

# The Optimization of Codas via Onset-Nucleus Sharing: Evidence from a Developing Second Language System\*

Walcir Cardoso

(Concordia University & Centre for the Study of Learning and Performance)

**Cardoso, Walcir. (2008). The Optimization of Codas via Onset-Nucleus Sharing: Evidence from a Developing Second Language System. *Language Research* 44.2, 319-344.**

Using sociolinguistic methodology for data collection and analysis, this study investigates the variable development of English word-final voiceless stops (codas) by Brazilian Portuguese (BP) speakers. In particular, based on phonetic evidence and along the lines of Goad (2002), the study provides evidence for an intermediate developmental stage in the acquisition of English codas by BP speakers, characterized by the phenomenon of Onset-Nucleus Sharing (ONS). Under this analysis to the syllabification of syllable-final consonants, it is assumed that the potential coda (C) syllabifies as an onset (O) and, in order to be licensed, some of its features spread into the following empty nucleus (N) in order to optimize the syllable shape of the emerging grammar (i.e., to render a highly marked ONC syllable – e.g., [ʃɪp] – into a relatively less marked ON.ON structure – e.g., [ʃɪ.p<sup>h</sup>]).

**Keywords:** onset-nucleus sharing, syllabification of word-final stops, Brazilian Portuguese-English interphonology, codas in interlanguage, variationist second language acquisition

## 1. Introduction

The development of word-final English stops (codas) by Brazilian Portuguese (BP) speakers is characterized by three distinct stages: (1) i-Epenthesis,

---

\* Lots of “obrigados” to the people who have contributed to this research project. I would like to start by thanking Graça and Gilberto (from Beverly Curso de Idiomas), and Renata and Paulo (from Yáziqi Internexus) for allowing me to recruit students in their classrooms and use their facilities to conduct the study reported in this paper. I am also grateful to my research assistants Malik Boudaoud, Claudia Escartin, and Paul John, who helped me in the transcription and analysis of the data. For their insightful comments, criticisms and suggestions, special thanks also go to three anonymous reviewers as well as to the audiences of the conferences where preliminary versions of this study were presented: The Second Language Research Forum (SLRF 2004) and the Conference on Generative Approaches to Language Acquisition North America (GALANA 2). Finally, I would like to acknowledge funding from two Canadian granting agencies: Fonds québécois de la recherche sur la société et la culture grant (FQRSC NC-96880) and the Canadian Social Sciences and Humanities Research Council (SSHRC 410-2006-1920).

an early phonological phenomenon in which the coda syllabifies as the onset of the epenthetic vowel [i] (e.g., do/g/ → do.g[i]; Cardoso 2005, 2007), and which results from the direct interference of BP phonology; (2) Stop Devoicing (e.g., do/g/ → do[k]; Major 1986a), a developmental process that is also found in the first language (L1) acquisition of English and across languages; and (3) native-like Coda Production (e.g., do/g/ → do[g]), the final stage in the acquisition of this syllable constituent. Based on phonetic evidence and along the lines of Goad (2002), Goad and Brannen (2003), and Goad and H-S Kang (2003), we provide evidence for another developmental stage in the acquisition of English codas: Onset-Nucleus sharing (ONS henceforth). Under this approach to the syllabification of word-final consonants, it is assumed that the potential coda syllabifies as an onset and, in order to be licensed, some of its features spread into the following empty nucleus in order to optimize the syllable shape of the intermediate grammars that characterize the interlanguage of these learners. This analysis reflects a minimal change from an L1 grammar that permits only CV syllables (i.e., BP), while still being faithful to the English input CVC melodic string, as illustrated in the representation for “ship” [ʃɪp<sup>h</sup>] in Figure 1.

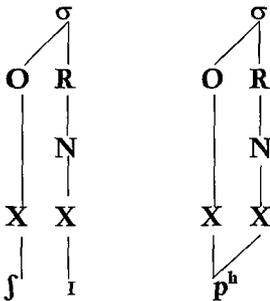


Figure 1. Onset-Nucleus Sharing in interlanguage.

Note:  $\sigma$  = Syllable, O = Onset, R = Rhyme, N = Nucleus, X = A unit of time (skeleton)

More generally, this investigation focuses on the variable syllabification of word-final voiceless stops (i.e., /p/, /t/ and /k/, to which we will also refer as codas) in BP-based learner speech (to which we will occasionally refer as “Brazilian Portuguese-based English Interlanguage” – BPEI), in the context of data collected in a cross-sectional study involving 60 BP speakers learning English in a classroom environment.<sup>1</sup> The results of the statistical analysis

<sup>1</sup> Note that the term “Brazilian Portuguese-based English Interlanguage” is conceptually inadequate to refer to one specific variety of Brazilian Portuguese (that spoken in Belém), as there are many regional varieties of the language. However, for ease of exposition, we will employ the term and its acronym BPEI as a cover term to refer to the variety of interlanguage that characterizes the speech of English learners from the city of Belém,

(conducted using VARBRUL 2, Pintzuk 1988) indicate that i-epenthesis is favored in the speech of beginners, in less formal stylistic environments and in the context of labial or dorsal segments, while codas are more likely to surface as such in more advanced proficiency levels, when more careful attention is paid to speech (Formal), and when the consonant in question is the coronal/t/. ONS, on the other hand, is more likely to occur in intermediate stages of acquisition, with an increase and then decrease in frequency as the level of proficiency increases, in more formal stylistic environments (just like codas), and when the potential coda's place of articulation is dorsal [k] or labial [p] (just like i-epenthesis). In general, these results conform to the predictions of Major's (2001) Ontogeny Phylogeny Model for second language acquisition, and support the view that formal speech interactions require more faithful (i.e., target-like) forms (e.g., Labov 1966, Oostendorp 1997). As regards the effect of place of articulation, the results corroborate the relative markedness of labials and dorsals (vis-à-vis coronals) in coda position (e.g., Prince & Smolensky 1993).

The main objectives of this study are: (1) Following a sociolinguistic (variationist) methodology for data collection, to investigate the variable development of English (L2) word-final voiceless stops /p t k/ by Brazilian Portuguese speakers learning English in a classroom environment; and (2) Along the lines of Goad (2002) and Goad and H-S Kang (2003), to provide evidence for an intermediate stage in the acquisition of these codas by Brazilian ESL learners: Onset-Nucleus Sharing.

The paper is organized as follows: in section 2, we provide an introduction to codas in Brazilian Portuguese and in BP-based interlanguage, and describe the relevant initial and subsequent states in the phonology of these learners, with a focus on ONS as an interlanguage phenomenon. The third section addresses the data collection procedures, and introduces the statistical package used in the analysis (VARBRUL 2). Section 4 presents and discusses the quantitative results obtained. Finally, in section 5, we present our concluding remarks for the study.

## 2. Background

### 2.1. Word-final Stops in Portuguese-based English Interlanguage and the Initial State

In Brazilian Portuguese, only four consonants can potentially appear in coda position (Barbosa 1996, Cardoso 1999): /l N r s/. However, /l/ and /N/

(an underspecified nasal consonant) never surface as codas in most varieties of BP, triggering either diphthongization in the case of /l/, or the nasalization of the preceding vowel in the case of /N/ (see (1a) below, where “.” indicates syllable boundaries). /r/ and /s/, on the other hand, are the only consonants that syllabify as codas in the language. Word-finally, however, these two phonemes may variably undergo deletion in informal styles, as illustrated in (1b). For a variable investigation of /r/-deletion in the same variety of Portuguese under investigation, see Cardoso (1999).

(1) Codas in BP

a. Consonants that do not surface as codas

/l/:	/brazil/	→	[bra.zi.w]	‘Brazil’	(cf. [bra.zi.lej.ru] ‘Brazilian’)
	/papel/	→	[pa.pew]	‘paper’	(cf. [pa.pe.la.da] ‘paperwork’)
/N/:	/boN/	→	[bõ]	‘good’	(cf. [bõ.ɲa.jãw] ‘good person’)
	/be.leN/	→	[be.lẽj]	‘Belém’	(cf. [be.le.ɲẽ.si] ‘person from Belém’)

b. Consonants that variably surface as codas<sup>2</sup>

/r/:	/dor/	→	[dor]	~	[do_]	‘pain’
	/falar/	→	[fa.lar]	~	[fa.la_]	‘to speak’
/s/:	/kazas/	→	[ka.zas]	~	[ka.za_]	‘houses’
	/lapis/	→	[la.pis]	~	[la.pi_]	‘pencil’

If the syllable-final consonant is an obstruent stop (i.e., [p, t, k, b, d, g]), BP opts for the syllabification of the illicit segment as the onset of the default epenthetic vowel in the language: [i] – i-epenthesis henceforth. This applies to both native (2a) and loan words (2b), as illustrated below.

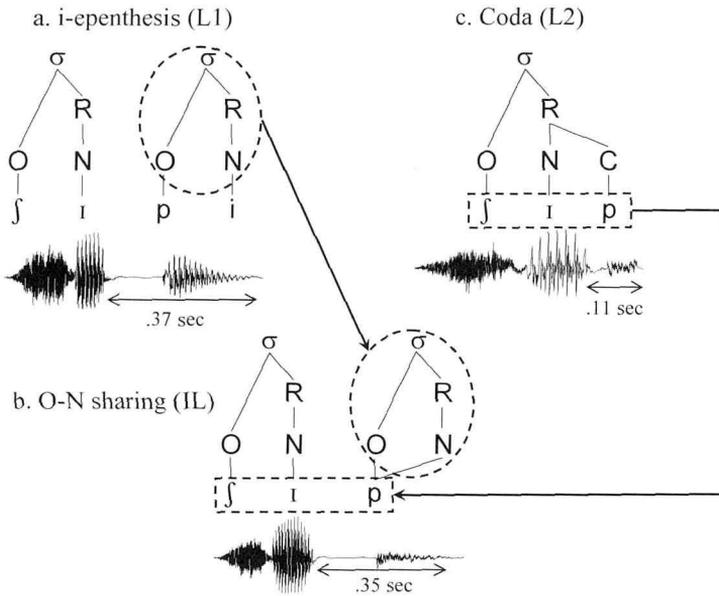
(2) i-epenthesis in BP

a. BP native words:	/sub+ɟugar/	→	[su.bi.ɟu.gar]	‘to subjagate’
			(cf. [su.bes.tʃi.mar]	‘to underestimate’)
b. Loan words:	/hat dag/	→	[hət̚[i] dɔgi]	‘hot dog’
	/kejk/	→	[kej.ki]	‘cake’

Assuming the standard view in the generative second language literature that the initial state for L2 acquisition coincides with the final state of the L1

<sup>2</sup> We are not considering the geographical and stylistic variables that condition the realization of /r/. This consonant may be realized in BP as the following: [r h χ x fi ʁ]. For ease of exposition, we ignore the different phones for /r/ in the transcriptions. The realization of /s/ is also geographically variable in coda position: [s] ~ [ʃ] and their phonetic variants [z] ~ [ʒ] preceding a voiced consonant. Unlike r-deletion, s-deletion is stigmatized in BP.

grammar (e.g., Archibald 1993, Broselow & Finer 1991, Davidson et al. 2004, Hancin-Bhatt & Bhatt 1998, Pater 1997, inter alia), we assume that the initial grammar of the English learner will directly reflect the phonology of BP, and will therefore constitute a transitory system in which i-epenthesis will categorically operate in order to syllabify illicit word-final voiceless stops. In subsequent stages during the acquisition of English codas, however, voiceless stops syllabify variably via one of the following variants: (1) i-epenthesis, which, as described above, directly mirrors the phonology of the L1 (see (a) in Figure 2); (2) onset-nucleus sharing, a developmental stage in which the potential coda syllabifies as both onset and nucleus (see (b) and forthcoming section); and (3) syllabification via coda licensing, the target-like English form illustrated in (c) in Figure 2 (the waveforms are for illustrative and comparison purposes). Note that the term “coda” encompasses the two variants involved in the coda production of stops in word-final position in English: Its overt release (illustrated in (c) in Figure 2), and its unreleased counterpart, not illustrated but with similar timing properties as released codas (i.e., it occupies a single timing slot).



**Figure 2.** Word-final stops in interlanguage: Syllabification via i-epenthesis, ONS and Coda.

## 2.2. The Subsequent States: Onset-Nucleus Sharing and Target-like Coda Production

Let us now concentrate on the syllabification of word-final stops via ONS, a phenomenon described and formalized by Goad (2002) and adopted later in Goad and Brannen (2003), and in Goad and H-S Kang (2003). As illustrated in Figure 1 and in item (b) in Figure 2, under this approach to the syllabification of word-final consonants, it is assumed that the illicit constituent syllabifies as an onset. Because segments must be licensed by a head constituent within the syllable domain (e.g., a nucleus), some of the onset's features (e.g., the laryngeal feature *spread glottis*) spread into the following empty nucleus via a "homorganic burst of noise" (Goad & Brennan 2003: 13, as illustrated in (b) in Figure 2), sometimes with an undistinguishable vowel quality.<sup>3</sup> In the context of the monosyllabic (and consequently stressed) words considered in the study (see forthcoming section 3 for a description of the data collection procedures), the phenomenon is characterized phonetically by aspiration and consequential lengthening of the voiceless stop segment.<sup>4</sup> ONS could then be interpreted as a type of vowel deletion followed by a remedial compensatory lengthening (or feature *epenthesis* – Bernhardt & Stemberger 1998: 378) in which the developing grammar reflects the CV structure of the L1, while attempting to emulate the input CVC melodic structure of the L2 English, as shown in (b) in Figure 2. Accordingly, the ONS representation for the aspiration found in word-final codas in BPEI is in essence an instantiation of the emergence of the unmarked (TETU: the emergence of a un unmarked form that is featured neither in the L1 nor in the L2, and which is triggered by general linguistic principles – universals; McCarthy & Prince 1994). ONS is not only unmarked because it optimizes the syllable shape in BPEI (ON.ON is less marked than ONC), but its application also renders the originally monosyllabic word into a less marked disyllabic structure (the enforcement of Word Minimality via disyllabicity has been observed across languages – e.g., McCarthy & Prince 1993, Ussishkin 2000, Zec 2005, in first language acquisi-

<sup>3</sup> This phenomenon has also been observed by Prator & Robinett (1972: 89): "Many students from abroad try to pronounce final consonants with a great deal of force. This may sound like aspiration [...]. The little puffs of air after /t/ and /k/ sound like extra syllables". The intuition behind this observation has led Goad and colleagues to propose ONS as a developmental phenomenon in first and second language acquisition.

<sup>4</sup> Note that this study involves the syllabification of word-final *voiceless* stops (codas) and, accordingly, an analysis of what happens with *voiced* codas is beyond the scope of the investigation. Briefly, in intermediate developmental stages that coincide with the emergence of ONS for voiceless stops, one observes two phonological phenomena affecting the surfacing of English L2 voiced codas: (1) stop devoicing (e.g., do/g/ → do[k] – also discussed in Major (1986a) and briefly alluded to at the outset of section 1), and (2) consonant lengthening (e.g., /dog/ → do[g:]), the latter possibly an instantiation of ONS for voiced stops (see also Goad & Brannen 2003).

tion – e.g. Tzakosta 2003, and in second language acquisition – e.g., Wang 1995, Broselow et al. 1998). Clearly, the ONS representation is not the most unmarked option available to the learner (the L1-based i-epenthesis option is), but it is a form that is melodically closer to that of the target language, and structurally closer to the L1. When the novel L2 system is not easily accessible to the learner (e.g., for perceptual, articulatory or maturational reasons), s/he still has the option of falling back on her/his innate linguistic knowledge (ONS) to accommodate the changes required for the development of the target L2 grammar.

The aspiration and lengthening associated with ONS were also attested via an ad hoc acoustic analysis conducted in *Praat* (Boersma & Weenink 2000) of the word “ship”, pronounced in careful and relatively slow speech rate (*Formal*; see forthcoming discussions in the next section) by 21 of the participants from the different levels of proficiency considered. We computed the duration and analyzed the waveforms of the voiceless stop from its outset to its completion via one of the variants considered in this study, namely i-epenthesis, ONS, and (released) coda. The results are illustrated in Figure 2, where we show that the average length of voiceless stop [p] plus epenthetic [i] was .37 seconds, closely corresponding to the average duration of the form in which ONS has occurred, i.e., .35 seconds. Codas, on the other hand, are the shortest of the three variants, with an average of .11 seconds in slow, careful speech. In the waveforms in Figure 2, the differences in the shape of the sound frequency for each variant’s content, especially those that distinguish vowel epenthesis from aspiration in (a) and (b) respectively, confirm that ONS, i-epenthesis and coda production are different entities in the grammar of these learners.

The data and discussion provided above allow us to formulate some general questions that we will attempt to answer in this study. Firstly, within a variationist approach to language study, how systematic is the variation observed in the development of English word-final voiceless stops in interlanguage? More specifically, how do the different phenomena observed in coda acquisition develop across proficiencies and how do they compare with those found in other languages and/or forms of language? Secondly, at what stage of proficiency is ONS acquired and when does the phenomenon develop into full codas? These questions will be addressed in the forthcoming section.

To summarize, during the acquisition of L2 English codas, the language learner progresses hypothetically from an initial state in which the grammar is merely a reflection of the L1 (i-epenthesis) to a full-fledged grammar that is strikingly analogous to that of the target language (coda production). This process, however, is mediated by a developmental phenomenon in the form of ONS, which combines features from both the L1 and the L2 in order to optimize the syllable shape of the emergent grammar, thus rendering a highly marked syllable structure ending in a coda (e.g., [ʃɪp]) into a relatively less

marked coda-less structure (e.g., [ʃi.p<sup>h</sup>]). In addition, the acquisition of codas is a variable process, one that reflects not only the phonology of the two languages involved, but also certain universal linguistic principles on syllable structure. In the following sections, we will show that variability in coda acquisition results from the interaction of both linguistic and extralinguistic factors as well as the influence of the two languages involved in the process.

### 3. Methodology

#### 3.1. Introduction to Variationist Sociolinguistic Methodology

The investigation adopts a variationist sociolinguistic (Labovian) methodology for data collection in order to obtain a reliable corpus of non-categorical data such as those encountered in developing languages. As is customary in variationist studies, the study also includes separate tasks to elicit distinct levels of formality in a stylistic hierarchy. Following the standard sociolinguistic view that “the individual doesn’t exist as a unit” because language is the property of the community (Labov’s answer to an interview question in Gordon 2006: 341), we assume in this study that these proficiencies constitute different speech communities and, consequently, that the patterns of inherent variable behavior within the individual (i.e., the participant) are similar to those encountered within the group (i.e., proficiency). For data and analyses that confirm this claim in a second language environment, see Bayley 1991; Regan 1996, 2004; Young 1991.

Even though variationist sociolinguistics and second language acquisition (e.g., psycholinguistic approaches) share basic assumptions about language representation and acquisition (e.g., a commitment to linguistic data and the use of multiple interacting factors to explain linguistic variation – see Ellis 2002), there has been very little interaction between these two linguistic fields (but see the volume organized by Bayley & Preston 1996, and Tarone 1983). One of the reasons why this is the case might be due to the irreconcilability of, on one hand, an approach that views language as part of a speech community (the variationist sociolinguistic view), and on the other hand, an approach that views language as part of the competence of individuals (the standard SLA/psycholinguistic view). As an anonymous reviewer pointed out, it is possible that no single individual is similar to what characterizes the group, a claim that invalidates in some respect one of the premises of the sociolinguistic enterprise, as noted above. It is beyond the scope of this paper to provide a solution to this conundrum and, as the same reviewer acknowledged, it is still an open and empirical question whether the individual (the L2 learner in our case) and its associated speech community share the same linguistic knowl-

edge (competence). Accordingly, there is still very little empirical evidence that this view is valid to describe interlanguages, given the recognized importance of individual variation in second language acquisition (e.g., Krashen 1988, Dewaele & Furnham 2000, and a variety of studies conducted in the 1970s, the “good language learner studies”, which aimed to identify the distinctive factors that make some learners more successful than others – e.g., Naiman et al 1975). In a recent study on the issue, however, Regan (2004) found similar patterns in individuals and their respective “L2 learning” communities in their acquisition of “*ne*” deletion in French, which led the author to conclude that “it is legitimate to apply group standards to individual speakers” (p. 335).

### 3.2. Data collection Procedures

The methodology for data elicitation was inspired by Labov’s (1966) seminal investigation of the pronunciation of (r) in coda position in three New York City department stores. Briefly, Labov attempted to elicit the phrase “fourth floor” from sales representatives by asking for the location of items found on the *fourth floor*. Whenever a response was provided, Labov would search for a more careful repetition of “fourth floor” by pretending not to hear the salesperson’s response. The study examined the effects of style (casual versus careful speech), social class (via the three department stores, each representing a specific socioeconomic clientele), and the position of the variable within the word (word-internally preceding a consonant versus word-finally preceding a pause). The current study followed a similar procedure for data elicitation, except that the target phrase “fourth floor” was replaced by codafinal words, elicited via a picture naming task consisting of 10 pictures representing words that end in one of the voiceless stops under investigation (e.g., shi[p], ca[t] and boo[k]; see forthcoming discussions regarding the concerns involved in the selection of the target words, and Appendix A for an illustration of the 10 pictures used). In the interview (to which we will occasionally refer as a picture-naming task), which was part of another larger study on the development of syllable structure in BPEI (reported in Cardoso 2005, 2007), participants were sporadically asked the question “What’s this?”. Mimicking Labov’s tactic, the interviewer pretended not to hear the participant’s response by using body language or asking questions such as “Can you say that again?”<sup>5</sup> For convenience and in the spirit of the variationist methodology

<sup>5</sup> In some occasions (e.g., the picture of a chair to elicit the word “sit”, or the picture of the back of a head to elicit the word “neck”), the participants did not produce the intended word in their first attempt. In these cases, the question “What’s this?” was replaced by more suitable questions such as “What do you do with this” (e.g., in the context of the picture of a “chair”), or by pointing at the relevant section of the picture (e.g., in the context of the picture of the back of a head to elicit the target word “neck”).

adopted, the first and more spontaneous utterance was coded as *informal* while the second, more careful response (in which more attention is paid to speech) was coded as *formal* (see Diaz-Campos 2006, Eckert & Rickford 2001, Escartin 2005, John 2006, Labov 1972 for similar approaches to defining style). Because the developing grammars of L2 learners are characterized by monostylism (Cardoso 2007), this picture-naming interview was an opportune and (we believe) effective way to elicit data from two distinct levels of formality.

The interviews were audio recorded via a Marantz CDR300 CD/RW Recorder and an Audio-Technica AT831b lavalier microphone, and later transcribed with the help of two research assistants and coded for VARBRUL 2 analysis (see forthcoming discussions).

### 3.3. Materials: The Selection of Pictures and Linguistic Factors

Motivated by the notion that certain prominent positions (e.g., stressed syllables) are more likely to maintain contrasts and thus less likely to undergo phonetic changes (e.g., Beckman 1998, Trubetzkoy 1939), the words selected for the picture-naming interview were all monosyllabic (and consequently stressed) to ensure that the codas under investigation occurred exclusively in positions of prominence. In addition, the selection of the words for inclusion in the study followed three other criteria: (1) The word had to end in one of the three voiceless stops, each of which corresponding to a different place of articulation, namely labial [p], coronal [t] and dorsal [k]. This was based on the well-documented observation that dorsal and labial codas are relatively marked with respect to coronal codas (e.g., Prince & Smolensky 1993). (2) The words had to be highly frequent in the language (i.e., within the 2,000 list of the most frequently-used words in English; analysis conducted via Cobb's *The Compleat Lexical Tutor* – version 4.5: <http://www.lextutor.ca>) in order to minimize word-frequency effects (Bybee 2001): One could argue, for instance, that learners are more likely to produce codas correctly in more frequently-occurring words (see also Almeida, Knobel, Finkbeiner & Caramazza 2007) for the effect of word frequency in picture-naming tasks); and (3) the words had to conform to a CVC syllable sequence (where V represents a lax vowel; e.g., [æ] [t] [p] as in 'cat', 'sick', 'neck' and 'book' respectively). This was motivated by the hypothesis that final consonants in more complex rhyme structures such as C[VVC] and C[VCC] could in fact be syllabified as onsets of empty-headed syllables given that English rhymes abide by constituent binarity (i.e., bimoraicity, a constraint requiring that syllables be maximally bimoraic); see Goad and Brannen (2003) for a comprehensive discussion of this proposal.

### 3.4. Participants

This study is cross-sectional and involves the participation of 60 English learners, stratified into three proficiencies, as outlined above. They were post-pubescent male and female native BP speakers, with an age average of 25. The participants were divided into 3 groups of 20 participants each based on their proficiency in L2 English, established via a combination of criteria that include time of exposure to ESL in a classroom environment, their placement within the school's proficiency system, and a background questionnaire (containing questions such as the amount of exposure to English outside of the language classroom, whether they had completed a pronunciation course or lived abroad for an extended period of time, the type of first exposure to the target language, etc.): (1) Beginner, (2) Intermediate, and (3) Advanced. The data were collected by the author at a private language school in the city of Belém, Brazil, where English is rarely used outside of the language classroom.

### 3.5. Coding and VARBRUL 2 Statistical Analysis

1,208 tokens were collected and analyzed for this study, which were later stratified among the variables listed in Table 1. The tokens were transcribed (using the software Transcriber 1.4) and coded independently (using Calc in OpenOffice 2.0) by three research assistants and myself for statistical analysis. For the quantitative analysis, only tokens realized with one of the three variants under investigation were considered:<sup>6</sup> (1) i-epenthesis (e.g., [ʃi.pi]); (2) Coda (e.g., [ʃɪp] or [ʃɪp̚]), where “C” indicates an unreleased consonant; and (3) Onset-Nucleus Sharing (e.g., [ʃɪ.p<sup>h</sup>]). To distinguish cases of final consonant release (English-like) from ONS (developmental), the transcribers employed impressionistic judgments to determine whether the form was a native-like coda, or an exaggerated onset-like consonant release (*not* native-like), similar to what Prator & Robinett (1972: 89) describe as produced with “a great deal of force [...] with puffs of air that sound like extra syllables”. After the coding was completed by each transcriber, the results were compared for consistency with respect to the variables included in the investigation. Inter-transcriber reliability was initially of approximately 86%. Whenever we encountered discrepancies, the disputed items were listened repeatedly until an agreement was reached. If, however, we could not arrive at a consensus, the dubious items were removed from the corpus.

<sup>6</sup> Cases involving the incorrect production of one of the three variants (i.e., i-epenthesis, ONS and target-like coda production) were discarded from the statistical analyses. These include forms with (possibly L1-triggered) incorrect word selection (e.g., “labial” – with vocalized [ɪ] – instead of “tip”) and mispronunciations (e.g., ([mæ.pa] instead of [mæp]). In the corpus analyzed, there were 17 tokens with the profile just described.

**Table 1.** Factor Groups for VARBRUL 2 Analysis

Factor Groups	1	2	3
Dependent Variables	Epenthesis	Coda	ONS
Place of articulation	Labial [p]	Coronal [t]	Dorsal [k]
Level of proficiency	Beginners	Intermediate	Advanced
Style	Informal (First reply)	Formal (Careful reply)	
Participants	# 1	# 2	# 3, etc.

For the statistical analysis of the BPEI corpus, we adopted the VARBRUL 2 program for DOS (Pintzuk 1988). This program has been extensively used in variationist studies in linguistics because, along with GoldVarb (Rand & Sankoff 1990, for Macintosh computers) and GoldVarb X (Sankoff et al 2005, for both PC and Macintosh computers), it is the only one explicitly designed to handle the types of data derived from studies of language variation; other probabilistic tests such as ANOVA were designed to handle data collected from controlled experimentation that result in rather balanced data (see Cedergren & Sankoff 1974 for an introduction to this statistical analysis technique for linguistic investigation). In Young and Bayley's (1996: 258) terms, VARBRUL is able to manage "the distributional imbalances of linguistic features in sociolinguistic data." One critical difference between the different incarnations of these applications for running variable analyses is that VARBRUL is the only one able to handle multinomial analyses that contain more than two dependent variables or application values (Tagliamonte 2006: 217). Because the development of codas in BPEI involves three phenomena (and consequently three dependent variables), VARBRUL 2 was selected to analyze our data.

The results of a VARBRUL study should be interpreted as holding over the whole of the data corpus that is being investigated and, to the extent that this is a representative sample, to all similar speakers and linguistic and extralinguistic contexts. The output of a typical VARBRUL analysis contains the following information:

(1) The raw number (N) and the percentage of rule application involving each factor. These results, however, do not provide enough information since they do not express the influence of each factor independently of the others.

(2) The factor weight measures the influence that each factor has in the process under investigation, based on the corpus analyzed. It provides the most accurate view of the likelihood of variant occurrence. It consists of a list of values associated with each factor independently of others in the same factor group. The value indicates the degree to which a factor promotes the occurrence of each variant for the process being investigated. Because the development of coda production in BPEI consists of three variants, the factor

weight of .33 was established as the watershed between the weights that enhance the likelihood of a certain variant's occurrence (above .33) and those that inhibit its appearance (below .33) (see also Major 1996 and Preston 1996).

Finally, (3) the input probability (also more descriptively called Overall Tendency) is the likelihood that each variant has of occurring in general, regardless of the specific contribution of particular factors. In other words, it represents the general propensity of the process to apply on its own, without the interference of the other factors included in the investigation.

#### 4. Results & Discussion

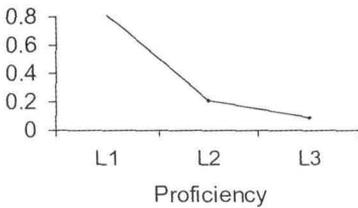
The VARBRUL results of this study are illustrated in Table 2 (significant factors are shaded for illustrative purposes), where the probabilistic weights indicate that the independent variables adopted (i.e., the external variables *proficiency* and *style* and the internal variable *place of articulation*) have significant conditioning effects on the variable development of English codas by BP speakers. The factor group *participants* was excluded from the final VARBRUL analyses to prevent interference with the significant *proficiency* factor: every participant inherently belongs to a proficiency group (or 'speech community', as discussed in the previous section). The results indicate that while i-penthesis is favored in the speech of beginners, in less formal stylistic environments and in the context of labial or dorsal segments, potential codas are more likely to surface as such in more advanced proficiency levels, when more careful attention is paid to speech (Formal), and when the consonant in question is the coronal/t/. ONS, on the other hand, is favored in intermediate stages of L2 acquisition (Intermediate), in more formal stylistic environments, and when the potential coda is the more marked labial /p/ or dorsal /k/ segment. As is typical in developmental phenomena, ONS is not an idiosyncrasy of developing grammars such as that of BPEI: the lengthening and release properties (i.e., aspiration) that characterize ONS have also been observed in adult languages (e.g., in Yapese – Jensen 1977), in first language acquisition (e.g., in English – Leopold 1939, in Quebec French – Rose 2000), and in the development of second languages (e.g., in Korean English – Goad & H-S Kang 2003, Mandarin English – Heyer 1986, Mandarin French – Steele 2002).

**Table 2.** VARBRUL probabilistic results

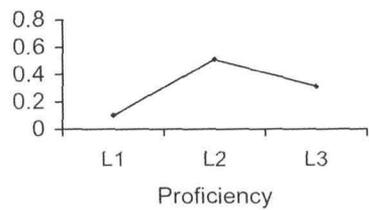
		Epenthesis	ONS	Coda
Proficiency	Beginners (L1)	.81	.10	.09
	Intermediate (L2)	.21	.51	.28
	Advanced (L3)	.10	.31	.59
Style	Informal	.53	.26	.28
	Formal	.18	.37	.44
Place of Articulation	Labial	.41	.37	.22
	Coronal	.29	.30	.41
	Dorsal	.37	.39	.24
Input Probability		.49	.29	.22

The results clearly demonstrate that while the likelihood of the transfer process of i-epenthesis decreases as a function of increased proficiency, the reverse is observed for coda production. In contrast, the phenomenon of ONS increases and decreases over the course of L2 English acquisition. This is exactly what Major's (2001) Ontogeny Phylogeny Model (OPM) predicts, a model that posits that learners progress from an initial stage with a prevalence of L1 features, to a final, target-like stage; in this process, L1 features (i.e., i-epenthesis) gradually decline, L2 features (i.e., codas) gradually rise, and developmental phenomena (i.e., ONS) steadily rise, peak and then fall again over the course of L2 acquisition, as represented graphically in the three charts in Figure 3 (values from the VARBRUL results in Table 2).

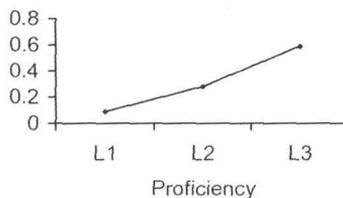
a. i-epenthesis by proficiency



b. ONS by proficiency



c. Coda by proficiency

**Figure 3.** The OPM and the development of codas across proficiencies.

With regards to level of formality, the VARBRUL results show the robust effect of this factor group, in which the more faithful coda and ONS variants are more likely to occur in more formal environments. In contrast, the least faithful of the three variants, i.e., i-epenthesis, is favored only when less attention is paid to speech (Informal). This pattern is compatible with a variety of studies in L2 acquisition (e.g., Cardoso 2007; Escartin 2005; Gatbonton 1978; Major 1986a; Tarone 1979, 1982, 1983; but see Beebe 1980; Diaz-Campos 2006; Major 1986b for opposite views on the subject), and with the standard view that more formal styles require more “prestigious” and/or faithful forms (e.g., Cardoso 2001, 2003; John 2006; Labov 1966; Oostendorp 1997; and most of the sociolinguistic literature).

Finally, the results related to the effect of the place of articulation of the word-final stops attest that variant selection is also determined by the markedness of the potential coda. The probabilities assigned by the variable analysis indicate that the least marked coronal [t] is more likely to surface as a coda in BPEI, more evidently in intermediate and advanced proficiency levels. The labial [p] and dorsal [k], on the other hand, are less likely to syllabify as codas. Because consonant deletion is not an option in the BPEI phonology, these consonants undergo one of the two strategies available to the L2 learner: i-epenthesis and ONS. In the framework of Optimality Theory (Prince & Smolensky 1993), this observation can be captured by the markedness sub-hierarchy of place of articulation (i.e., NoCoda<sub>[LABIAL]</sub>, NoCoda<sub>[DORSAL]</sub> >> NoCoda<sub>[CORONAL]</sub>). Being less marked than labials and dorsals, coronals are more likely to syllabify as codas in BP-based Interlanguage.

The patterns observed in the development of codas vis-à-vis place of articulation can also be explained within two other theoretical approaches: (1) via an L1 transfer analysis (in which general BP-based place of articulation restrictions are considered), and (2) via an analysis that take into consideration the phonotactic distributions of place of articulation in the input to which the language learner is exposed (in this particular case, via English-based teacher talk). Let us start with the first alternative. Recall from (1) in section 2 that, in BP, only four consonants can surface in coda position. Leaving aside the complications regarding nasal consonants in BP (see for example Mateus & d’Andrade 2000, Wetzels 1997), what this set has in common is the fact that they all share the coronal articulator: /l/, /N/ (an underspecified nasal consonant), /r/, and /s/. Under an L1 transfer-based approach (e.g., Gass & Selinker 1983, Odlin 1989, Selinker 1983, Sharwood-Smith 1994, Tarone 1978), one can hypothesize that BP speakers are merely transferring their general knowledge of their L1 place of place of articulation restrictions into the target language, thus explaining the higher incidence of coda production for the coronal /t/.

The second alternative for explaining the place of articulation restrictions observed in BPEI is via an approach that recognizes that language users are

highly sensitive to the frequency with which certain linguistic structures occur in the input of the language to which they are exposed (e.g. Bybee 2001, Bybee 2007, Bybee & Hopper 200, Gass 1997, Leonard & Ritterman 1971, Munson 2001). In this approach, it is assumed that linguistic knowledge (competence) is mediated by frequency (quantified in probabilistic rather than absolute terms, as is customary in standard generative linguistic theory): Learners build linguistic representations according to the frequency of structures or patterns in the input. In the context of our study, one could posit that the initial emergence of coronal vis-à-vis labial and dorsal codas can be determined by the frequency with which each form occurs in the input. More specifically, one can speculate that /t/ is acquired earlier simply because it is more frequent in the language used in the English classroom (e.g., in the speech that characterizes that of a language teacher, “teacher talk”). In attempt to test this hypothesis, we analyzed a corpus of teacher talk involving the same community from which the ESL learners who participated in this study were recruited (the corpus was conceptualized for a different research project that aimed to test and contrast the effects of markedness and input frequency in the acquisition of foreign /s/ plus consonant onset clusters; see Cardoso 2008). The corpus consisted of approximately 30 hours of audio recordings of student-directed teacher talk from a highly proficient English instructor, in two classrooms of beginner and intermediate level students. The frequency computation of the data was conducted via ConcApp version 4 (<http://www.edict.com.hk/PUB/concapp>), a text analysis suite that includes a concordancer and a word frequency analyzer. The corpus consisted of 4,770 words containing word-final voiceless stops (i.e., codas followed by either another consonant – e.g., “talk to”, or by a pause – e.g., “speak”). The results of a frequency count of the voiceless stop codas in the corpus conform to the prediction of the frequency-based hypothesis, as /t/-final words considerably outnumber the two other types of codas, namely labial /p/ and dorsal /k/: 80.86% (n=3,857) ended with the coronal coda /t/, 13.38% (n=638) with the dorsal /k/, and 5.8% (n=275) with the labial /p/. In sum, it is likely that the participants involved in our study learned to syllabify /t/ in coda position before they were able to produce codas /p/ and /k/ because they had had more experience (i.e., learning opportunities) with the former, which increased their chance of perceiving (and noticing) and consequently producing the form in a target-like fashion.

The three different approaches outlined above to explain the effect of place of articulation in BPEI coda production reflect three distinct (but sometimes overlapping) views on second language acquisition. It is beyond the scope of this study to address the advantages and disadvantages of each approach or to voice our partiality in favor of one; in fact, the empirical data collected and analyzed here cannot serve that purpose. The issue is controversial and, for that reason, has been the subject of heated debates over the past five decades;

for instance, the debate involving generative (Universal Grammar; e.g., White 1982) versus psycholinguistic approaches to second language acquisition (e.g., Gass & Mackey 2002). What we may conclude, based on the limited scope of the investigation, is that there seems to be a variety of factors that conspire to make the language learner select a form that is the least marked, L-1 influenced, and the most frequent in the language being learned: the coronal coda /t/.

We will now address the cross-tabulations between level of proficiency and style (presented in percentages), illustrated in Table 3. We assume here the following standard views on the nature of grammar: (1) that proficiency levels correspond to different interlanguages and, by definition, to different grammars characterized by a series of transitional and permeable systems (Adamson 1988, Adjémian 1976, Preston 1996, Selinker 1972); and (2) that formality levels constitute separate grammars (Cardoso 2001, 2003; Chomsky 1988; Oostendorp 1997; Selkirk 1972). Note that there are certain similarities between the assumptions made here and those inherent to the Multiple Grammar approach proposed by Kroch (1994) and Kroch and Taylor (1997) for whom variation is the result of distinct grammars in operation and in competition with each other (see also Roper 1999, Yang 2003). The view adopted here, however, differs from that of Kroch (1994) and colleagues in a crucial way: in their Multiple Grammar approach, competing grammars are invoked to explain variable phenomena that are intrinsically *internal* to the grammar (e.g., the effect of place of articulation). In this study, however, we limit the assignment of grammar status to *external* factors such as style and proficiency, as is customary in the generative literature (see Henry 2002 for a criticism of Kroch's Multiple Grammar approach). In this respect, Kroch's view on variation is similar to that of the Cophonology approach, a controversial proposal according to which phonological constituents (e.g., a prosodic word, a syllable), morphological components (e.g., a root, an affix), or even classes of specific morphemes may be associated with their own subgrammars or cophonologies (e.g., Itô & Mester 1995ab, Orgun 1996, Inkelas et al 1997, Inkelas 1998; Inkelas & Orgun 1995, Inkelas & Zoll 2000). By these assumptions, we may then conclude that the data investigated comprise the six distinct variable grammars illustrated in Table 3.

**Table 3.** The development of word-final codas (%)

Grammars by Proficiency & Style	i-epenthesis	ONS	Coda
Initial state: BP	100	0	0
a. Level 1, Informal	89	7	5
b. Level 1, Formal	84	9	7
c. Level 2, Informal	51	38	10
d. Level 2, Formal	18	54	28
e. Level 3, Informal	39	25	36
f. Level 3, Formal	5	38	58
Final state: English	0	0	100

Triggered by the exposure to the L2 English and the knowledge available to second language learners (i.e., L1 features and a set of innate linguistic principles), the initial grammar represented by BP in Table 3 undergoes a series of modifications in an attempt to emulate the grammar of the target language. In the context of English coda acquisition, these modifications are motivated by a series of linguistic and extralinguistic factors that guide the acquisition process and, more importantly, they follow a developmental path that is characterized by three phonological phenomena (variants): (1) i-epenthesis, an L1 BP-based process; (2) ONS, an interlanguage phenomenon motivated by a combination of L1, L2 and general linguistic principles on syllable structure; and (3) coda production, the target L2 feature.

To conclude, we have shown in this section that the variable acquisition of codas in BPEI is mediated by the transfer process of i-epenthesis and, in later stages, by the developmental phenomenon of ONS. It was also shown that the occurrence of each of the variants observed is strictly conditioned by a combination of extralinguistic (i.e., *proficiency* and *style*) and linguistic factors (i.e., *place of articulation of the potential coda*).

## 5. Conclusion

This study provided further evidence for Goad's (2002) proposal that the process of acquiring codas in L1s (Goad & Brennan 2003) and L2s (Goad & H-S Kang 2003) may be mediated by a transitory stage which, in the case of Brazilian Portuguese-based English interlanguage, is triggered by a combination of L1 and L2 features as well as universal principles on syllabification: Onset-Nucleus Sharing. Under this approach and based on phonetic evidence, we concluded that the aspiration and lengthening observed in the production of word-final voiceless stops in BPEI are better analyzed as instantiations of onset production, phonetically characterized by lengthened aspiration (i.e., the

spread of the feature *spread glottis* to an empty nucleus position so that the onset can be licensed). This view reflects a minimal change from the BP syllable structure, which permits only CV syllables, to a form that seems more faithful (at least perceptually) to the segmental content of the English input CVC melodic string.

More generally, within a sociolinguistic approach for data collection and analysis, this study investigated the variable development of word-final codas in BPEI across three stages of proficiency and two formality levels. The VARBRUL statistical results have shown that the occurrence of the three variants that characterize L2 coda acquisition (namely i-epenthesis, ONS and coda production) is conditioned by both extralinguistic (i.e., proficiency and style) and linguistic factors (i.e., the markedness of labials and dorsals vis-à-vis coronals when they syllabify in coda position).

## References

- Adamson, H. D. (1988). *Variation Theory and Second Language Acquisition*. Georgetown University Press.
- Adjémian, C. (1976). On the nature of interlanguage systems. *Language Learning* 26, 297-320.
- Almeida, J., M. Knobel, M. Finkbeiner and A. Caramazza. in press. The locus of the frequency effect in picture naming: When recognizing is not enough. *Psychonomic Bulletin & Review*.
- Almeida, J., M. Knobel, M. Finkbeiner and A. Caramazza. (2007) The locus of the frequency effect in picture naming: When recognizing is not enough. *Psychonomic Bulletin & Review* 14.6, 1177-1182.
- Archibald, J. (1993). *Language Learnability and L2 Phonology*. Kluwer Academic Publishers.
- Barbosa, P. A. (1996). At least two microrhythmic units are necessary for modeling Brazilian Portuguese duration. In *Proceedings of the First European Speech Communication Association(ESCA) Tutorial Research Workshop on Speech Production Modeling and Forth Speech Production Seminar*, 85-88.
- Bayley, R. (1991). *Variation Theory and Second Language Learning: Linguistic and Social Constraints on Interlanguage Tense Marking*. Ph.D. thesis, Stanford University.
- Bayley, R. and D. Preston, eds. (1996). *Second Language Acquisition and Linguistic Variation*. John Benjamins.
- Beckman, J. (1998). *Positional Faithfulness*. Ph. D. dissertation, University of Massachusetts, Amherst.
- Beebe, L. M. (1980). Sociolinguistic variation and style shifting in second language acquisition. *Language Learning* 30, 433-447.
- Bernhardt, B. and J. Stemberger. (1998). *Handbook of Phonological Development: From the*

- Perspective of Constraint-Based Nonlinear Phonology*. Academic Press.
- Broselow, E. and D. Finer. (1991). Parameter setting in second language phonology and syntax. *Second Language Research* 7, 35-59.
- Broselow, E., S-I. Chen and C. Wang. (1998). The emergence of the unmarked in second language phonology. *Studies in Second Language Acquisition* 20, 261-280.
- Bybee, J. (2001). *Phonology and Language Use*. Cambridge University Press.
- Bybee, J. (org.) (2007). *Frequency of Use and the Organization of Language*. Oxford University Press.
- Bybee, J. and P. Hopper, eds. (2001). *Frequency and the Emergence of Linguistic Structure*. John Benjamins Publishing Company.
- Cardoso, W. (1999). A quantitative analysis of word-final /r/-deletion in Brazilian Portuguese. *Linguistica Atlantica* 21, 13-52.
- Cardoso, W. (2001). Variation patterns in regressive assimilation in Picard. *Language Variation and Change* 13, 305-341.
- Cardoso, W. (2003). *Topics in the Phonology of Picard*. Ph. D. thesis, McGill University. Published by the McGill Working Papers in Linguistics.
- Cardoso, W. (2005). The variable acquisition of English word-final stops by Brazilian Portuguese speakers. In Dekydtspotter et al., eds., *Proceedings of the 7<sup>th</sup> Generative Approaches to Second Language Acquisition Conference (GASLA 2004)*, 38-49. Cascadilla Proceedings Project.
- Cardoso, W. (2007). The variable development of English word-final stops by Brazilian Portuguese speakers: A stochastic optimality theoretic account. *Language Variation and Change* 19, 1-30.
- Cardoso, W. (2008). The development of sC onset clusters in interlanguage: Markedness vs. frequency effects. In R. Slabakova, J. Rothman, P. Kempchinsky & E. Gavrusseva, eds., *Proceedings of the Generative Approaches to Second Language Acquisition (GASLA 9)*, 15-30. Cascadilla Proceedings Project.
- Cedergren, H. and D. Sankoff. (1974). Variable rules: Performance as a statistical reflection of competence. *Language* 50, 333-355.
- Chomsky, N. (1988). *Language and Problems of Knowledge: The Managua Lectures*. MIT Press.
- Davidson, L., P. Jusczyk and P. Smolensky. (2004). The initial and final states: Theoretical implications and experimental explorations of richness of the base. In R. Kager, J. Pater, & W. Zonneveld, eds., *Constraints in Phonological Acquisition*, 321-368. Cambridge University Press.
- Dewaele, J. and A. Furnham. (2000). Personality and individual differences. *Personality and Speech Production: A Pilot Study of Second Language Learners* 28, 355-365.
- Diaz-Campos, M. (2006). The effect of style in second language phonology: An analysis of segmental acquisition in study abroad and regular-classroom students. In C. Klee & T. Face, eds., *Selected Proceedings of the 7<sup>th</sup> Conference on the Acquisition of Spanish and Portuguese as First and Second Languages*, 26-39. Cascadilla Proceedings Project.

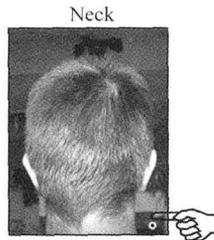
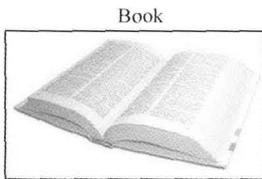
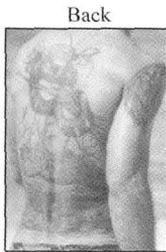
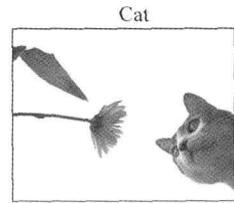
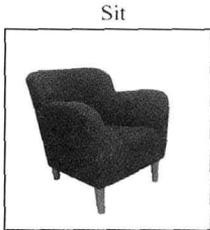
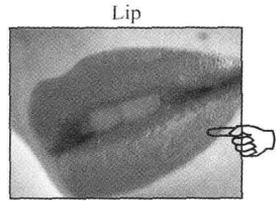
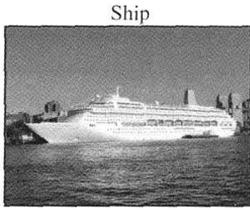
- Eckert, P. and J. Rickford, eds. (2001). *Style and Sociolinguistic Variation*. Cambridge University Press.
- Ellis, N. (2002). Reflections on frequency effects in language processing. *Studies in Second Language Acquisition* 24, 297-339.
- Escartin, C. (2005). *The acquisition of English sC onset clusters by Mexican Spanish EFL learners*. Unpublished master's thesis, Concordia University, Montréal.
- Gatbonton, E. (1975). *Systematic Variation in Second Language Speech: a Sociolinguistic Study*. Ph. D. thesis, McGill University.
- Gass, S. and A. Mackey. (2002). Frequency effects and second language acquisition – A complex picture? *Studies in Second Language Acquisition* 24, 249-260.
- Gass, S. (1997). *Input, Interaction and the Second Language Learner*. Erlbaum.
- Gass, S. and L. Selinker, eds. (1983). *Language Transfer in Language Learning*. Newbury House.
- Goad, H. (2002). Markedness in right-edge syllabification: Parallels across populations. *Canadian Journal of Linguistics* 47, 151-186.
- Goad, H. and K. Brannen. (2003). Phonetic evidence for phonological structure in syllabification. In J. van de Weijer, V. van Heuven and H. van der Hulst, eds., *The Phonological Spectrum* 2, 3-30. John Benjamins.
- Goad, H. and Hyun-Sook Kang. (2003). Word-final syllabification in L2 acquisition with emphasis on Korean learners of English. In J. Liceras et al., eds., *Proceedings of the 6th Generative Approaches to Second Language Acquisition Conference (GASLA)*, 122-129.
- Gordon, M. (2006). Interview with William Labov. *Journal of English Linguistics* 34.4, 332-351.
- Hancin-Bhatt, B. And R. Bhatt. (1998). Optimal L2 syllables: Interactions of transfer and developmental effects. *Studies in Second Language Acquisition* 19, 331-378.
- Henry, A. (2002). Variation and syntactic theory. In J. Chambers, P. Trudgill, & N. Schilling-Estes, eds., *The Handbook of Language Variation and Change*, 267-282. Blackwell.
- Heyer, S. (1986). *English Final Consonants and the Chinese Learner*. MA Thesis, Southern Illinois University.
- Inkelas, S. (1998). The theoretical status of morphologically conditioned phonology: A case study of dominance effects. In G. Booij & J. van Marle, eds., *Yearbook of Morphology* 1997, 121-155. Kluwer Academic.
- Inkelas, S. and O. Orgun. (1995). Level ordering and economy in the lexical phonology of Turkish. *Language* 71, 763-793.
- Inkelas, S., O. Orgun, O. and C. Zoll. (1997). The implications of lexical exceptions for the nature of grammar. In I. Roca, ed., *Derivations and Constraints in Phonology*, 393-418. Oxford University Press.
- Inkelas, S. and C. Zoll. (2000). Reduplication as morphological doubling. Ms., University of California, Berkeley and Massachusetts Institute of Technology. *Rutgers Optimality Archive* 412.

- Itô, J. and R.-A. Mester. (1995a). The core-periphery structure of the lexicon and constraints on reranking. In J. Beckman, L. Walsh-Dickey and S. Urbanczyk, eds., *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, 181-209. GLSA.
- Itô, J. and R.-A. Mester. (1995b). Japanese phonology. In J. Goldsmith, ed., *The Handbook of Phonological Theory*, 817-38. Blackwell.
- Jensen, J. T. (1977). *Yapese Reference Grammar*. University of Hawaii Press.
- John, P. (2006). *Variable h-epenthesis in the interlanguage of francophone ESL learners*. Unpublished master's thesis, Concordia University, Montréal.
- Krashen, S. D. (1988). *Second Language Acquisition and Second Language Learning*. Prentice-Hall International.
- Kroch, A. (1994). Morphosyntactic variation. In K. Beals, J. Denton, R. Knippen, L. Melnar, H. Suzuki & E. Zeinfeld, eds., *Papers from the 30<sup>th</sup> Regional Meeting of the Chicago Linguistic Society 2. The Parasession on Variation in Linguistic Theory*, 180-201. Chicago Linguistic Society.
- Kroch, A. and A. Taylor. (1997). Verb movement in old and middle English: Dialect variation and language contact. In A. van Kemenade & N. Vincent, eds., *Parameters of Morphosyntactic Change*, 297-325. Cambridge University Press.
- Labov, W. (1966). *The social stratification of English in New York City*. Center for Applied Linguistics.
- Labov, W. (1972). *Sociolinguistic Patterns*. University of Pennsylvania Press.
- Leonard, L. and S. Ritterman. (1971). Articulation of /s/ as a function of cluster and word frequency of occurrence. *Journal of Speech and Hearing Research* 14, 476-485.
- Leopold, W. (1939). *Speech Development of a Bilingual Child: a Linguist's Record*. AMS Press.
- Major, R. (1986a). Paragoge and degree of foreign accent in Brazilian English. *Second Language Research* 2, 53-71.
- Major, R. (1986b). The ontogeny model: Evidence from L2 acquisition of Spanish *r*. *Language Learning* 36, 453-504.
- Major, R. (1996). Markedness in second language acquisition of consonant clusters. In R. Bayley & D. Preston, eds., *Second Language Acquisition and Linguistic Variation*, 75-96. John Benjamins.
- Major, R. (2001). *Foreign Accent. The Ontogeny and Phylogeny of Second Language Phonology*. Lawrence Erlbaum Associates.
- Mateus, M. H. and E. d'Andrade. (2000). *The Phonology of Portuguese*. Oxford University Press.
- McCarthy, J. and A. Prince. (1993). *Prosodic Morphology I. Constraint Interaction and Satisfaction*. Ms. University of Massachusetts, Amherst, and Rutgers University.
- McCarthy, J. and A. Prince. (1994). The emergence of the unmarked. Optimality in prosodic morphology. González, M., ed., *Proceedings of the North East Linguistics Society*, 24, 333-379. GLSA.
- Munson, B. (2001). Phonological pattern frequency and speech production in adults

- and children. *Journal of Speech, Language, and Hearing Research* 44, 778-792.
- Naiman, N., M. Frohlich and H. Stern. (1975). *The Good Language Learner: A Report*. Ontario Institute for Studies in Education.
- Odlin, T. (1989). *Language transfer*. Cambridge University Press.
- Oostendorp, M. V. (1997). Style levels in conflict resolution. In F. Hinskens, R. van Hout & W. Wetzels, eds., *Variation, Change and Phonological Theory*, 207-229. John Benjamins.
- Orgun, C. (1996). *Sign-based Morphology and Phonology with Special Attention to Optimality Theory*. Ph. D. dissertation, University of California, Berkeley.
- Pater, J. (1997). Metrical parameter missetting in second language acquisition. In S. Hannahs & M. Young-Scholten, eds., *Focus on Phonological Acquisition*, 235-262. Benjamins.
- Pennington, M. (2002). Real language phonology: Optimality Theory meets sociolinguistics [A review of McMahon's (2000) *Change, Chance and Optimality*]. *Journal of Sociolinguistics* 6, 418-448.
- Pintzuk, S. (1988). *VARBRUL programs*. University of Pennsylvania.
- Prator, C. and B. Robinett. (1972). *Manual of American English Pronunciation*, 3rd edition. Holt, Rinehart & Winston.
- Preston, D. (1996). Variationist perspectives on second language acquisition. In R. Bayley & D. Preston, eds., *Second Language Acquisition and Linguistic Variation*, 1-45. Benjamins.
- Prince, A. and P. Smolensky. (1993). *Optimality Theory: Constraint interaction in generative grammar*. MIT Press.
- Regan, V. (1996). Variation in French interlanguage. In R. Bayley & D. Preston, eds., *Second Language Acquisition and Linguistic Variation*, 177-203. John Benjamins.
- Regan, V. (2004). The relationship between the group and the individual and the acquisition of native speaker variation patterns: A preliminary study. In R. Mougeon & J-M. Dewaele, eds., Special Issue of the *International Review of Applied Linguistics* 42.4, 335-348.
- Roeper, T. (1999). Universal bilingualism. *Bilingualism: Language and Cognition* 2, 187-203.
- Rose, Y. (2000). *Headedness and Prosodic Licensing in the L1 Acquisition of Phonology*. Ph. D. thesis, McGill University.
- Selinker, L. (1972). Interlanguage. *International Review of Applied Linguistics* 10, 209-231.
- Selinker, L. (1983). *Language Transfer in Language Learning*. 137-174. Newbury House.
- Selkirk, E. (1972). *The phrase Phonology of English and French*. Ph. D. thesis, MIT.
- Sharwood-Smith, M. (1994). *Second Language Learning: Theoretical Foundations*. 3-21. Longman.
- Steele, J. (2002). L2 learner's modification of target language syllable structure: Prosodic licensing effects in interlanguage phonology. In A. James & J. Leather, eds., *New sounds 2000*, 315-324. University of Klagenfurt.
- Tagliamonte, S. A. 2006. *Analysing Sociolinguistic Variation*. Cambridge University Press.

- Tarone, E. (1978). The phonology of interlanguage. In J. C. Richards, ed., *Understanding Second and Foreign Language Learning: Issues and Approach*, 15-33. Newbury House Publishers.
- Tarone, E. (1979). Interlanguage as chameleon. *Language Learning* 29, 181-191.
- Tarone, E. (1982). Systematicity and attention in interlanguage. *Language Learning* 32, 69-84.
- Tarone, E. (1983). On the variability of interlanguage systems. *Applied Linguistics* 4, 142-163.
- Tranel, B. (1996). French liaison and elision revisited: A unified account within Optimality Theory. In C. Parodi, C. Quicoli, M. Saltarelli & M. Zubizarreta Eds., *Aspects of Romance Linguistics*, 433-455. Georgetown University Press.
- Trubetzkoy, N. (1939). *Grundzuge der Phonologie*. Göttingen: Vandenhoeck und Ruprecht. (The book also appears in English translation as *Principles of Phonology*, translated by C. Baltaxe. University of California Press, 1969).
- Tzakosta, M. (2003). *Morpho-phonological Conflicts in the Acquisition of Stress in Greek*. Paper presented at GLOW 2003.
- Ussishkin, A. (2000). *The Emergence of Fixed Prosody*. Ph.D. dissertation, UC Santa Cruz
- Wang, C. (1995). *The Acquisition of English Word-final Obstruents by Chinese Speakers*. Ph. D. dissertation, SUNY at Stony Brook.
- Wetzels, W. L. (1997). The Lexical Representation of Nasality in Brazilian Portuguese. *Probus* 9, 203-232.
- White, L. (1982). *Grammatical Theory and Language Acquisition*. Foris.
- Wilson, J. and A. Henry. (1998). Parameter setting within a socially realistic linguistics. *Language in Society* 27, 1-21.
- Yang, C. (2003). *Knowledge and Learning in Natural Language*. Oxford University Press.
- Young, R. (1991). *Variation in Interlanguage Phonology*. Peter Lang.
- Zec, D. (2005). Prosodic differences among function words. *Phonology* 22, 77-112.

**Appendix A.** Pictures used in the Picture-naming Task\*



\* The name above each image indicates the intended word containing the target word-final coda. The pictures used in the data collection and illustrated above were downloaded from Yotophoto and are not subject to copyright: "These are images that are either in the Public Domain or released under Creative Commons, GNU FDL or similar licenses [...] to help educators, bloggers and digital artists find photos they can use" (<http://yotophoto.com>).

### Appendix B. Final VARBRUL Results\*

Factor Groups	Factors	i-epenthesis			ONS			Coda		
		<i>N</i>	%	<i>P</i>	<i>N</i>	%	<i>P</i>	<i>N</i>	%	<i>P</i>
(1) Proficiency	<i>Beginners – L1</i>	344	86	.81	32	8	.10	24	6	.09
	<i>Intermediate – L2</i>	124	31	.21	192	48	.51	84	21	.28
	<i>Advanced – L3</i>	68	17	.10	136	33	.31	204	50	.59
(2) Style	<i>Informal (N= 476)</i>	292	61	.53	108	23	.26	76	16	.28
	<i>Formal (N= 732)</i>	176	24	.18	249	34	.37	307	42	.44
(3) Place of Articulation	<i>Labial (N= 392)</i>	151	39	.41	142	36	.37	99	25	.22
	<i>Coronal (N= 398)</i>	119	30	.29	121	30	.30	158	40	.41
	<i>Dorsal (N= 418)</i>	159	38	.37	168	39	.39	91	23	.24
Input probability		.49			.29			.22		

\* The probability weights (rounded off to the nearest two-digit value) result from the final VARBRUL analysis conducted without the group *participants* (N = 1,208).

Walcir Cardoso  
 TESL Centre  
 Concordia University  
 LB-520-7 / 1455 de Maisonneuve Blvd. West  
 Montreal, Quebec H3G 1M8, Canada  
 E-mail: walcir@education.concordia.ca

Received: September 30, 2007

Revised version received: December 14, 2008

Accepted: December 19, 2008