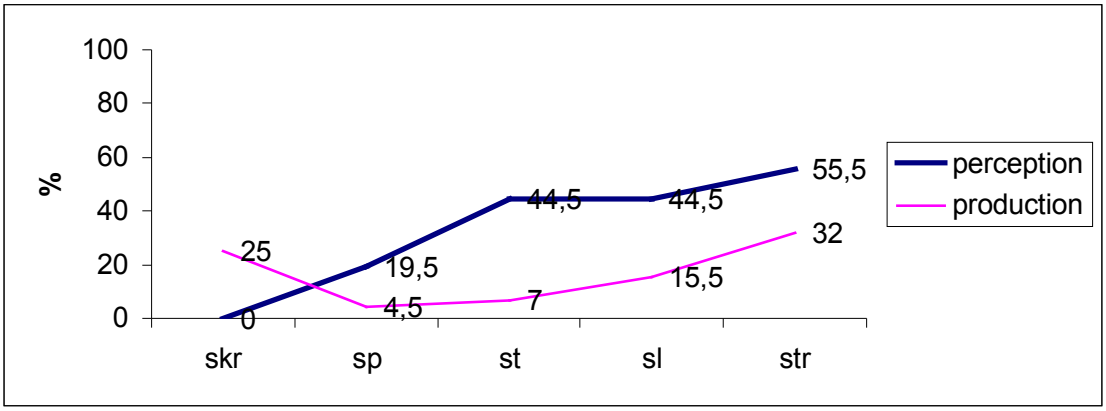

Figure 6. Percentage of accuracy of perception and production in relation to cluster type.

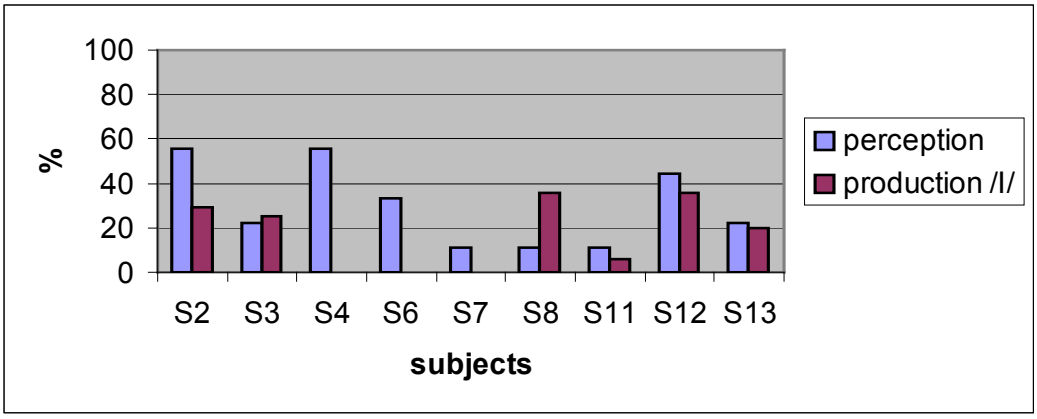

Figure 7. Interface perception/production as revealed by the subjects' performance in the perception and production test

The interface perception/production was also tested between subjects (Figure 7). The results indicate that perception is generally ahead of production, except for subject 3, whose production of the /♦/ clusters seems slightly better than perception, and subject 8, whose production is further ahead of perception. One has to keep in mind, however, that the best the subjects could do at the production test was to resort to a short epenthetic vowel /✋/. No subject rendered authentic English initial /♦/ clusters. A comparison of the perception and production tests yielded the following hierarchies of difficulty:

Perception test	**Production test**	
/♦♦❒/	/♦♦❒/	Least difficult
/♦♦/ /♦●/	/♦&/	
/♦◘/	/♦&❒/	
/♦&❒/	/♦◘❒/	
	/♦●/	↓
	/♦♦/	
	/♦◘/	
	/♦■/	Most difficult

The comparison and contrast of the results of the perception and production tests point to a possible interaction between the two processes. As suggested by Flege (1988), the subjects' interphonology seemed to be at a certain developmental stage, where some subjects were beginning to hear the phonetic differences between /♦C(C)/ and /V♦C(C). Consequently, some subjects were also attempting to produce this distinction, but the best they managed to do so far was to employ a reduced vowel /✋/ instead of the longer /♓/. Provided these subjects gain more experience and further instruction on the L2, they are likely to establish separate categories for both syllabic patterns. The only cluster that seemed easier to produce than to perceive is /♦&❒/, which presents a challenge to the hypothesised influence of perception on production.

The present study also aimed at testing the hierarchies of difficulty for the production of initial /♦/ clusters proposed by previous research. Thus, it should be interesting to compare the hierarchy yielded by the present study to those proposed by Carlisle (1994) and Rebello (1997).

Present study	Rebello		Carlisle		
/♦♦❒/	/♦◘❒/ /♦◘●/	/♦♦❒/	/♦●/		Least difficult
/♦&/	/♦&♦/ /♦&❒/		/♦❍/ /♦■/		
/♦&❒/	/♦♦/ /♦&/ /♦◘/		/♦♦/ /♦◘/ /♦&/		
/♦◘❒/	/♦❍/ /♦■/ /♦●/		/♦◘❒/	/♦◘●/	↓
/♦l/			/♦♦❒/	/♦&♦/	
/♦♦/			/♦&❒/		
/♦◘/					
/♦■/					Most difficult

The hierarchy of difficulty yielded by the present study has many points in common with the one proposed by Rebello (1997), including a slight tendency for /♦/ followed by sonorant consonants to be more difficult. Although the present study did not take into account the environment preceding the clusters, it is possible to say that, in terms of markedness and UCSS, the subjects followed the pattern pointed out by Rebello. It seems appropriate to suggest that any hierarchy of difficulty for

initial /♦/ clusters has to take into account the factor L1 interference. As discussed before, L1 was a relevant factor in the production of all clusters, since all subjects resorted to an epenthetic vowel in order to pronounce them. The markedness of the cluster seems to be of little relevance when L1 interference is so pervasive as it is in the case of the process of inserting an epenthetic vowel to accommodate illicit syllabic patterns. Carlisle's (1994) hierarchy might be pertinent to account for what happens with the interlanguage of Spanish speakers learning English, but it seems inappropriate to explain what happens with the acquisition of initial /♦/ clusters by Brazilian learners.

As most subjects started developing the speaking and listening abilities in L2 after puberty, it is difficult to say to what extent they will be able to set representations for the L2 phonetic system, or how articulatory constraints will prevent them from producing initial /♦/ clusters without resorting to epenthesis. Furthermore, as the subjects who participated in this study are learning English in a foreign language environment, it is probable that the formation of separate categories proves more difficult, due to the fact that the amount of use of L1 is very high, while the L2 usage is generally restricted to the classroom.

It is important to ask how much the data obtained for the production test were influenced by the task used to elicit them. The use of translation was positive in the sense that it diminished subjects' attention towards pronunciation, making them focus primarily on vocabulary and grammar. Nevertheless, while translating, subjects tended to speak very slowly, with lots of pauses between words. As pointed out by Rebello (1997), avoiding the use of an epenthetic vowel seems more difficult when the word containing the initial /♦/ cluster begins a sentence. It is possible that the long pauses before the /♦/ clusters also triggered more epenthesis.

CONCLUSION

The results obtained here partially support studies which propose that perception influences production, since some of the subjects who did well in the perception test performed better in the production task. There was also support for the power of L1 interference over Markedness and UCSS, since all subjects employed an epenthetic vowel at the beginning of the cluster in order to legalise illicit clusters, a strategy Brazilians use in Portuguese. Epenthesis was present in all cluster types. Some subjects, though, resorted to a short epenthetic vowel (/✋/), thus indicating that they might be developing a separate category for initial /♦/ clusters. Contrary to Brazilians, English native speakers tend to use the deletion strategy. Therefore, Markedness and the UCSS seem to play a less important role in the acquisition of initial /♦/ clusters by Brazilian learners of English. As a matter of fact, the hierarchies of difficulty of such clusters yielded by the present study and Rebello's (1997) indicate that the more marked tri-literal

clusters are not always more difficult to produce. Similarly, /♦/ clusters that violate the UCSS do not seem to be more difficult, on the contrary, they seem to be easier to produce than those that are not in violation.

It is necessary to mention that the design of the tests used to collect the data for this study restricted the types of clusters being investigated. The sentences for the production test were constrained in two ways. First, I tried to include grammar structures that were being studied by the subjects, so that the activity would not disrupt the class sequence. This might have resulted in rather complex grammatical structures, thus interfering with the subjects' fluency, which might have triggered more epenthesis. Second, I tried to control for the vocabulary used in the production test, especially the target words, which were supposed to be part of the subjects' active vocabulary. Nevertheless, as discussed in the Methods section, most subjects had problems remembering many target words and these words had to be written on the board. It might be the case that the spelling of the target words influenced their pronunciation somehow.

Other researchers have generally used the reading aloud technique or even natural conversation samples to collect production data. Due to the shortcomings of using translation to collect production data, it would be interesting to carry out a study testing for the effects of different methods of data collection on the production of initial /♦/ clusters.

The clusters assessed by the perception test were also limited, due to the minimal pair criterion. Future research should attempt at testing a larger variety of clusters, which might be accomplished by a different test design.

Finally, two other aspects that were not covered by the present study should be explored by future research. First, the extent to which markedness and environment together can influence the use of epenthesis in the production of initial /♦/ clusters. Second, it would be interesting to test for the effects of instruction and language experience on the acquisition of such clusters in a longitudinal study.

References

ABRAHAMSSON, N. Vowel epenthesis of initial /sC(C)/ cluster in Spanish speakers'L1 and L2 production: puzzle or evidence for natural phonology? In: JAMES, A.; LEATHER, J. (Ed.) *New Sounds 97: Proceedings of the Third International Symposium on the Acquisition of Second-language Speech*. Klagenfurt: University of Klagenfurt, 1997. p. 8-16.

CÂMARA, J.M. *Estrutura da Língua Portuguesa*. 8ª ed. Petrópolis: Editora Vozes, 1970.

CARLISLE, R.S. The influence of environment on vowel epenthesis in Spanish/English Interphonology. *Applied Linguistics*, v. 12, n.1, p. 76-95, 1991.

CARLISLE, R.S. Environment and markedness as interacting constraints on

vowel epenthesis. In: JAMES, A.; LEATHER, J. (Ed.) *New Sounds 92: Proceedings of the Third International Symposium on the Acquisition of Second-language Speech*. Klagenfurt: University of Klagenfurt, 1992. p. 64-75.
CARLISLE, R.S. Markedness and environment as internal constraints on the variability of interlanguage phonology. In: YAVAS, H. (Ed.) *First and second language phonology*. San Diego: Singular Publishing Group, Inc. 1994. p. 223-249.
CARLISLE, R.S. The acquisition of onsets in a markedness relationship: a longitudinal study. *Studies in Second Language Acquisition*, v.20, p. 245-260, 1998.
CRISTÓFARO, T. S. *Fonética e fonologia do português – roteiro de estudos e guia de exercícios*. São Paulo: Contexto, 1999.
ECKMAN, F.R. The structural conformity hypothesis and the acquisition of consonant clusters in the interlanguage of ESL learners. *Studies in Second Language Acquisition*, v.13, n.1, p. 23-41, 1991.
ECKMAN, F.R. & IVERSON, G.K. Sonority and markedness among onset clusters in the interlanguage of ESL learners. *Second Language Research*, v. 9, n.3, p. 234-252, 1993.
ECKMAN, F.R. & IVERSON, G.K. Pronunciation difficulties in ESL: coda consonants in English Interlanguage. In: YAVAS, H. (Ed.) *First and second language phonology*. San Diego: Singular Publishing Group, Inc., 1994. p. 251-265.
FERNANDES, P.R.C. *A Epêntese Vocálica na Interfonologia do Português Brasileiro*. 1997, 121 f. Dissertação (Mestrado em Letras) – Escola de Educação, Universidade Católica de Pelotas, Pelotas
FLEGE, J.E. Effects of equivalence classification on the production of foreign language speech sounds. In: JAMES, A.; LEATHER, J. (Ed.) *Sound patterns of second language acquisition*. Dortrecht: Foris, 1987. p. 9-39.
FLEGE, J. E. Factors affecting degree of perceived foreign accent in English sentences. *Journal of Acoustic Society*, v. 84, n. 1, p. 70-79, 1988.
FLEGE, J. E. Second language speech learning theory, findings and problems. In: STRANGE, W. (Ed.) *Speech perception and linguistic experience*. Baltimore: York Press, 1995. p. 233-277.
ISTRE, G.L. *Fonologia transformacional e natural: uma introdução crítica*. Florianópolis: UFSC, 1983.
KOERICH, R.D. *Perception and Production of Vowel Epenthesis in Word Final Single Consonant Codas*. (em andamento). Tese (Doutorado em Língua Inglesa) – Programa de Pós-Graduação em Língua Inglesa e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianóplois.
MAJOR, R.C. A model for interlanguage phonology. In: IOUP, G.; WEINBERGER, S.H. (Ed.) *Interlanguage phonology: the acquisition of a second language sound system*. New York: Newbury House, 1987. p. 101-124.
MAJOR, R.C. Current trends in interlanguage phonology. In: YAVAS, H. (Ed.) *First and second language phonology*. San Diego: Singular Publishing Group, Inc. 1994, p. 181-203.

NEUFELD, Gerald Phonological asymmetry in L2 perception and production. In: JAMES, A.; LEATHER, J. (Ed.) *New Sounds 97: Proceedings of the Third International Symposium on the Acquisition of Second-language Speech*. Klagenfurt: University of Klagenfurt, 1997. p. 176-185.

PRATOR, C.H.J.; ROBINETT, B.W. *Manual of American English Pronunciation*. 4. Ed. New York: Holt, Rinehart and Winston, 1985.

REBELLO, J.T. *The Acquisition of English Initial /s/ Clusters by Brazilian Learners*. 1997, 198 f. Dissertação (Mestrado em Língua Inglesa) – Programa de Pós-Graduação em Língua Inglesa e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianóplois.

ROCHET, B.L. Perception and production of second-language speech sounds by adults. In: STRANGE, W. (Ed.), *Speech perception and linguistic experience: issues in cross linguistic research*. Timonium: York, 1995. p. 379-410.

SILVA FILHO, J. *The Production of English Syllable-Final Consonants by Brazilian Learners*. 1998, 123 f. Dissertação (Mestrado em Língua Inglesa) – Programa de Pós-Graduação em Língua Inglesa e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianóplois.

TROPF, H. Sonority as a variability factor in second language phonology. In: JAMES, A.; LEATHER (Ed.), *Sound patterns in second language phonology.* Dordrecht: Foris, 1986. p. 173-191.