The Variable Acquisition of English Word-final Stops by Brazilian Portuguese Speakers

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1. Introduction

Similar to other human languages, the grammar of learner speech (Interlanguage) is characterized by a rule-governed system (e.g. Adamson 1988, Preston 1989, 1996) that is inherently (and in the case of learner speech *highly*) variable. The availability of studies that combine variable second language acquisition (SLA) data with sociolinguistic methodology for data collection and analysis are still scarce, aside from a few studies conducted over the last three decades in which variation is expressed in the form of variable rules (à la Labov 1969; e.g. Fasold 1984 – see also Bayley and Preston 1996), or accounted for in terms of Bickerton's (1973) Dynamic Paradigm (e.g. Gatbonton 1978). In recent years, however, these approaches have been deemed inadequate for the explanation of variable phenomena (e.g. Reynolds 1994, Taler 1997, and Cardoso 2003), and have thus been discarded in favor of a constraint-based framework: Optimality Theory (OT) (Prince and Smolensky 1993). Within this theoretical framework, the present study incorporates theoretical and methodological tools from three linguistic disciplines (i.e. sociolinguistics, second language acquisition and formal phonology) in order to provide a more comprehensive analysis of variation in the speech of second language learners, in an attempt to develop a "socially realistic linguistics" (Wilson & Henry 1998). For the analysis of variation, this paper adopts a stochastic version of OT: the Gradual Learning Algorithm (GLA), proposed by Boersma (1998) et seq. and Boersma and Hayes (2001). The main advantage of this approach is that it allows the encoding of variability and its frequency effects (i.e. quantitative values) within a language by means of a single grammar.

Following a sociolinguistic methodology for data collection, this paper provides a preliminary analysis for the variable acquisition of English (L2) singleton word-final stops (codas) by Brazilian Portuguese (BP) native speakers learning English as a foreign language in a classroom environment. The study is cross-sectional and includes data from six English learners in three proficiency levels: beginners, intermediate and advanced. The general questions that I address in this paper are:

(1) General questions:
   a. How systematic is the variation that is observed in the development of word-final singleton stops by BP speakers? How does it change during the development of English and how does it compare to other interlanguages and "full-fledged" languages?
   b. What are the relative contributions of the linguistic and extralinguistic independent variables included in this study?
   c. How can the variation observed be accounted for in light of current developments in phonological theory?

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Answers to the first question will be provided in section 3. I will show the systematic development of English word-final codas by BP speakers across three proficiency stages, and compare these results with those obtained in crosslinguistic studies and in first and second language acquisition research.

The second question will also be addressed in section 3. GoldVarb 2001 statistical results indicate that variation in coda acquisition by BP speakers is triggered by a combination of linguistic (e.g. codas are more likely to appear in polysyllabic – as opposed to monosyllabic – words) and extralinguistic factors (e.g. codas appear more frequently in more formal speech).

Finally, the third question will be the topic of section 4, in which I will show how a stochastic, GLA-based approach to the analysis of variation is preferable because it presupposes a simpler grammar, governed by the same constraints and principles that govern categorical phenomena.

The paper is organized in the following way: in section 2, I will provide an introduction to codas in Brazilian Portuguese and BP English. Section 3 will address the data collection procedures as well as discuss the GoldVarb 2001 quantitative results. This will be followed by section 4, in which I will provide the stochastic analysis for the variable results obtained within Boersma and Hayes' (2001) GLA approach. Finally, in section 4, I will present my concluding remarks of the study.

2. Codas in Brazilian Portuguese and Brazilian Portuguese English

In Brazilian Portuguese, only four consonants can potentially appear in coda position: /l N r s/. While /l/ and /N/ (an underspecified nasal consonant) never surface as codas in most varieties of BP (see (2a) below), /r/ and /s/ are the only consonants that syllabify as codas in the language (see (2b)). Word-finally, however, these two consonants may variably undergo deletion in informal styles (see Cardoso 1999 for a variable study of /r/-deletion in BP).

(2) Codas in BP

a. Consonants that do not surface as codas

/l/: /brazil/ → [bra.ziw] 'Brazil' (cf. [bra.zi.lej.ru] 'Brazilian')
/N/: /boN/ → [bõ] 'good' (cf. [bõ.na.ʃãw] 'good person')

b. Consonants that variably surface as codas

/r/: /dor/ → [dor][1] ~ [do_] 'pain'
/s/: /kazas/ → [ka.zas] ~ [ka.za_] 'houses'

If the syllable-final consonant is an obstruent stop, BP opts for the syllabification of the illicit consonant as the onset of the epenthetic vowel [i] – i-epenthesis henceforth. This applies to both native and loan words:

(3) i-epenthesis in BP

a. In BP native words

/sub+ʒugar/ → [su.bi.ʒu.gar] 'to subjugate' (cf. [su.bes.tʃi.mar] 'to underestimate')

b. In borrowings

/hɑt dɑg/ → [hɔtʃi dɔgi] 'hot dog'

During the acquisition of L2 English, the language learner goes from an initial stage in which the grammar directly reflects the phonology of BP (i.e. illicit codas surface as onsets of epenthetic vowels), to a stage that resembles that of the target language and in which codas may appear freely. From the outset of coda acquisition to its target-like production, the development of English codas by BP speakers is a variable process: the coda [g] in the English form "dog", for instance, may surface

[1] I am 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 ɦ ʁ]. For ease of exposition, I 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.

identical to its English counterpart (i.e. [dɑg]), or followed by an epenthetic [i] (i.e. [dɑ.gi]), as was illustrated in (3b).[2] Based on the aforementioned discussion, the most obvious explanation for i-epenthesis is to assume that the phenomenon results from the direct interference of BP phonology. However, a closer examination of the data indicates that the phenomenon can be described as an "error" that reflects not only the phonology of BP (transfer), but also more general and universal principles. In the following sections, I will demonstrate that variability in coda production results from the interaction of both linguistic and extralinguistic factors as well as transfer from BP phonology.

3. Data Collection Procedures and Quantitative Results

This study consisted of 1,279 tokens of word-final stops, collected in the field by the author in the city of Belém, Brazil. The data collected were stratified among seven independent variables and later analyzed by the GoldVarb 2001 (Robinson et al 2001) statistical program: four linguistic factor groups: (1) *word status*, (2) *place of articulation of the word-final stop*, (3) *word size* (one versus more than one syllable), and (4) *stress placement within the word* (i.e. on the syllable where the coda occurs versus elsewhere); and three extralinguistic factor groups: (1) *level of proficiency* (Beginners = Level 1, Intermediate = Level 2, and Advanced = Level 3), (2) *style*, and (3) *subjects*. A summary of the factor groups included in this study is displayed in (4).

The subjects were three male and three female native speakers of Brazilian Portuguese, with an average age of twenty-one. In order to collect tokens from a wide range of stylistic levels, the data collection methodology used in this study provides a three-level distinction in a formality hierarchy: (1) reading of word lists; (2) reading of passages; and (3) informal oral interview.[3] The interviews were audio recorded via a Marantz CDR300 CD/RW Recorder and an Audio-Technica AT831b lavaliere microphone, and later transcribed for GoldVarb 2001 analysis.

(4) Table 1: Factor Groups for GoldVarb 2001 Analysis

Factor Groups	**1**	**2**	**3**	**4**	**5**	**6**
Dependent Variables	Coda	Epenthesis				
Word status	Content	Function				
Place of articulation	Labial [p, b]	Coronal [t, d]	Dorsal [k, g]			
Word size	1 syllable	2+ syllables				
Stress placement	Coda σ	Other σ				
Level of proficiency	Level 1 (±20h)	Level 2 (±150h)	Level 3 (±400h)			
Style	Word lists	Passages	Interview			
Subjects	# 1	# 2	# 3	# 4	# 5	# 6

From the factors included in this study, GoldVarb's probabilistic results indicate that the internal variables *place of articulation* and *word size* and the external variables *level of formality* and *style* have significant conditioning effects on variability in English coda acquisition by BP speakers. Because of the near-categorical results towards i-epenthesis obtained in Level 1 (beginners) and to prevent its interference in the results for other proficiency levels, this factor was excluded from subsequent

[2] Major (2001:46) proposes intermediate, developmental stages in the development of English codas by BP speakers, characterized by the devoicing of obstruent stops (e.g. /lɛg/ → [lɛk] 'leg') and [ə] epenthesis (e.g. /lɛg/ → [lɛ.gə]). In this study, I am simply considering the presence versus the absence (via i-epenthesis) of codas in the data. The issue deserves consideration in future analyses.

[3] The only way to elicit more formal oral data was through these reading tasks because the grammar of L2 learners (especially in earlier stages in the acquisition of an L2) is characterized by monostylism. Major (2001:70) notes, however, that "word lists can be more or less systematic and variable than conversation because of different proficiencies of L2 learners."

GoldVarb analyses.[4] The stylistic factors *word list* and *passages*, on the other hand, displayed no significant difference and were therefore regrouped into a single group: *Formal* (which will now contrast with *Informal* – the oral interview task). The final GoldVarb statistical results are illustrated in (5). In general, these results indicate that codas are more likely to appear: in the speech of more proficient speakers (.61), in more formal styles (.65), in the context of coronal consonants (.54), and in words larger than one syllable (.84).

(5) Table 2: Final GoldVarb probabilistic results (Level 2 and Level 3)

	Likelihood of coda occurrence		
Factor Groups		**Factors**	
Proficiency Level	Level 2	Level 3	
	.37	.61	
Style	Informal	Formal	
	.36	.65	
Place of Articulation	Labial	Dorsal	Coronal
	.31	.24	.54
Word Size	Monosyllabic	Polysyllabic	
	.23	.84	
Input probability		.29	

The following discussions will be based on the results in percentage because they derive from cross-tabulations per level of proficiency. I also assume the following standard views on the nature of grammar: (1) that proficiency levels correspond to different interlanguages and, by definition, different grammars (Selinker 1972, Adamson 1988, Preston 1996); and (2) that stylistic levels constitute separate grammars (Selkirk 1972, Chomsky 1988, van Oostendorp 1997, Cardoso 2001, 2003). By these assumptions, we may then conclude that the data investigated comprise five distinct grammars: one (near-) categorical grammar for Level 1, in which codas are unlikely to occur in both formal and informal environments; (2) two variable grammars for Level 2 (formal and informal); and two variable grammars for Level 3 (formal and informal). The results in percentage are illustrated in Figure 1.

Figure 1: Coda development by Proficiency & Style (%)

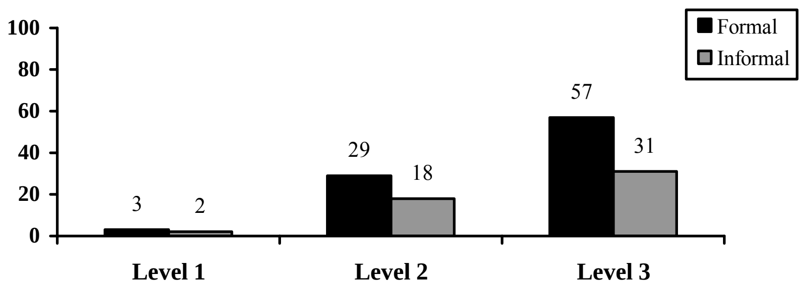


Figure 1 illustrates that the occurrence of codas in L2 speech increases as the BP learner becomes more proficient in English.[5] It also shows that the likelihood of coda occurrence is higher in more

[4] Most of the examples of coda production in Level 1 involve the voiceless stops [p, t, k]. In rapid speech, these consonants usually trigger the devoicing of the following unstressed, word-final vowel in BP. This could have had an influence on our judgment of unstressed word-final consonant production in the data.

[5] In intermediate and advanced stages in the acquisition of English codas, it is possible that certain word-final obstruents are realized as onsets and syllabified through onset-nucleus sharing (Goad 2002 and Goad and Kang 2003): features of a final consonant may spread into an empty nucleus in order to optimize syllable shape. There is phonetic evidence in the data that indicates that this is the case in some instances of "coda" production. The issue requires further investigation.

formal stylistic environments, a pattern that is compatible with a variety of studies in Second Language Acquisition (e.g. Gatbonton 1978, Major 1986; cf. Beebe 1980 and Major 1994) and with the standard view that more formal styles require more "prestigious" and faithful forms (e.g. Labov 1966, van Oostendorp 1997, Cardoso 2001, 2003).

The results involving the factor group *word size* (by proficiency level) are illustrated in Figure 2. Observe that in intermediate and advanced proficiency levels, word-final stops are more likely to surface as codas if they appear in polysyllabic words (e.g. [kə.mit] is more likely than [kə.mi.ti] 'commit'). A corollary of this observation is to say that i-epenthesis is more frequent in monosyllabic words (e.g. [dɑ.gi] is more likely than [dɑg] 'dog'), a pattern that clearly reflects the crosslinguistic tendency for words to be minimally disyllabic (Word Minimality; e.g. Wang 1995, Everett 1996, Broselow et al 1998). Interestingly, BP does not enforce this tendency since the language gives shelter to a large number of monosyllabic words (e.g. [pɔ] 'powder', [li] 'I-read-PAST'). In addition, we cannot presuppose that this tendency is triggered by the phonology of the target language, since English also allows monosyllabic words to appear freely (e.g. [si:] 'to see', [bɛd] 'bed'). We may then conclude that the effect of Word Minimality, a markedness constraint that is not visible in either the native language (BP) or the target language (English), only becomes apparent in Interlanguage – a clear illustration of the emergence of the unmarked Word Minimality constraint in BP English. This result is not an idiosyncrasy of second language speech, since the enforcement of Word Minimality has been observed across languages (e.g. Ussishkin 2000), in first language acquisition (e.g. Tzacosta 2003), and in second language acquisition (e.g. Wang 1995, Broselow et al 1998).

Figure 2: Coda development by Proficiency & Word Size

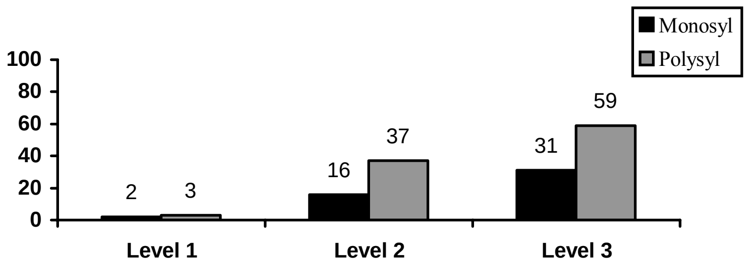
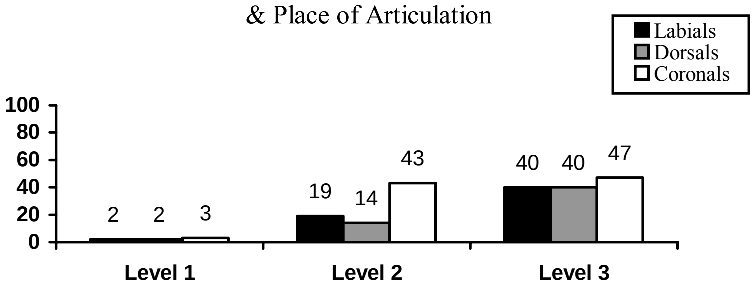


Figure 3 illustrates the quantitative results for the factor group *place of articulation of the word-final consonant*. The figure shows that coronal word-final consonants (i.e. [t d]) are more likely to surface as codas in BP English, more evidently in intermediate proficiency levels (Level 2). Labials (i.e. [p b]) and dorsals (i.e. [k g]), on the other hand, are less likely to syllabify as codas. Because consonant deletion is not an option in the phonology of BP English, these consonants undergo i-epenthesis in order to surface in Interlanguage. In Optimality Theory, this observation can be captured by the markedness sub-hierarchy of place of articulation (Prince and Smolensky 1993): $\text{NoCoda}_{[\text{LABIAL}]}$, $\text{NoCoda}_{[\text{DORSAL}]}$ >> $\text{NoCoda}_{[\text{CORONAL}]}$. Being less marked than labials and dorsals, coronals are more likely to syllabify as codas in BP-based Interlanguage (cf. Kim and Zsiga 2002).

Figure 3: Coda development by Proficiency
& Place of Articulation



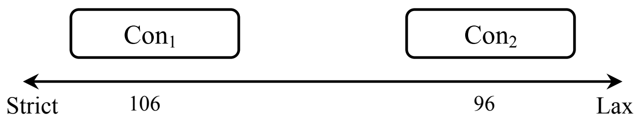
I have shown in this section that variation in the L2 acquisition of English codas is conditioned by a combination of linguistic (i.e. *word size* and *place of articulation*) and extralinguistic (i.e. *proficiency* and *style*) factors. In the following section, I will demonstrate how the tools provided by current developments in phonological theory can be used to account for the variable results illustrated above.

4. The Stochastic OT Analysis

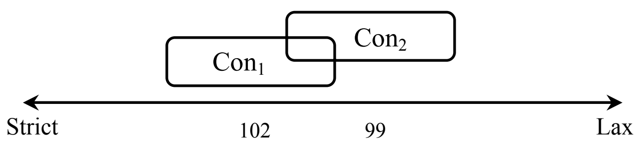
To analyze the variable data presented and discussed in section 3, I adopt Boersma's (1998, 2000) and Boersma and Hayes' (2001) methodology for investigating and representing variability in the framework of Optimality Theory (Prince and Smolensky 1993): Stochastic OT (SOT). SOT comes with an associated learning algorithm: the Gradual Learning Algorithm (GLA). The GLA is in some aspects a development of Tesar and Smolensky's (1993) Constraint Demotion algorithm, which was not originally designed to handle variation and gradient grammaticality.

Within the SOT approach, variation and gradient well-formedness are accounted for by a probabilistically determined reranking of constraints at certain intervals during evaluation time (i.e. during the process of speaking). Briefly, SOT postulates a continuous scale of constraint strictness in which constraints (e.g. Con$_1$ and Con$_2$) are annotated with arbitrary numerical strictness values established by a GLA (e.g. Boersma and Weenink's 2000 Praat program, Hayes et al's 2003 OTSoft software). The probability of reranking (i.e. variation) is determined by the distance between Con$_1$ and Con$_2$ on the strictness scale and by the amount of evaluation noise (i.e. standard deviation, typically 2.0) added to the strictness values. This way, constraints not only dominate other constraints (as is the case in standard OT), but they are also specific distances apart. The two figures in (6) and (7) below illustrate the distinction between a categorical grammar (in which crucially ranked constraints are distant) and a variable one (in which crucially ranked constraints overlap).

(6) Categorical ranking



(7) Variable ranking



In the context of a variable ranking, as shown in (7), the grammar might select any point within the overlap of Con1 and Con2. Most likely, the grammar will select the ranking Con1 >> Con2 because of the higher ranking of Con$_1$ over Con$_2$. However, it is also possible for the grammar to select a point within the leftmost (higher ranked) area of Con$_2$ and the rightmost (lower ranked) area of Con$_1$. In this case, Con$_2$ is ranked higher than Con$_1$ and a different candidate is selected.

For the analysis of variation, the main advantages of this approach are: (1) we are able to obtain a simpler grammar, with fewer constraints (cf. Reynolds 1994, Anttila 1997, Cardoso 2001, 2003), and still predict the same frequency data: variation is governed by the same linguistic constraints and principles that govern categorical phenomena (e.g. the crucial ranking of constraints); (2) other approaches to variation (i.e. Reynolds' 1994 "floating constraints" and Anttila's 1997 "crucial non-ranking of constraints") predict that quantities of variation should be in small integer fractions (e.g. 2/3, 1/2, 1/3). The data in this study do not always show this type of variation (see also Pater and Werle 2001).

The relevant OT constraints adopted in this analysis are:

(8) OT constraints

NoCoda(Obs)	Syllables do not have obstruent codas (e.g. Broselow et al 1998)
MAX-IO	Every element of the input has a correspondent in the output (i.e. No deletion) (McCarthy and Prince 1995)
DEP-IO	Every element of the output has a correspondent in the input (i.e. No epenthesis) (McCarthy and Prince 1995)

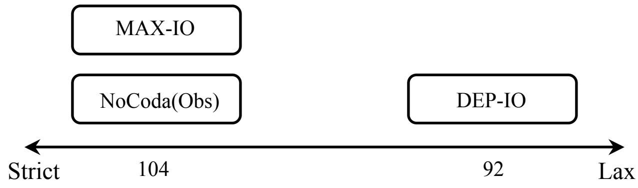
With these constraints at hand (along with a set of inputs, surface forms and their respective quantitative values established by GoldVarb, incorrect rival candidates, constraints, and constraint violations), a series of computer simulations was performed using the OTSoft software package (Hayes et al 2003).[6] In brief, the simulations proceeded as follows: as indicated in section 3, the data set investigated represent five distinct grammars (i.e. Level 1, Level 2 Informal, Level 2 Formal, Level 3 Informal, and Level 3 Formal). Each of these grammars was individually "learned" by OTSoft by exposing its algorithm to one million input data (evaluation noise or standard deviation: 2; Initial/final plasticity: 2/00.2; original arbitrary ranking for each constraint: 100). At the end of the simulations, the algorithm arrived at a final grammar that mimics the relative frequency of variants in the data, by assigning a ranking value for each of the constraints included in the analysis. This procedure was repeated for every grammar.

To illustrate how the GLA works in the context of categorical phenomena, consider the results obtained in Level 1 grammar. After being exposed to a data set in which the occurrence of i-epenthesis is categorical, the GLA located an empirically appropriate ranking value for each constraint, as illustrated in (9) and depicted graphically in (10). Because the standard deviation typically assumed by the GLA is 2.0 and the distance between MAX-IO and NoCoda(Obs) (which have equal ranking values, i.e. 104) from DEP-IO is higher than ten units, we may safely assert that this ranking is effectively categorical (see Boersma and Hayes 2001). This ranking and candidate evaluation are represented in a standard OT tableau in (11), which categorically selects the candidate in which i-epenthesis took place as the optimal form, similar to what was illustrated for Level 1 grammar in Figure 1.

(9) Level 1: ranking values

Constraint	Ranking value
MAX-IO	104.000
NoCoda(Obs)	104.000
DEP-IO	92.000

(10) Level 1 grammar



[6] The constraints Word Minimality and those that comprise the markedness sub-hierarchy of place of articulation ($NoCoda_{[labial]}$, $NoCoda_{[dorsal]}$ >> $NoCoda_{[coronal]}$) discussed in section 3 were removed from the SOT analysis because they are unnecessary and at times redundant. These constraints were also deemed unnecessary by OTSoft.

(11) Categorical i-epenthesis in Level 1

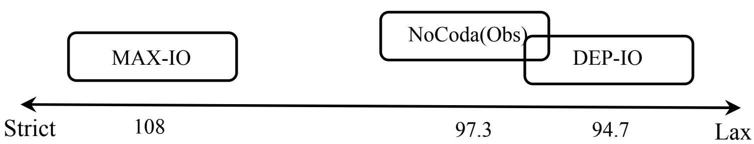
	/dɑg/	MAX-IO	NoCoda(Obs)	DEP-IO
☞	a. dɑgi			*
	b. dɑg		*!	
	c. dɑ	*!		

I will now demonstrate how the same approach adopted for the analysis of categorical phenomena can be utilized in the analysis of variation. Consider the results obtained in the interlanguage Level 2 Informal (see Figure 1), in which word-final obstruents are likely to be produced as codas 18% of the time, while the likelihood of i-epenthesis to occur is 82%. These frequencies in the data were learned by the GLA (OTSoft), which generated the following ranking values for Level 2 Informal grammar (shaded constraints indicate that they overlap in their distribution and consequently result in variation). The graphical representation of these constraints and their ranking values are shown in (13).

(12) Level 2 Informal: ranking values

Constraint	Ranking value
MAX-IO	108.000
NoCoda(Obs)	97.278
DEP-IO	94.722

(13) Level 2 Informal grammar



Because MAX-IO is ranked more than ten units higher than the other two constraints, Level 2 Informal grammar will always rank MAX-IO at the higher end of the hierarchy and therefore coda deletion will never take place. NoCoda(Obs) and DEP-IO, however, overlap in their distribution as illustrated in (13). According to the ranking values assigned to these two constraints, NoCoda(Obs) will outrank DEP-IO in most evaluations (i.e. 82% of the time) because it has a higher ranking value, and the outcome will be i-epenthesis (see (14a)). The opposite ranking will occasionally hold (i.e. 18% of the time) because of the overlap between these two constraints: the grammar will sometimes select a point within the leftmost (higher ranked) distribution of DEP-IO and the rightmost (lower ranked) area of NoCoda(Obs). In this case, the outcome will be the production of word-final obstruents as codas, as shown in (14b). Compare the results obtained by the GLA (under *GLA*) with the ones encountered in the data (under O*bserved*): the grammar learned by the GLA generates output frequencies that are identical to those observed in the investigation (see Figure 1).

(14) Output selection for Level 2 Informal grammar (from (12) and (13)):

	Output selection		**Frequency (%)**	
Constraint rankings	Coda	i-epenthesis	GLA	Observed
a. MAX-IO >> NoCoda(Obs) >> DEP-IO		✓	82	82
b. MAX-IO >> DEP-IO >> NoCoda(Obs)	✓		18	18

Due to space limitations, I will not discuss the rankings assigned for each grammar assumed in this study. Instead, I summarize below the stochastic analyses for the five distinct grammars that characterize the development of English codas by Brazilian Portuguese speakers (where the superscripted numbers indicate the ranking value assigned by the GLA – OTSoft). Observe under *Coda Occurrence* that each grammar learned by the GLA generates output frequencies that are strikingly close or similar to those observed in the data, as was illustrated in Figure 1. Note also that what distinguishes these five grammars from each other is the distance between the constraints NoCoda(Obs) and DEP-IO in each hierarchy. For instance, while in Level 1 NoCoda(Obs) and DEP-IO have a ranking distance of 12 units (which yields categorical i-epenthesis), in Level 2 Informal the distance is reduced to 2.6 (and consequently variation is the outcome), and so forth until the two constraints are reranked in opposite ends of the hierarchy (e.g. in the speech of native-like English learners), as I illustrate in forthcoming (17). In addition, observe that as the distance between NoCoda(Obs) and DEP-IO decreases, the likelihood of coda occurrence increases.

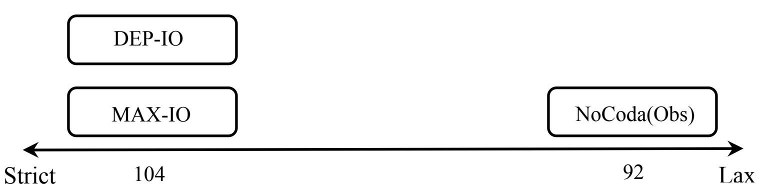
(15) Summary of grammars by proficiency and style

Grammars by Proficiency & Style	Coda Occurrence Predicted by the GLA	Coda Occurrence Observed
<u>Level 1</u>: MAX-IO^{104}, NoCoda(Obs)^{104} >> DEP-IO^{92}	0	2.5
<u>Level 2 Informal</u>: MAX-IO^{108} >> NoCoda(Obs)$^{97.3}$ >> DEP-IO$^{94.7}$	18	18
<u>Level 2 Formal</u>: MAX-IO^{106} >> NoCoda(Obs)$^{97.9}$ >> DEP-IO$^{96.1}$	27	29
<u>Level 3 Informal</u>:[7] MAX-IO$^{106.9}$ >> NoCoda(Obs)$^{97.9}$ >> DEP-IO$^{96.2}$	27	31
<u>Level 3 Formal</u>: MAX-IO^{106} >> NoCoda(Obs)^{97} >> DEP-IO$^{96.4}$	57	57

In sum, we may conclude that the acquisition of English codas by BP native speakers can be described as a mere reranking of NoCoda(Obs) with respect to DEP-IO. Due to L1 transfer, the English learner starts off with a grammar that resembles that of Brazilian Portuguese, in which case NoCoda(Obs) is ranked above (and in this version of OT more than ten units distant from) DEP-IO (see (16); cf. Level 1 grammar). The learner is then exposed to L2 English, which is characterized by the opposite ranking of these two constraints, as shown in (17):

(16) The grammar of Brazilian Portuguese (Cardoso 1999)

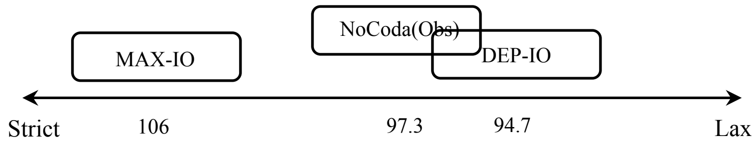
(17) The grammar of English (adapted from Archangeli 1997)



[7] Observe that, according to the GLA, the grammar of Level 3 Informal is strikingly similar to that of Level 2 Formal.

During the development of codas in BP English, within this stochastic version of OT, the initial distance between NoCoda(Obs) and DEP-IO illustrated in (16) gradually decreases (i.e. the two constraints are reranked) towards the opposite target-like ranking shown in (17). In the process of reranking, however, the different proficiency stages through which the language learner proceeds (i.e. interlanguages) are characterized by grammars in which the distribution of these two constraints overlap and the outcome is variation, as illustrated in (18).

(18) The grammar of an Interlanguage (e.g. Level 2 Informal)



5. Conclusions

Now this is not the end. It is not even the beginning of the end.
But it is, perhaps, the end of the beginning.
~ Winston Churchill

In this paper, I have demonstrated that the development of codas in Brazilian Portuguese English across three proficiency stages is systematic and, in most aspects, comparable to results obtained in the investigation of "full-fledged" languages and in first and second language acquisition research. For instance, the statistical results involving word size (i.e. that i-epenthesis is more likely to occur in monosyllabic words) support the crosslinguistic tendency for words to be minimally disyllabic, a pattern that has also been observed in the development of first (e.g. Tzacosta 2003) and second (e.g. Wang 1995, Broselow et al 1998) languages.

The GoldVarb statistical results have shown that variation in the acquisition of English word-final codas by BP speakers is triggered by a combination of both linguistic and extralinguistic factors. The study has shown that codas are more likely to occur in the speech of more proficient speakers, in more formal stylistic environments, in polysyllabic words, and in contexts in which the word-final coda is a coronal. The group factors word status and stress placement, on the other hand, did not have a significant effect on coda production during the development of English phonology.

For the analysis of variation in learner speech, this paper adopted a stochastic version of the framework of Optimality Theory: the Gradual Learning Algorithm proposed by Boersma (1998) et seq. and Boersma and Hayes (2001). I have argued in the context of the variable data utilized in this study that this approach is advantageous because it accounts for variation and its predictability via the same linguistic constraints and principles that govern categorical phenomena. This results in a simpler grammar, with fewer constraints (cf. Reynolds 1994, Anttila 1997, Cardoso 2001, 2003): "a grammar with fewer constraints should in principle be preferred to a grammar with more constraints, providing they make identical predictions" (Asudeh 2001:9). In addition, the GLA allows the encoding of variability and its frequency effects (i.e. quantitative values) within a language by means of a single crucially ranked grammar.

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