Investigating the Role of Orthography in the Acquisition of L2 Pronunciation: A Case Study

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1. Introduction and review of literature

In 1997, Baptista and Silva Filho published an important study investigating the production of English word-final consonants by Brazilian learners, focusing on the roles played by markedeness (Eckman, 1991), sonority (Tropf, 1987), and phonological environment (Carlisle, 1991). Since then, several Brazilian researches have conducted studies to map these and other factors that might affect the production of English word-final consonants by Brazilian learnes (e.g., Koerich, 2002; Silveira, 2004 and 2007; Zimmer, 2004; Kluge, 2004; Baratieri, 2006).

Silveira (2004 and 2007) and Zimmer (2004) have investigated the role played by orthography in the acquisition of English word-final consonants by Brazilian learners (see Section 2.2 for further detail). This paper draws on the findings of these studies and extends them by investigating the extent to which orthography may explain the pronunciation difficulties faced by an adult Brazilian learner when producing English word-final consonants in a free-speech task and in a reading-aloud task.

In the following section information about the syllabic structure of English and Brazilian Portuguese (BP) and syllable simplification strategies commonly found in the English word-final consonants produced by Brazilians will be presented. This will be followed by a review of previous studies on the effects of orthography on the acquisition of the L2 phonological component. The review of literature will be followed by information about the design and the results of the present study.

1.1 Production of word-final consonants and clusters

In English, all consonants except /h/ can appear in syllable-final position. Conversely, in BP a few consonants are permitted in syllable-final position: /r/ (pronounced, depending on regional variety, as a trill, velar fricative, flap, or retroflex), the lateral /l/, the nasal archiphoneme /N/, and the sibilant archiphoneme /S/ (Câmara, 1970; Collischonn, 1996). However, even these sounds are somewhat marginal in the coda: /r/ tends to be deleted (*comer* 'eat' [koˈme]); /l/ is generally realized as the glide [w] or, more rarely, as a dark [ɬ][1] (*mal* 'bad' [maw] or [maɬ]); /N/ loses its consonantal feature with preceding vowel diphthongization and assimilation of the nasal feature (*bom* 'good' [bõw]); leaving only /S/[2] as a final consonant phonetically. Due to these constraints on syllable structure, BP speakers tend to resort to vowel epenthesis to break up cross-syllabic consonant clusters in the L1. Thus, words that have not been officially modified to adapt to the constraints of contemporary BP phonotactics,[3] such as *pacto* ('pact') and *advogado* ('lawyer') are pronounced with the epenthetic vowel /i/ or /e/, yielding [ˈpakitu] and [adivoˈgadu], respectively.

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[1] See Collischonn (1996) and Monaretto, Quednau & Hora (1996)

[2] As pointed out by Cristófaro-Silva (2002), [ʃ] and [ʒ] are also found in several BP dialects (e.g., those of Rio de Janeiro and Santa Catarina states) as allophones of /s/ and /z/, respectively.

[3] Other words, such as *batismo* ('baptism') and *acidente* ('accident') have officially lost the offending consonants, the letters "p" (/p/) and "c" (/k/), respectively, dispensing the necessity of epenthesis.

This productive L1 process is also known to be a frequent syllable simplification strategy in BP/English interphonology. It is most commonly applied to structures such as the following: (a) initial /s/ clusters (*stop* [ɨs'tɑpi]); (b) medial clusters (*substitute*: [su'bistituti], frequently with change in word-stress); (c) final clusters (*faced*: ['fejsɨd'/fejsɨdi]); and (d) word-final singleton consonants that are not permitted in BP, to which a paragogic vowel is added (*map* ['mæpi])[4].

Other syllable simplification strategies employed by Brazilian learners of English have been identified. Zimmer developed a framework to classify several phonological processes employed by 156 Brazilians while reading aloud a set of English words. The participants were grouped according to four proficiency levels and nine non-target phonological processes were identified: (a) Syllable Simplification (epenthesis and paragoge); (b) Consonant Change; (c) deaspiration; (d) Terminal Devoicing; (e) Delateralization and Rounding of Final /l/; (f) Vocalization of Final /m/ and /n/; (g) Velar Consonant Paragoge; (h) Vowel Assimilation; and (i) Interconsonantal Epenthesis (-ed morphemes).

The present study adopts Zimmer's framework, with some adaptation to accommodate the free-speech data and focuses on the production of word-final consonants. These factors are explained in the next section, which also introduces information from previous studies of the role played by orthography in interphonology.

1.2 Effects of orthography

Interphonology studies have frequently relied on reading-aloud tasks to collect data. One question that we need to ask is the extent to which speech samples elicited by means of reading tasks are affected by orthographic input. Zimmer (2004) maintains that learners activate their knowledge of the L1 alphabetic and phonetic-phonological systems to some extent when performing reading-aloud tasks in the L2. This activation may account for some non-target productions of L2 sounds, such as when Brazilian learners of English pronounce "ge" as [ʒ] in words like *page* [pejʒ].[5]

Young-Scholten and Archibald (2000) proposed that the effects of task-type and input-type should be considered in this regard. According to these authors, most L2 learners are literate adults, whose contact with the L2 relies greatly on written material, especially for those who are not in a country where the target language is widely spoken. As the researchers point out, these learners' first contact with L2 words generally involves written input. This constant access to the orthographic representations of words may lead learners to rely heavily on L1 spelling and pronunciation correspondences when pronouncing L2 words. The authors also believe that exposure to orthographic input could explain why L2 learners (especially adults) resort to vowel epenthesis[6] as a syllable simplification strategy more often than do children acquiring their L1. In this view, literacy triggers *recoverability*. Thus, L2 learners resort more often to the strategy of adding a vowel, as opposed to strategies such as consonant deletion, because this strategy preserves all the elements of the target word, which can be recovered later[7]. Moreover, due to recoverability, tasks that provide adult learners with

[4] Brazilian learners may produce two different types of epenthetic vowels when producing English word-final consonants: the typical L1 vowel [i] or another one that results from developmental factors [ə] (Major, 1986). Silveira (2004) also found that speakers of certain BP dialects (e.g., from cities located in the south of Brazil) may also produce the epenthetic vowel [e] to deal with illicit English word-final consonants, a strategy that is also found in their L1.

[5] For a complete list of the correspondence between the alphabetic and the phonetic-phonological systems of English and BP, see Celce-Murcia, Brinton, and Goodwin (1996) and Scliar-Cabral (2001), respectively.

[6] The examples provided by the authors refer to both epenthesis and paragoge.

[7] The notion of recoverability is also discussed in Weinberger (1994), who argues that the occurrence of vowel epenthesis or paragoge is directly connected to the possession of functional and phonotactic knowledge. Thus,

written input, such as word-list reading or sentence-reading, are expected to yield higher rates of vowel epenthesis or paragoge than tasks that do not include written input (e.g., interview, picture description and narration). As we shall see in discussing Zimmer's (2004) study, however, orthography can trigger other phonological processes in addition to paragoge and deletion.

Zimmer (2004) is one of the few researchers tot have investigated the effects of orthography on the acquisition of English syllabic structures by adult Brazilian learners. This large-scale study was carried out using a word-reading-aloud task to determine the extent to which 156 Brazilian learners of English at various proficiency levels would transfer L1 grapheme-phoneme correspondence to reading monosyllabic words in the L2. The effects of orthography were also attested by the occurrence of nine phonological processes related to the influence of L1 sound-spelling correspondence (see Section 1.1).

Based on data elicited by means of a sentence-reading task, Silveira (2004) tested the hypothesis that the paragogic vowel rates for words ending in a consonant followed by graphic *–e* (e.g., *made*) would be different from the rates for words ending in a grapheme consonant only (e.g., *mad*), both before and after treatment. The consonants tested were /p/, /b/, /t/, /d/, /k/, and /f/. A control group and an experimental group of Brazilian learners participated in Silveira's (2004) study. The results indicated that orthography plays an important role in the frequency of paragoge in the production of word-final consonants by beginner-level Brazilian learners of English, since the words containing the silent *-e* triggered significantly more paragogic vowels than those ending in the consonantal grapheme. The same study also showed that spelling caused participants to transfer L1 processes such as the deletion of nasals, with the preceding vowel assimilating the nasal feature (e.g., *noon* [nũw]), and the substitution of alveopalatal affricates for alveolar stops (e.g., *made* [mejdʒ]). Silveira also found that, after receiving explicit instruction in how to pronounce singleton word-final consonants, the experimental group considerably reduced its paragogic vowel rates for both types of words, thus indicating that the negative effects of the silent *–e* condition were minimized. These results seem to corroborate Young-Scholten and Archibald's (2000) prediction concerning the effects of orthography on the selection of syllable simplification strategies by adult learners. Nevertheless, Silveira's study, like Zimmer's (2004), relied on a single test to collect data, a sentence-reading task, and therefore included on crosscheck regarding the interaction between task type and orthography effects.

Erdener and Burnham (2005) followed a different line of investigation and examined the facilitative effects of orthography and audiovisual information. The authors claimed that speech perception relies greatly on visual input and that, for literate learners, orthography is one important source of this type of input. Their study addressed the role of orthography as a tool to facilitate L2 speech perception and production. They distinguished between languages in which the relationship between graphemes and phonemes is relatively direct (so called transparent languages, such as Portuguese), and those in which this relationship is not so obvious (opaque languages, such as English). The authors' study with Turkish (transparent) L1 and Australian (opaque) L1 speakers producing Spanish (transparent) L2 and Irish (opaque) L2 non-words provided support for the claim that the beneficial effects of orthography are more evident for learners whose L1 is transparent and who are learning an L2 that is also transparent regarding the grapheme-phoneme relationship. However, if these learners are attempting to acquire an L2 whose grapheme-morpheme relationship is opaque, they will be subject to greater L1 influence, which may tend to reduce accuracy of production. This is the

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the fact that epenthesis or paragoge is more frequent in adult learner production of L2 sounds than in children's production of L1 sounds is due to the adults' functional and phonotactic knowledge of the L2. This kind of knowledge leads advanced learners to resort to syllable simplification strategies that minimize ambiguity and maximize recoverability.

case of Brazilian learners of English, and the present study is expected to provide further support for Erdener and Burnham's claims.

Finally, Silveira (2007) investigated the effects of *task-type* and *orthography* on the production of English word-final consonants by Brazilian learners. Ten participants who are students in a first-semester English course completed three different tasks: (1) reading a sentence-list; (2) reading a dialog; and (3) answering a set of questions. The three tasks were recorded and items containing word-final consonants were transcribed in order to verify the extent to which these learners resorted to an epenthetic vowel to produce English word-final consonants not found in BP. A comparison was also made between words ending in a consonantal grapheme (*mad*) and words spelled with a final *–e* (*made*) in order to assess whether spelling influenced the production of word-final consonants.

Silveira's findings regarding the effects of orthography indicate that this variable influences the production of word-final consonants not only in reading tasks but also in speaking tasks. However, it is important to point out that even the speaking task used in Silveira's study provided participants with some written input (the questions), and that this might partially explain why participants resorted to a paragogic vowel more often in the case of words graphed with a silent *–e*, since some of the words produced by the participants were present in the questions (e.g., *name*, *like*). Another plausible explanation for orthographic effects in the interview task – as proposed by Young-Scholten and Archibald (2000) – is that the participants were adult learners in a foreign language learning context whose first contact with L2 words tends to occur through written input. Thus, these participants can be expected to have orthographic representations for most of the words that they have already learned, and they are likely to rely on these orthographic representations in pronouncing words.

All the empirical studies reviewed above suggest that orthography influences the production of L2 sounds and that this influence is related to learners transferring their knowledge of L1 spelling-sound correspondences. Koda (2007) points out that traditional definitions of transfer (e.g., Gass & Selinker, 1983) have implied that transfer phenomena tend to hinder L2 acquisition and are likely to disappear once L2 proficiency is attained. However, Koda proposes a different view of transfer as "the ability to learn new skills by drawing on previously acquired resources" or "automatic activation of well-established L1 competencies (mapping patterns) triggered by L2 input" (p. 17). Koda's definition of transfer encompasses a number of assumptions. First of all, transfer cannot be easily controlled: both L1 and L2 are activated automatically, thus L1 information cannot be "suppressed by learners when processing L2 lexical information." (p. 18). Moreover, transfer happens when a particular item is fully automatized in the L1 and is unlikely to cease completely.

Although relatively few studies have investigated the effects of orthography on L2 production, research published so far has provided interesting insights into the interaction between L1 and L2 grapho-phonic-phonological knowledge. One important issue is that tasks containing written input may trigger performance that is affected by the transfer of L1 sound-spelling correspondence into the L2 (Young-Scholten & Archibald, 2000). It is equally important to investigate the extent to which such transfer also takes place when learners perform tasks without orthographic input, which might reflect their knowledge of orthographic representations of L2 words. The following section describes the methodology employed in the present study in order to contribute to this goal.

2. Method

This section begins with a description of the study participant. The following section describes the data collection instruments and procedures. Finally, the last section explains the criteria that were used to analyze the speaking and reading.

2.1 Participant

This research adopted a case-study methodology. The participant was a 44 year-old Brazilian Social Science professor who started learning English in high school (age 15-17), where he primarily studied English grammar. He has been studying English in various instructed settings in his home country since then, either in language institutes or through private lessons. In his mid 30s, he enrolled in a language course at *Cultura Inglesa*, where he had classes once per week and completed level 4 within two years. After that, he had private lessons with various instructors for about ten years, interrupting his studies often and for long periods during these years. This learner had little contact with native speakers and spent one month in the United States 1.5 years prior to data collection, at which time he took a 60-hour English course. By the time of data collection, the participant had been receiving private English lessons twice per week for three Months from a native speaker of British English.

In order to gather further information about the participant's proficiency level, two components of the Oxford Placement Test (Allan, 2004) were administered. The participant's total score was 138, based on 59 questions correct out of 100 on the grammar subtest and 77 correct out of 100 on the listening subtest. Given these results, the participant could have been placed in an upper intermediate level of English proficiency.

2.2 Materials and data collection

Data were collected by recording three free-speech samples and a text-reading-aloud task over a period of 3 weeks in March 2007. Biographical information about the participant was obtained by means of an unstructured interview, which took place immediately after the recording of the text-reading task.

In order to collect the free-speech samples, the researcher asked the participant and his tutor for permission to record three private lessons. A tape recorder was provided to the participant, who was responsible for turning it on once lessons started and turning it off when the lessons were finished. The initial five minutes of each lesson were excluded from the analysis, as well as any segment in which the tutor required the participant to read texts aloud. Thus, the three sessions generated about 80 minutes of free-speech data. Only the speech produced by the participant was transcribed, which was done using regular spelling.

One week after collecting the free-speech data, the researcher asked the participant to record the text-reading-aloud task. The text was taken from a website advertising speed reading software (retrieved from http://www.readingsoft.com/, April, 2007). In order to facilitate the reading task, the text was printed in 15 point fonts and double spaced. The participant read the text first for meaning in order to minimize misreading and to help him feel more comfortable completing the task. During the first reading, the participant was allowed to use his dictionary to check the meanings of unfamiliar words. The next step was to ask the participant to record his reading aloud of the text by using an MP4 device, equipped with a wearable head-set microphone.

Once the data were collected, the researcher transcribed the singleton word-final consonants in all CVC words, taking note of the phonological environment immediately following the target word-final consonants (pause, vowel, voiced or voiceless consonant). When a word containing the target sound was misread in the reading test, it was excluded. This happened twice: once with the word *screen*, pronounced as *scream*, and once with the word *time*, pronounced as *tine*. The decision to exclude these words was based on the fact that Brazilians do not substitute /m/ for /n/, or vice-versa when producing English words. These productions were probably due to the similarity between the graphemes "m" and "n", which can easily be confused in reading.

As the consonants /s/, /z/, and /ŋ/ proved to be difficult to transcribe, an educated native speaker of English was hired to help the researcher determine the correct transcription for these sounds. In the free-speech data the two listeners could not agree on the correct transcription in several cases, and these tokens were excluded from the analysis.

2.3 Data analysis

In order to analyze the dataset, the framework proposed by Zimmer (2004) was adapted. In her study, Zimmer identified nine non-target phonological processes employed by Brazilians when performing a reading-aloud task with English words, namely: (a) syllable simplification (paragoge and deletion), (b) consonant change, (c) deaspiration, (d) terminal devoicing, (e) delateralization and rounding of final /l/, (f) vocalization of final /m/ and /n/, (g) velar consonant paragoge, (h) vowel assimilation, and (i) interconsonantal epenthesis.

As the focus of the present research was on the production of singleton word-final consonants, processes (c), (h), and (i) were not relevant to the analysis because they address the production of consonants in onset or syllable-final position, as well as vowel sounds. The remaining processes, however, as well as how they were adapted for use with free speech-data, are explained in what follows.

Zimmer used the category *syllable simplification* to refer to word-final consonants that were produced with the addition of a paragogic vowel (e.g., *fog* [fɔgi]), resulting in the creation of an additional open syllable. In this study, the same term was also applied to cases in which the target consonants were deleted (e.g., *fog* [fɔ]), thus reducing the number of sounds constituting the syllable. To mark this difference, however, a distinction was made between *syllable simplification – paragoge* and *syllable simplification – deletion*.

The *consonant change* process occurred when the participant preserved the original syllable structure but replaced the target consonant with another – for instance, when a word such as *page* was produced as [pejʒ]. The present study adopted this category as originally proposed by Zimmer (2004).

What Zimmer (2004) called the *terminal devoicing* process involves producing voiced consonants, especially the plosives /b/, /d/, and /g/, as their voiceless counterparts. This category had to be adapted for the present study because preliminary analysis of the present study's dataset, in addition to results presented in Silveira (2004), indicate that some voiceless consonants can be produced as voiced sounds as well. This is particularly true in the case of /s/ and /v/, generally as a result of the application of L1 spelling-sound correspondence to the pronunciation of L2 words. Thus, for the present study, this category was identified as *voice change* in order to encompass both voicing and devoicing processes.

Delateralization and rounding of final /l/ is a nearly canonical process in BP[8] resulting in the production of words such as *mel* 'honey' as [mɛw]. Similarly, the *vocalization of /m/ and /n/* is also a canonical process in BP, so that words like *sem* 'without' are realized as [sẽj̃] and *som* 'sound' as [sow̃]. Zimmer (2004) proposed that this process occurs only with the bilabial and with the alveolar nasal. However, the participant in the present study sometimes produced the velar nasal /ŋ/ by applying the vocalization process, thus producing the word *sing* [sɪŋ] as [s̃] ([sɪ̃]). Therefore, in the present study, this category will be renamed as *vocalization of nasals*.

Finally, the *velar paragoge* process involves producing words like 'sing' as [sɪŋg], that is, the speaker inserts the velar stop /g/ immediately after the velar nasal. This process

[8] As pointed out by Tasca (2002), only the older generation in some areas of Rio Grande do Sul and Santa Catarina still produce the dark [ɬ] in word-final position.

has been found to be common in the pronunciation of Brazilian speakers (Zimmer, 2004)[9]. Part of the difficulty that Brazilians face may be due to orthography, since in BP the sequence "ng" is often recoded as /ŋg/. In English, however, the sequence "ng" may be pronounced as [ŋg] or [ŋ], as illustrated by the words *finger* [fɪŋgər] and *singer* [sɪŋər]. It is important to draw attention to the fact that some Brazilian learners of English may also add an epenthetic vowel after the epenthetic velar stop, thus producing *sing* as [ˈsɪŋ.gɪ]. Whenever this happened in the dataset for the present study, the token was classified under both *velar paragoge* and *syllable simplification – paragoge*.

To summarize the framework of analysis, Table 1 displays the phonetic production processes used to classify the data in this study, as well as the consonant sounds that are likely to be produced according to these processes.

Table 1. Summary of phonetic production processes and relevant consonant sounds

Processes	**Consonants**
Syllable simplification (SSP or SSD)	All consonants being tested
Consonant change (CC)	All consonants being tested
Voicing change (VC)	/p, b, t, d, k, g, f, v, s, z, θ, ð, ʃ, tʃ, dʒ/
Delateralization and rounding of final /l/ (DRL)	/l/
Vocalization of nasals (VN)	/m, n, ŋ/
Velar stop paragoge (VSP)	/ŋ/

The study was originally intended to include the following consonants: /p, b, t, d, k, g, f, v, ʃ, ʒ, s, z, θ, ð, m, n, ŋ, dʒ, tʃ, l/. However, once the data were transcribed, the sounds /ð/ and /ʒ/ were excluded due to their lack of occurrence in word-final position. These consonants are indeed rare in word-final position in English, and neither the free speech data nor the reading-aloud data contained any tokens with these sounds in this context.

Numerous studies investigating the production of English word-final consonants by Brazilians have excluded the alveolar fricatives /s/ and /z/, since they also occur in BP. Nevertheless, the alveolar fricatives were analyzed in this study due to the fact that in BP these consonants are subject to a phonological process in coda position. Thus, the alveolar fricatives are represented by the archiphoneme /S/ and may be produced as voiced or voiceless consonants, depending on whether the following sound is voiced or voiceless (e.g., *pasta* 'folder' [ˈpasta]; *desde* 'since' [ˈdezde]; Cristófaro-Silva, 2002). In word-final position, the voicing rule also applies (e.g., *dez nomes* [dɛz̲ nomes]; *dez carros* [dɛs̲ kaχos])[10]. Moreover, when followed by a pause, the graphemes "z" and "s" are both realized as [s]. Zimmer (2004) points out that Brazilians tend to transfer this phonological process into the L2 extensively, a claim that is supported by my experience as an EFL learner and instructor.

The following section presents the results of this study, first in terms of the frequency of the seven phonological processes under investigation here and then by focusing on each of the twelve consonants. These analyses are expected to help answer the central research questions posed in this study: What is the effect of orthography on the production of singleton word-final consonants in a reading task and a speaking task?

[9] Note that some non-standard dialects in the USA and UK allow for the production of a velar stop following the nasal, such as in [sɪŋg] and [sɪŋgər]. This is the case of the New York City dialect (Pennington, 1996).

[10] In some BP dialects, these sounds may be realized as [ʃ] and [ʒ], but this was not the case in the dialect spoken by the participant. Nevertheless, in those dialect in which palatalization occurs, the assimilation rule also applies.

3. Results and discussion

This section begins by presenting and discussing the results by phonological process, which facilitates comparison of the results of the present study with those obtained by Zimmer (2004). The second subsection analyzes the data by type of consonant, which makes it possible to discuss the extent to which orthography may have influenced the production of singleton word-final consonants.

3.1 Results by phonological process

As the framework of analysis adopted here is based on that of Zimmer (2004), it is important to compare the findings of the present study to her results. Table 2 shows (a) the number of times that the participant used each process, (b) the number of words the participant could have used each process, and (c) the frequency rate of usage for each process, both for the reading and the speaking data (see Table 1 for explanation of abbreviations).

Table 2. Process frequencies for the speaking and reading tasks

	Speaking Test			**Reading Test**		
Process	Words	Usage Rate		Words	Usage Rate	
SSP	1107	10	(.90%)	293	1	(.3%)
SSD	1107	1	(.09%)	293	0	(0%)
CC	1107	0	(0%)	293	10	(3.41%)
VC	680	99	(14.55%)	124	30	(24.19%)
VN	361	15	(4.15%)	91	26	(28.57%)
DLR	91	91	(100%)	13	7	(53.84%)
VSE	73	17	(23.28%)	43	0	(0%)

Note: The percentages were obtained by dividing the number of times the process occurred by the number of times the process could have occurred and then multiplied by 100.

The results indicate that, in the speaking task, the most frequent process was Delateralization and Rounding of /l/ (100%), followed by Velar Stop Paragoge (23.28%), and Voicing Change (14.55%). By contrast, Consonant Change and Syllable Simplification - Deletion were rarely or never found in this speaker's speech sample. The rare occurrence of Deletion agrees with Young-Scholten and Archibald's (2000) claim that this process is very infrequent in the speech of L2 learners, and Baptista and Silva-Filho (1997) in turn corroborated this for Brazilian learners of English. As for Consonant Change, Silveira (2004) reported a reasonable frequency in the data produced by Brazilian learners, but her study relied on a reading task only and included only beginners as participants. These differences in methodology could account for variation between the results obtained at that time and the speaking data reported in this study.

For the reading data, Delateralization and rounding of /l/ was again the most frequent process (53.84%), followed by Vocalization of Nasals (28.57%), and Voicing Change (24.19%). The results also indicate that Syllable Simplification – Paragoge/Deletion (0.3% and 0%, respectively) and Velar Stop Paragoge (0%) were rarely or never found in the reading-aloud task. As for Consonant Change, the participant employed this process in 3.41% of the cases in the reading task, thus adding support to previous studies (e.g., Silveira, 2004) that have shown this process to be relatively common in reading tasks performed by BP speakers.

Table 3 compares these results to those obtained by Zimmer (2004). The table includes Zimmer's overall frequencies, as well as those for beginners only, alongside the frequencies for the reading and speaking tasks in the present study. Note that certain

percentages in Table 3 differ from the ones shown in Table 2 because, for comparisons, the categories of Syllable Simplification, Terminal Devoicing, and Vocalization of /n/ and /m/ are treated here as originally proposed by Zimmer (2004).

Table 3. Non-target phonological processes and their frequencies in Zimmer's (2004) study

Phonological Process	Zimmer		Present study	
	Overall	Beginners	Reading	Speaking
Word-final schwa paragoge	6.10%	13.5%	0.30%	0.90%
Terminal devoicing*	21.50%	22.9%	47.91%	23.12%
Consonant change	8.40%	13.3%	3.41%	0%
Delateralization and rounding of /l/	77.40%	89.7%	53.80%	100%
Vocalization of final /m/ and /n/vowel assimilation**	12.00%	19.3%	.06%	4.20%
Velar Stop Paragoge	89.70%	88.0%	0%	23.30%

* Note that only the data for devoicing were used here, in order to allow comparison with Zimmer's results.
** Note that only the results for /m/ and /n/ were used here, in order to allow comparison with Zimmer's results.

Comparing Zimmer's (2004) results for all proficiency levels and those for beginners only, with those obtained for the speaking task in the present study, we can see that the same three processes occupy the first three positions: Delateralization and Rounding of /l/, Terminal Devoicing, and Velar Stop Paragoge. Nevertheless, the positions occupied by each process are slightly different. The main differences lie in which processes occupy the first and second ranks. In Zimmer's data, for all proficiency levels combined, Velar Stop Paragoge was the most frequent process, followed by Delateralization and Rounding of /l/. For beginners, the result was reverse. In the present study, the ranking for the speaking task matches Zimmer's findings for beginners', i.e., Delateralization and Rounding of /l/ was the most frequently occurring process, followed by Velar Stop Paragoge, and Terminal Devoicing. Regarding the reading data collected in the present study, Delateralization continued to be the most frequent, but the second rank was occupied by Terminal Devoicing and the third by Consonant Change. Finally, one very different result obtained for this task was the non-occurrence of Velar Stop Paragoge, which was among the two most frequently occurring processes both in Zimmer and in the speaking data from the present study. A possible explanation for this difference is offered in section 4.2.

3.2 Results by consonant

Table 4 displays the results by consonants for the speaking task. As the table shows, several consonants were produced in target-like fashion in all cases, namely: /m/, /b/, /p/, /f/, /r/, /ʃ/, /tʃ/, and /dʒ/. Note that these sounds have been previously reported to cause pronunciation difficulties for Brazilians (e.g., Silveira, 2004), but that some of these difficulties (/tʃ, dʒ, r/) are greater for speakers of certain BP dialects than for others. For instance, the consonant /r/ is particularly difficult for learners whose Portuguese dialect involves pronouncing the letter "r" as a velar fricative [χ]. Such individuals are likely to produce words such as *car* and *rose* as [kaχ] and [χowz]. Nevertheless, the participant in the present study demonstrated no difficulty in producing /r/, probably because in his BP dialect, which is spoken in São Paulo city, the grapheme "r", in word-final position, tends to be produced as a retroflex /ɾ/ rather than the velar fricative, which is the most common realization in other BP dialects (Cristófaro-Silva, 2002).

Table 4. Speaking-test data by target consonant

	m	n	ŋ	t	d	b	p	k	f	v	s	z	l	r	ʃ	tʃ	dʒ	θ	total
grand total	**83**	**205**	**73**	**190**	**75**	**3**	**7**	**31**	**13**	**69**	**118**	**144**	**91**	**92**	**13**	**12**	**3**	**14**	**1236**
SSP	0	0	0	1	2	0	0	7	0	0	0	0	0	0	0	0	0	0	10
SSDl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VC				0	0	0	0	0	0	39	31	29			0	0	0	0	99
DLR													91					0	91
VN	0	2	13																15
VSE			17																17
partial total	**0**	**2**	**30**	**1**	**2**	**0**	**0**	**7**	**0**	**39**	**31**	**29**	**91**	**0**	**0**	**0**	**0**	**1**	**233**

As previous studies have shown (Major, 1987; Baptista & Silva-Filho, 1997; Silveira, 2004; Zimmer, 2004), word-final vowel paragoge is likely to occur with all final consonants in the speech of Brazilian learners of English, especially in the early stages of acquisition. As Table 4 shows, however, only three oral stop consonants triggered this process – /t, d, k/ – with the highest frequency being found for the velar stop /k/ (70%)[11]. Yavas (1997) had already proposed that the velar stop is more prone to syllable simplification, due to markedness, and Baptista and Silva-Filho (1997) and Silveira (2004) provided empirical data to corroborate this proposal. Another possible explanation might be attributed to the fact that six out of the ten words produced with the paragogic vowel are cognates (e.g., *romantic* 'romântico', *public* 'público'). As Silveira (2004) proposed, word frequency seems to play an important role in the production of word-final consonants, since the learner's previous L1 experience with these cognate words might have led him to resort to a paragogic vowel.

As previous studies have shown (e.g., Baptista & Silva-Filho, 1997), deletion is not a common syllable simplification process in the speech of Brazilian learners of English, nor of other L2 learners (Young-Scholten & Archibald, 2000). The study participant employed this process only once in the speaking task. This happened with the sound /θ/, which is not part of the PB consonantal inventory, thus causing articulatory difficulties for Brazilian learners, who often replace it with /t/, /s/ or even /f/.

Another interesting result displayed in Table 4 is the frequent occurrence of Voicing Change. The interphonology literature has widely investigated terminal devoicing (Yavas, 1994, 1997; Major, 1987), but the results reported here show that terminal voicing is also possible. In this dataset, three sounds led to Voicing Change: /f/, /s/, and /z/. In the case of /f/, voicing took place on a single word: the preposition *of*, whose pronunciation is really an exception, since the "f" grapheme should be recoded as [v]. Although this preposition is among the most frequent words in English, Brazilian learner tend to pronounce it as [əf] or even [ɔf], realizations that show obvious influence of orthography.

The case of /s/ and /z/ is much more complex, since it is not restricted to a single word. As Cristófaro-Silva (2002) observes, in BP the alveolar fricatives are realized as voiced or voiceless consonants, depending on whether the following sound is voiced or voiceless (e.g., *pasta* 'folder' [ˈpasta]; *desde* 'since' [ˈdezde]. When followed by a pause, both the "z" and "s" graphemes are realized as [s]. Note that the "s" grapheme may be recoded either as /s/ or /z/ in PB, but that when the preceding and following sounds are vowels, it is always realized as [z] (*asa* 'wing' [ˈazɐ]). This lengthy explanation about the allophonic variation of /s/ and /z/ can help us to understand some of the findings of the present study.

[11] All percentages reported in this section were calculate by dividing the number of times the process was employed with a specific consonant, by the number of times that particular process was used.

Table 4 shows that the participant voiced the fricative /s/ 31 times out of 118 possibilities (26.3%). This happened with high frequency words such as *yes*, *this*, and *house*. On the other hand, the participant devoiced /z/ in 29 out of 144 words (20.1%). This process was employed with words such as 'is' and 'was', as well as with the –s morpheme (*companies*). A closer look at the dataset shows that the participant was relying heavily on his knowledge of the L1 grapho-phonic-phonological correspondence and phonotactic rules to produce words ending in alveolar fricatives. Thus, the participant produced the word *this* either as [θɪs] or [θiz], depending on the phonological environment following the sound. Conversely, the word *house* was produced as [hawz] because the "s" grapheme in this word is preceded and followed by vowel graphemes. Again, word-frequency was insufficient to override the transfer of L1 grapho-phonic-phonological knowledge, as well as phonotactic rules to pronounce L2 words, since the transfer process was applied to frequent English words such as *this* and *house*. Note that the participant never voiced /s/ when the word-final consonant was spelled with "ss" (e.g., *grass*) or "ce" (e.g., *experience*), which is in perfect agreement with the L1 sound-spelling correspondence.

Turning to the Delateralization and rounding of /l/, the results shown in Table 4 indicate that the participant applied this process 100% of the time in the speaking task, suggesting that, while speaking, the participant was relying on this canonical BP process to realize words ending in /l/. As this task offered no orthographic input, we can hypothesize that the participant's previous contact with the L2 words and their spelling, added to the fact that some of the produced words were also cognates, might have influenced the results. As proposed by Young-Scholten and Archibald (2000), adult learners in a foreign language learning context have constantly exposed to written input. Thus, these participants are expected to have orthographic representations for the words that they have already learned, and they are likely to rely on these orthographic representations to pronounce these words, even when the task does not provide them with orthographic input.

Vocalization of Nasals is a canonical process in BP; however, the results show that while speaking English the participant vocalized /ŋ/ 17.8% of the time. At the same time, /n/ was hardly ever vocalized (.09%), whereas /m/ was always produced in a target-like fashion. One possible explanation for this result might lie in the fact that the velar nasal /ŋ/ is more marked than the other nasals (Yavas, 1997), thus making it harder for the participant to produce it without relying on an L1 phonological process. It is important to mention that in BP the graphemes "m" and more rarely "n" can appear in word-final position, but this is not the case for the sequence "ng" which only appears in loan words (e.g., *ping-pong*) in word-fianl position, or in syllable-final position ("sangue" *blood* [sãŋgi]. As explained above, in the L1, Brazilians recode word-final "m" and "n" by vocalizing the preceding vowel and realizing it as a diphthong, while the sequence "ng" is realized as [ŋgi]. The results show that the participant has managed to suppress the Vocalization process when producing words ending in /m/ and /n/, but that he still struggles with the pronunciation of word-final /ŋ/, thus (a) producing it in a target-like fashion 58.9% of the time, (b) relying on the L1 sound-spelling correspondence and adding the paragogic /g/ 23.3% of the time, and (c) applying the Vocalization process 17.8% of the time. The result in (c) might be related to the presence of the grapheme "n" in the sequence "ng".

The production of /ŋ/ clearly illustrates that transfer is not a process that ceases once a particular L2 item or structure is acquired (Gass & Selinker, 1983). Rather, as proposed by Koda (2007), a more reasonable view regards transfer in L2 acquisition as a continuum that might be more or less recurrent depending on the combinations of several factors, such as proficiency level, previous experience, task-type, and specific language items and structures.

Turning to the results for the reading task, Table 5 shows that the Syllable Simplification processes involving inserting a paragogic vowel after the word-final consonant or deleting it was rarely employed (0.34%) again. Consonant Change was much more

frequent in this task (3.07%), and it was employed most of the time with the velar nasal (88.8%), which was pronounced as the alveolar nasal (e.g., *reading* [ˈridɪn]). This supported the hypothesis, proposed above, that the participant tended to recode the sequence "ng" as "n", thus accounting for the results in the speaking test, in which /ŋ/ was frequently vocalized. The other case of Consonant Change took place with /θ/, which was replaced by /t/, thus corroborating previous findings regarding Brazilian learners of English.

Still focusing on the velar nasal, the results indicated that the Vocalization process was again recurrent (60.4%), whereas the Velar Stop Paragoge process was not employed at all. Regarding the other nasals, the results indicated that, in the reading test, the alveolar nasal was always produced in target-like fashion, and that the bilabial nasal was deleted once, probably due to misreading. These results confirmed the hypothesis that this participant seemed to have acquired the pronunciation of English word-final /m/ and /n/, but was still struggling with /ŋ/.

Table 5. Reading-test data by target consonant

	m	n	ŋ	t	p	k	f	v	s	z	r	l	tʃ	dʒ	θ	total
grand total	**7**	**41**	**43**	**18**	**5**	**10**	**4**	**20**	**24**	**20**	**65**	**13**	**8**	**8**	**7**	**293**
SSP	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
SSDl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CC	1	0	8	0	0	0	0	0	0	0	0	0	0	0	1	10
VC				0	0	0	0	11	7	12	0	0	0	0	0	30
DLR												7				7
VN	0	0	26													26
VSE			0													0
partial total	**1**	**0**	**34**	**0**	**0**	**0**	**0**	**11**	**8**	**12**	**0**	**7**	**0**	**0**	**1**	**74**

Voicing Change proved to be a powerful process, and was applied to the same consonants in the reading task: /v/, /s/, and /z/. Here the results mirrored what was found for the speaking data, with the word *of* being responsible for all the cases of devoicing of /f/ and highly frequent words and the –s morpheme being responsible for the cases of voicing of /s/ and devoicing of /z/.

One finding that was slightly different for the reading data as compared to the speaking data involved the Delateralization and Rounding of /l/. In the reading task the participant relied heavily on this process (53.8%), but not as often as he did in the speaking task (100%). One possible interpretation is that, as Dickerson (1975) proposed, task-type may have played a role in these results, with the more formal task (reading-task) leading to more accurate production, since this type of task provides participants with planning time.

4. Final remarks

The results reported in the previous section suggest a strong effect of L1/L2 grapho-phonic-phonological transfer while indicating that the pronunciation of some word-final consonants is more commonly affected by orthography than others. Another important finding is that several factors seemed to affect the production of these consonants. These factors included the following: (a) previous experience with words in terms of orthographic knowledge; (b) L1 spelling-sound correspondence; (c) cognate words; (d) words that have irregular pronunciation; (e) L1 phonotactic rules, and (f) task-type.

As the results reported here are based on data collected from a single participant, further research should investigate the extent to which these results may be due to individual learners' characteristics. Thus, this study should be replicated with a larger sample, perhaps one that includes learners with different proficiency levels or who have been extensively exposed to English in non-instructional settings.

A further implication of the results reported here is that explicit pronunciation instruction might be useful in raising awareness about particular sounds and about the inappropriate transfer of L1 processes, especially for /l/, /k/, /ŋ/, /s/ and /z/ and exception words such as *of*. Furthermore, researchers should take into account task-type effects, more specifically, the more pronounced effects of orthography in reading tasks, when collecting interphonology data.

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