Ranking Transfer and Constraint Emergence in the Interlanguage*

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Second language learners tend to transfer phonological constraints and pronunciations from their first language (L1) into their second language (L2) (Gass and Selinker 1994). Optimality Theory (Prince & Smolensky 1993) captures the phonology of the L1 using a system of ranked constraints. The ranking of constraints provides us with a detailed understanding of the phonological processes that occur in the language. For example, which constraints are higher ranked or more prominent within that language, as well as which constraints the language is willing to violate in order to satisfy the higher ranked constraints is inherent within the theory. The goal of this paper is to rank the constraints of Brazilian Portuguese (henceforth BP) syllable structure, adopting an Optimality Theory approach, and determine if native speakers of BP transfer the ranking into their L2 English.

First, the paper gives a brief overview of syllable structure, and secondly, it discusses aspects of the phonological system of BP (i.e. regressive nasalization, the vowel system, and lateral/vowel gliding), including constraints on the syllable structure (onset and rhyme) as compared to those in English. Next, the methodology of the data collection is presented. The data collected were English sentences read by native speakers of BP that contained phonological constructions found in English but not in BP. Then, a phonetic and phonological analysis has been done on the collected data and is presented in §5. Next, the constraints on BP syllable structure are ranked, and finally that ranking is compared and contrasted to the L2 English ranking, as well as L1 English.

It was found that the constraint on the coda in BP was transferred high in the interlanguage ranking, and thus processes like regressive assimilation of nasality/nasal

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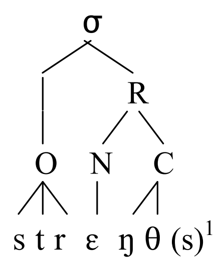
deletion and lateral gliding were apparent in the interlanguage phonology. Furthermore, a constraint that captured the unmarked structure deviant from both BP and English emerged in the interlanguage. However, the data did not support the hypothesis that epenthesis would occur when a native-speaker of BP was confronted with complex syllable margins, as in English.

1.1 The Syllable

The syllable is phonologically composed of two parts, the onset and the rhyme, which in turn consists of a nucleus and a coda. The nucleus of the syllable is generally a vowel, except in marked cases, such as Berber (a language spoken in Morocco), where consonants are sometimes used in the nuclear position, such as the word *txdmt* 'to gather wood' (Archangeli 1997). As for the onset and coda, languages have constraints on which segments are allowed to occur in consonant clusters in each position. For instance, English, as we will discover, has more permissible consonant clusters than BP in both the onset and the coda. English allows up to three consonants to fill the onset and two in the coda. A well-known example is the English word *strengths,* when syllabified:

(1) Maximal Syllable in English



1.2 The Sonority Hierarchy

English consonant clusters are also restricted with regards to the sonority hierarchy. The sonority hierarchy, ranking segments from least to most sonorous, is as follows: voiceless obstruents > voiced obstruents > nasals > liquids > glides > vowels. In English, as in other languages, permissible syllable constructions tend to follow this hierarchy going from least to most and back to least sonorous (in closed syllables) within the syllable. For example, again using the English word *strengths*, the syllable begins with two voiceless obstruents (the fricative will always precede the stop mono-morphemically in English) which are least sonorous on the hierarchy. The liquid [r] follows, which is higher than the voiceless obstruents but lower than the vowels on the hierarchy. Next, is the vowel [ε], the highest on the sonority hierarchy, before falling back down the hierarchy, from the nasal to the voiceless obstruents. This applies in BP syllable structure as well, but only in the onset, because that is the only part of the syllable where consonant clusters can occur. Example (2) shows the sonority hierarchy applied to the English words *grump* and *smart.*

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[1] In some accounts of syllable structure, the third consonant in the coda in English is syllabified into the word appendix and not the syllable coda (Spencer 1996).

(2)

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       _                 _
     -   -             -   -
   _       _         _       _
   g  r ʌ m p        s m a r  t
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In the example, the lines represent the levels of sonority for the individual segments, where the highest lines are most sonorous and lowest are least. Notice the gradual rise and fall in sonority throughout the word. This holds true for all words in English and BP. Next, a similar representation will be given for the BP lexical items *tres* 'three' and *flor* 'flower' to show that BP also follows the sonority hierarchy in terms of which consonants are permissible in clusters.

(3)

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        _                     _
     -                     -
  _        _            _        _
  t  r  e  s            f  l  o  r
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2.0 The Syllable Structure of Brazilian Portuguese and English

The following section will present the basic workings of Brazilian Portuguese phonology, much of which will be necessary for our constraint-based analysis that follows in § 7. Also, in this section the onset and coda of English will be discussed to show how the languages are different, as well as how they are similar in relation to the permissible clusters and the sonority hierarchy.

2.1 The Onset in Brazilian Portuguese

The most typical consonantal cluster in BP is plosive + approximate, and except for a few fricative + liquid cases, all other sequences are impossible in Portuguese, regardless of whether or not they follow the sonority hierarchy (Mateus and d'Andrade 2000). In the onset there tends to be no debate as to how many consonants can occur and which can occur sequentially. All Portuguese consonants occur syllable-initially (with the exception of the alveolar trill [r]), but prenuclear consonant clusters are restricted. The only possible combination is an obstruent /p b t d k g f v/ followed by an approximant, and there are certain obstruents that cannot occur with the liquid in the onset. For example, [dl] does not occur except across morpheme boundaries in borrowed lexical items, which means that it is not syllabified in the onset. The clusters [vr] and [tl] never occur, and [vl] is a rare case occurring in borrowed words only, such as *Vladimir* and cross syllables, as in the brand name *Revlon* (Azevedo 1981), which also means that it is not syllabified in the onset.

In BP, we find that clusters made of segments with identical sonority values (i.e. two stops or two fricatives *[pt], *[sf], etc.) do not occur, nor do plosive + fricative (i.e. *[tf], *[ts], etc.) or fricative + nasal (i.e. *[sn], *[fm], etc.) clusters. Furthermore, BP does not allow fricative + rhotic, except in a few cases such as, [fɾ]io 'cold', pala[vɾ]a 'word' and re[fr]escar 'to refresh', nor does it allow fricative + lateral clusters, except in a few such cases as [fl]or 'flower' and a[fl]orar 'to emerge' (Mateus and d'Andrade 2000).

One more comment regarding onset clusters needs to be made. In Portuguese, non-permissible onset clusters appear in the input forms (underlying forms and orthographically), in such cases as **pn pneu* 'tyre', **gn gnomo* 'gnome', and **ps psicologia* 'psychology'. In these examples we find epenthesis, whereby [i] is inserted to break up the impermissible cluster. For example, *pneu* is [pi-néw] and *gnomo* is [gi-nɔ́mu] (Mateus and d'Andrade 2000). This shows that when native speakers of Portuguese are confronted with non-native like clusters they use epenthesis in order to retain the ideal CV syllable structure.

2.2 The Onset in English

The restrictions on the onset in BP are, in general, similar to those on the onset in English, except that the onset in English is a little more flexible. English, like BP, allows onsetless syllables and any consonant with the exception of [ŋ] can stand alone in the onset. English allows two consonants to occupy the onset position of the syllable, where the first must be an obstruent, followed by an approximant /l r w j/, unless the first consonant is [s], then nasals, with the exception of [ŋ], voiceless stops and approximants can occur in the second position of the cluster. English does, however, permit three consonants to occupy the onset of a syllable, where the first must be /s/, followed by a voiceless oral stop, followed by an approximant. Furthermore, the consonant clusters in the onset of both languages must be rising in sonority.

2.3 The Coda in Brazilian Portuguese

The coda in BP undergoes far more restrictions than the onset, and the number of segments in the coda position of the syllable in BP has been debated extensively in the literature. Girelli (1988) argues against BP allowing possible CVC type syllable constructions. According to Girelli, in his X-bar theory approach to phonology, consonants (namely /s/ in his account) are allowed to follow the nucleus but they do not occupy the coda position of the rhyme. Instead, the segment is part of the nucleus, and the only allowable segment in this position is [s]. He also makes note of /n/ regressively assimilating its nasality onto the preceding vowel, and /l/ gliding and adjoining onto the nucleus. These issues will be addressed later in the paper (see §2.5 and § 3.3, respectively).

Mateus and d'Andrade (2000) argue that BP does allow the phoneme /s/ to appear in the coda position of the syllable, and in this position it is phonetically realized as /ʃ/ or /ʒ/ depending on the voicing of the initial consonant of the following morpheme.

Azevedo (1981) notes that the segments /r s l n/ are all allowed in the coda position of BP and that the sequence [ns] is the only consonant cluster found in the coda. But, it needs to be mentioned that in Azevedo's analyses the [n] nasalizes onto the preceding vowel and is deleted while leaving the [s] as the only consonant occupying the coda position on the surface. For example, *campa* 'handbell' becomes [kãpa] and *interim* becomes [ĩterĩ].

BP allows [s] and [r] in coda position, however, /l/ and /n/ only occur in the underlying forms and do not appear in surface representations. This is an important point because as we will see in the OT analysis, BP wants to minimize its coda constituents, and both the /l/ and /n/ are lost because of it, especially when /ns/ occurs in the underlying representation. The phonotactics of BP will force regressive nasalization of the vowel and deletion of the nasal consonant, thereby avoiding consonant clusters in the coda position of the syllable (see §2.5).

2.4 The Coda in English

The possible consonant clusters permissible in the coda of the syllable in English are far more flexible than those in BP. For example, English allows up to two consonants in the coda, and one or two more occurring in the appendix of the syllable, such as in the word *strengths* [strɛŋθs] discussed above (see §1.1). This is as opposed to BP, which allows only one consonant in the coda, and it must be an allophone of /s/ or /r/. The consonants in the coda in both languages must also be falling in sonority.

2.5 Regressive Nasalization and Nasal Deletion in Brazilian Portuguese

Wetzels (1997) classifies nasal vowels in BP as being either contrastive or allophonic, and labels the former "nasal vowels" and the latter "nasalized vowels." He argues that nasality is systematically realized on the vowel. Furthermore, nasal vowels in BP occur in both stressed and unstressed syllables, both word-internally and word-finally. Examples appear below (from Wetzels 1997):

(4) Nasalized Vowels

	Surface Representation	Underlying Representation	Spelling	Gloss
a.	word-internal stressed			
	[f ĩ ka]	/finka/	*finca*	'fixes'
	[pẽtʃi]	/pente/	*pente*	'comb'
	[kãpa]	/kampa/	*campa*	'handbell'
b.	pretonic			
	[ũbígu]	/umbigo/	*umbigo*	'navel'
c.	word-final stressed			
	[kupĩ]	/kupim/	*cupim*	'termite'
d.	word-final unstressed			
	[ĩterĩ]	/interim/	*interim*	'interim'
e.	nasal consonants in onset position			
	[anuaw]	/anual/	*anual*	'annual'
	[natu]	/nato/	*nato*	'native'
	[mata]	/mata/	*mata*	'wood, forest'

These examples show that regressive assimilation of nasality is occurring onto the preceding vowel and that the nasal consonant in the underlying form is being deleted. This plays a role in the construction of the coda in BP, in terms of which segments are allowed. The syllable of BP allows for only three positions in the rhyme, and the non-nuclear position tolerates only /s l r n/ in the underlying form and only [s] and [r] on the surface. If the nucleus of the rhyme is nasalized due to regressive assimilation, and the nasal consonant is deleted, then no other consonant can occupy the coda position except [s] (Wetzels 1997).[2] To further explain the repercussions nasal assimilation and the deletion of the nasal consonant have on the syllable structure of BP, we will look across morpheme boundaries. When we regressively nasalize a vowel, the nasal consonant is deleted, as was mentioned above, but its phonological properties, namely its position in the coda, remain in the underlying representation. For instance, in BP a nasal followed by /l/ violates the phonotactics of BP consonantal clusters, and is therefore disallowed. The same is true across morpheme boundaries. Therefore we will never find a nasalized vowel followed by a /l/. In fact, the only place we find /C/ + /l/ cross-morphemically is when /C/ is an allophone of /r/ (Wetzels 1997).

Nasal vowels in BP are contrastive when followed by a non-nasal consonant, as well as when they occur word-finally (Reider 1981). For example, [kãpa] 'tombstone' and [kápa] 'cloak' and [lã] 'wool' and [lá] 'there'. However, as was previously mentioned, this is not the case when the vowel occurs before a nasal consonant.

Reider (1981) argues that traditionally nasalized vowels in BP, vowels occurring before a nasal consonant, are becoming denasalized in non-stressed positions in northern and central regions of Brazil.

(5)

Traditionally	Northern/Central dialects of BP	
[bãnãna]	[banãna]	'banana'
[ãnĩmãw̃]	[animáw]	'animal'

Participants from these regions were not used in the this research project because of this reason.

3.0 The Vowel System of Brazilian Portuguese
3.1 The Inventory

Portuguese has seven oral vowels / i u e o ɛ ɔ a / (Wetzels 1997), and Mateus and d'Andrade (2000) argue for an eighth /ɐ/, which are found in stressed position only. In unstressed position the vowels undergo a variety of phonological processes, which will be addressed later in the paper (see §3.2 - 3.4). The vowels tend to follow the same features (height, backness, and rounding) as they do in English, with /i/ and /u/ being [+high] and [+ATR] and so forth.[3]

[2] It should be noted that regressive assimilation of nasality does not always occur, and for a more detailed analysis, see Wetzels 1997.

[3] There has been argumentation over the actual placement of /a/ in the vowel chart. Harris (1974) argues that Portuguese has three vowel heights, which are distinguished by tongue height. Redenbarger (1981), who proposes that Portuguese has the vowel /æ/ in its inventory, also claims that Portuguese has three vowel heights, but two layers of mid vowels, where the high vowels are realized by tongue height, and the mid vowels, namely /a/ and /æ/ in his analysis, by the feature constricted pharynx (known in his account as [+cp]). This feature is reliant on articulatory and acoustic properties, rather than phonological representations. It was created by Redenbarger in order to allow the distinctive feature-based system of

3.2 Diphthongization

In BP vowels in stressed positions have a strong tendency to become diphthongs. In the Carióca dialect these vowels typically lengthen and add a [j] or [ʒ]. This is also seen in the speech of young children in the Carioca dialect, for instance, [pajʒ] *paz* 'peace' and ['nɔyʒ] *nós* 'us.' BP nasal vowels /ẽ õ/, in many dialects, become diphthongs in primary stress and word finally, such as [bõw̃] *bom* 'good' and [a'lẽj̃] *alem* 'besides' (Major 1985).

3.3 Liquid and Vowel Gliding and its Effects on Syllabification

It can be predicted that high vowels become glides when occurring immediately after a stressed vowel and that VG diphthongs occur both tonically and pre-tonically (Giangola 1997).

(7) Vowel Gliding
V [+high] → G / V [+stress] ___
a) ai → [áj] 'woe'
b) sarau → [sa.ráw] 'evening party'

VG Diphthongs
a) eu → [ew] 'I'
b) euforia → [ew.fo.rí.ʌ] 'euphoria'

Generally when an intervocalic glide occurs, VGV, the glide is traditionally syllabified in the coda. Many dialects of BP will epenthesize a glide between the stressed vowel and the [s] if occurring word-finally (from Giangola 1997).

(8)
a) [lujs] *luz* 'light'
b) [dɛjs] *dez* 'ten'
c) [hapájs] *rapaz* 'guy'

Post-tonically, [l] undergoes gliding when syllabified in the coda, and remains a lateral when syllabified in the onset (Giangola 1997).

(9)
a) [fa.siw] *fácil* 'easy'
b) [fa.si.li.mʊ] *facîlimo* 'easy (superlative)'

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phonology proposed by Chomsky and Halle (1968) in the *Sound Pattern of English* to fully account for the vowel /a/ in Portuguese. According to his analysis, SPE, within the features proposed, could not distinguish between the Portuguese vowels /a/ and /æ/. He concluded that by adding the distinctive feature [+cp] it would eliminate the phonological ambiguities between /a/ and /æ/ when drawing up the framework of a vowel chart which incorporates all the vowels into their correct position, both acoustically and articulatorally, and for these positions to hold in phonological analysis.

The affixation in this case causes the morpheme to be syllabified differently. In a) we see that the liquid is syllabified in the coda, and therefore undergoes gliding. However, in b), the addition of the superlative morpheme causes the liquid to be syllabified in the onset, where no feature changes take place (Giangola 1997).

The glides discussed so far would all be considered off-glides, as opposed to on-glides, which will be discussed next. In BP on-glides also occur, and they are syllabified in the onset of the syllable (from Giangola 1997).

(10)

a) [lá.bjʊ] *labio* 'lip'

b) [la.bí.aw] *labial* 'labial'

aa) [tá.bwʌ] *tábua* 'board'

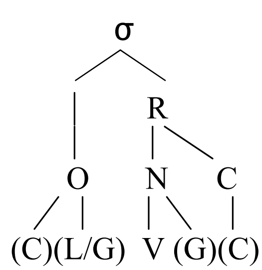
bb) [ta.bu.á.dʌ] *tabuada* 'multiplication table'

Examples a) and aa) in (10) exemplify the point that the on-glide is syllabified in the onset of the syllable in BP. However, when an additional morpheme is added, stress is realized on a different syllable, and here we find that the glides [j] and [w] are realized as their vowel counterparts [i] and [u], respectively. Glides in the nucleus position appear as vowels.

3.4 A Template for the Syllable Structure of BP and OT in SLA

From the phonological issues addressed so far, a surface syllable template will be formulated for Brazilian Portuguese.

(11)



From this template of the syllable structure of BP, we can see that any consonant occurring in Portuguese is allowed in the onset. But as noted before, the permissible obstruents occupying the consonant of consonant/approximant cluster are limited. Next, we find the vowel (diphthongs are also present as indicated by the V(G) representation dominated by the nucleus (N) node) occupying the nucleus position, and in the coda we find only one position, which can only be occupied by some variant of /r/ or /s/ and not both. Remember that /l/ and /n/ are permissible coda consonants in the underlying form, but they are glided or force regressive nasalization on the previous vowel and deleted, respectively, in the surface form. Notice also that the only obligatory component of the syllable is the vowel occupying the nucleus position in the syllable.

Before moving onto the methodology and analysis sections of the paper, it is important to briefly discuss second language acquisition and interlanguage phonology as it has been treated in OT. One of the better known studies is Broselow, et al. (1998), where the interlanguage production of obstruents in the coda position by native speakers of Mandarin Chinese learning English was analyzed using an OT approach. What was found was quite interesting in the sense that the language learner preferred unmarked forms that are not native to either Chinese or English. For example, if the form was monosyllabic, the speaker would epenthesize to utter the form as disyllabic, and if the form was disyllabic, the speaker would delete the final obstruent in the coda position. Other times, the speaker would devoice the obstruent, as voiceless obstruents are less marked than voiced ones. Essentially the study showed that disyllabic forms, less marked than any other word construction and voiceless obstruents were preferred in the interlanguage phonology. These processes do not occur in English or Chinese, which illustrates an interlanguage phonology that can deviate from both the native and target languages. According to Broselow et al., these forms result from low ranking constraints that are masked or hidden in the native language becoming higher ranked because of the richness of the base of the target language. The interlanguage grammar thus differs from the native-like grammar. This reranking of constraints is responsible for differences in the phonology of the interlanguage from both the native or target language, and as the language learner continues to learn the target language, the constraints continue to be reranked, moving closer to the ranking of the target language.

4.0 Methodology[4]

This study was designed to determine the interlanguage constraint ranking of native speaker's of BP learning English. The purpose was to determine if this ranking matched the native language ranking, the target language ranking, or if unmarked structures that deviated from both the native and target languages emerged in the interlanguage phonology, as argued by Broselow et al.

4.1 Participants

Five native speakers of Brazilian Portuguese pooled from the University of Florida and Santa Fe Community College student bodies participated in the project. Their ages ranged from 21 to 28 years old, and they have resided in the United States from four months to three years. Most of them studied English while in Brazil and have studied English for more than a year.

4.2 Procedure

The participants were asked to read 67 English sentences at three different rates of speech, careful (slow), casual (normal) and fast (quickly). These sentences contained a target word embedded within them, isolated by vowels on either side. Example (12) provides the template of the sentence construction used when collecting the data, where the X represents the position of the target word in the sentence.

(12) *I will say X again.*

[4] The sentences containing the target words are found in appendix A.

The target words were chosen because they contained either a consonant cluster non-existent in BP or a segment or phoneme not present in the BP segmental inventory. For example, as was previously mentioned, BP does not allow complex consonant clusters in the coda of the syllable, but English does, so a word like *twelfths* was chosen to be a part of the data set. The choice for these words was based on the idea that if a certain construction or phone is not present in a particular language, then when the native speaker learns a second language that may contain those constructions or phones, the speaker will introduce traits of their native language into their second language. For example, BP does not allow complex consonant clusters in the coda of the syllable, therefore when confronted with a word like *twelfths* we would expect the second language learner to epenthesize and break up the "foreign" consonant cluster.

The participants were then asked to read two paragraphs, which contained a large percentage of the selected words in the sentences. In the paragraphs, however, the target words were placed before and after words with consonants and consonant clusters in the edges. This was done to vary the environments in which the target words occurred. For instance, in the sentences the target words were located between a word ending in a vowel, *say*, and a word beginning with a vowel, *again*. In the paragraph, the goal was to place these target words in different environments. The goal was to determine how, for example, the native speaker would adjust if the target word began with a consonant cluster and followed a word that ended in a consonant cluster.

The participants were recorded in a sound proof booth located in the basement of the Department of Psychology at the University of Florida. The data was recorded onto a digital audiotape (DAT) using a SONY DAT recorder. The data was then burned onto a compact disc and broken up using Cool Edit from Syntrillium. Finally, the data was analyzed on a spectrogram Wave Surfer 095 from Scriptics Corp., to determine processes that could not be distinctively deciphered by just listening to the tape. Such processes as regressive nasalization and vowel deletion, lateral gliding in the coda, and vowel epenthesis to break up non-native like clusters, among others, were acoustically analyzed.

5.0 Phonetic & Phonological Analysis[5]

The aim of this section is to explain the phonetic and phonological findings of the interlanguage English of native BP speakers, as extracted from the data collected. In the previous sections such processes as epenthesis to alleviate impermissible consonant clusters, regressive assimilation of nasality and nasal deletion in the coda position, and lateral gliding in the coda position have been discussed. The focus of the rest of the paper is to assess three of these processes in terms of the interlanguage English (§ 5), the constraint ranking motivating these alternations in BP (§ 6), and finally the comparison of the interlanguage constraint ranking to English and BP (§ 6). The three processes to be addressed are epenthesis (§5.1), regressive assimilation of nasality and nasal deletion in the coda position (§5.2), and lateral gliding in the coda position (§5.3).

[5] Sample acoustic spectrograms from the analysis are found in appendix B.

5.1 Epenthesis

To recall from §2.1, BP epenthesizes a vowel between two underlyingly adjacent consonants that violate the phonotactics of permissible consonant sequences. For example, the form *gnomo* surfaces as [gi.nɔ.mu] 'gnome' with the epenthetic [i] surfacing to break up the /gn/ cluster. According to the second language acquisition literature, processes like this should occur in the speaker's interlanguage when the speaker is confronted with a consonant cluster not occurring in their native language.

This expectation was tested in the data collection, where non-BP like consonant clusters found in English were placed in both the onset and coda positions of the syllable (see §1.1 for a review of the syllable). Complex syllable margins in English words such as *strengths*, *script*, *scripts*, *sixth*, *six*, *burst*, *stow*, *spay* amongst many others (for the complete list consult Appendix A) were tested in the data collection. The general notion was that the native speakers of BP would epenthesize at some place in the target word in order to break up the non-BP consonants clusters presented to them. For instance, when considering the word *stow*, the expectation would be epenthesis, similar to Spanish, by adding an [ɛ], or some other vowel, at the beginning of the morpheme in order to resyllabify the [s] into the coda of the new syllable, while [t] remains in the onset of the original syllable. This eliminates the [st] onset cluster not by epenthesizing to break up the cluster but rather by epenthesizing to breakup the onset into two syllables. So, the expected utterance of a native speaker of BP pronouncing *stow* would be [ɛs.tow], thereby syllabifying the [s] into the coda of the syllable formed around the epenthesized [ɛ], while leaving [tow] to remain as a well-formed syllable in both English and Brazilian Portuguese. Continuing this section is an explanation of the acoustics of vowel epenthesis, as well as what was found in the collected data, where the question "do native speakers of BP epenthesize to make their English utterances well-formed BP syllables?" is posed and answered negatively based upon the collected data.

In a spectrogram analysis, an epenthetic vowel has the same acoustic characteristics as that of a non-epenthesized, or input faithful, vowel depending on the actual vowel itself. For example, an epenthesized [u] has the same acoustic characteristics as an input faithful [u], where the formants are similar and differ only, of course, based on transitions to following segments.

In a very small number of cases the native speakers of BP did epenthesize where expected; however, in general, the speakers did produce most utterances in a native-like way, in the sense that epenthesis did not occur. The forms used in the constraint analysis of epenthesis are, for the most part, input faithful.

The isolated cases illustrated the expected phonological alternations, in terms of epenthesis, whereby a vowel, [ɛ] when epenthesized at the beginning of the root, and [ə] elsewhere. For example, *scripts* was produced as [skrɪ.pəts] and [ɛs.krɪpts], where in both cases a vowel was epenthesized to break up at least one non-BP cluster. Another example of this was the word *strengths*, which in some cases was produced as [strɛ.ŋəs], whereby [ə] was epenthesized to break up a [ŋs] cluster.[6]

[6] Here, the omission of [θ] is not really relevant as [ŋs] itself does not constitute a well-formed consonant cluster in BP and [θ] is not a naturally occurring segment in BP. Deletion is beyond the scope of this paper.

5.2 Regressive Assimilation of Nasality and Nasal Deletion in the Coda Position

Previously, regressive assimilation of nasality and nasal deletion was discussed (§2.5) to illustrate that BP regressively assimilated nasalization onto a vowel from a nasal consonant in the coda position and deleted the nasal consonant. As before, the same phonological alternation is expected to occur in the English of native BP speakers.

Within the data set a number of English words which had the nasal in the coda were tested to determine if native BP speakers transfer this process into their interlanguage English. For example, the form *plant* appeared in the data, and it would be expected to surface as [plæ̃t], as the nasalization is assimilated and [n] is deleted. To illustrate this process more clearly, figure (13) presents a derivational account of this expected alternation using the English form *plant*.

(13) A Derivational Account of Regressive Nasality and Nasal Deletion in the Coda Position

/plænt/	
⇓	
[plæ̃nt]	Regressive Nasality
⇓	
[plæ̃t]	Nasal Deletion

This process is indeed evident throughout the data, as it was suspected to be, with a few non-notable exceptions. Throughout the data, heavy nasalization of vowels was present and in most cases there was no, or in other cases very little, evidence of the nasal consonant surfacing.

Acoustically, nasalized vowels are realized by a reduction in the intensity of the first formant, while the third formant is typically higher than the third formant of the fully oral vowel. The third formant is rising in lightly nasalized vowels, and in fully nasalized vowels the third formant is fully high with no rising or falling in frequency (Ladefoged and Maddieson 1996). This is seen in most of the cases in the data, where the first formant of the vowel is decreased in amplitude and the third formant is high. This illustrates that the first step of the process, regressive assimilation of nasality, is evident in the interlanguage; next, the second step, that of nasal deletion in the coda, will be addressed.

Acoustically, a nasal consonant, [n] especially, is realized with a first formant around 280 and a nasal zero at 1780. In other words, a nasal consonant is acoustically realized with one formant at 280 and nothing at the higher frequencies (Ladefoged and Maddieson 1996). These formant characteristics are evident throughout the data. In the native English speaker's speech, the first formant remained around 280 for the duration of the nasal articulation; however, in the non-native's speech, the first formant was indeed not present and no traces of a nasal articulation were found with the exception of the nasalization features on the preceding vowel. Therefore it can be concluded that this constraint, one against nasal consonants surfacing in the coda position, was transferred into the interlanguage. The resulting surface representations of the English forms are listed below in (14):

(14) Surface Representations of the Nasal Forms

a. English	b. BP Interlanguage English	c. Gloss
[plæ̃nt]	[plæ̃t]	'plant'
[klæ̃n]	[klæ̃]	'clan'
[õw̃nz]	[õw̃z]	'owns'
[ãw̃ns]	[ãw̃s]	'ounce'

The forms in (14a), the English forms, are as they would appear by a native speaker of English, in which the vowel is nasalized due to the following nasal consonant, which regressively assimilates its nasality onto the preceding vowel. The nasal consonant is articulated and if another consonant remains in the coda (or appendix) position then it too is articulated. The forms in (14b), the BP interlanguage English, illustrate that nasality is regressively assimilated, however, the difference lies in that the nasal consonant is deleted. This follows from the phonology of BP.

5.3 Lateral Gliding in the Coda Position

The final phonological alternation to be discussed is that of lateral gliding in the coda position. It has already been discussed that BP is very restrictive in terms of coda position (§2.3), and in cases where a lateral is present in the underlying form it is glided on the surface and syllabified into the nucleus of the syllable (§3.4). This is illustrated in (15) (a recapitulation of 9a and 9b):

(15) Lateral Gliding in the Coda Position

Underlying	Surface	Gloss	English Gloss
a. /fá.sil/	[fá.siw]	*facil*	'easy, simple'
b. /fa.si.li.mʊ/	[fa.si.li.mʊ]	*facilimo*	'easy (superlative)'

The example in (15) illustrates that when a lateral is syllabified in the coda position (typically word-finally) it is glided and syllabified into the nucleus. However, using the same underlying form and suffixing a vowel-initial morpheme, which forces the lateral into the onset position of a syllable, the segment surfaces as a lateral. This illustrates that 1), the underlying form is lateral and 2), when that lateral is syllabified in the coda it is glided, and when it is syllabified in the onset then it surfaces as a lateral.

As in the previous two cases discussed so far, this process is expected to be transferred into the interlanguage English of native BP speakers, and like nasalization (§5.2), it is evident that this process is transferred. First, the acoustic characteristics of lateral gliding will be discussed and finally the surface forms that will be used in the constraint analysis are introduced.

A lateral in the spectrogram is indicated by antiformants occurring on the higher vowel formants, indicated by a weakening in amplitude. A glide in spectrogram analysis is characterized by a change in the formant frequencies of the preceding vowel. For example, in the form *stow*, the vowel [o] glides to [w] and this is reflected in the transitions of the formants. For instance, depending on the vowel and the glide under inspection here, the formants of the vowels may diverge, converge, or rise or lower in unison. In English, pure vowels are generally rare, so in almost all cases there is some formant transition, as there is in BP. However, the difference is evident in the presence of the lateral and the length of transition. In the English data, the transition from vowel to glide is relatively short and the lateral is present and indicated by a strong low first formant, a weaker second formant and a third stronger high frequency formant (Ladefoged and Maddieson 1996). In many of the cases, in the BP speakers' data the gliding was perceptually evident. Ladefoged and Maddieson (1996) argue that, in fact, in BP the raising of the back of the tongue creates a segment similar to [ʊ] and this segment merges with the lateral to become a vowel or semi-vowel.[7]

The forms used in the constraint analysis are presented below. The schema in (16) illustrates the differences between the English and BP interlanguage English utterances.

(16) Lateral Gliding in the Coda Position

English	Interlanguage English	Gloss
a. [tɐl]	[tɐw]	'tall'
b. [ɐl]	[ɐw]	'all'

The examples in (16) illustrate the differences in the pronunciation of the English forms *tall* and *all*. The gliding in the English forms is not extremely evident and is therefore not included in the transcriptions. The interlanguage forms are lacking the [l]; however, they do show significant gliding and it is therefore evident in the transcription.

5.4 Conclusion of Analysis

This concludes the section on the phonetic and phonological analysis of the collected data. Three topics of particular importance to the constraint analysis below were discussed, that of epenthesis (§5.1), regressive assimilation of nasality and nasal deletion (§5.2), and lateral gliding in the coda position (§5.3). It was evident from the data that both nasalization/deletion and lateral gliding were wide spread; however, epenthesis was not. Based on this data, regressive assimilation of nasality, nasal deletion, and lateral gliding in the coda position seem to be transferred into the interlanguage of the BP native speaker's English. Epenthesis did not always occur in the forms it was expected to, or at least not enough to generalize as in the other two processes of interest. Such clusters as [rst], [str] and approximant plus obstruent clusters posed little or no difficulty to the native BP speakers. There are some possible explanations that will be discussed in the conclusion of the paper.

6.0 OT: Constraint Ranking from L1 to L2

This schema in (13), showing nasal assimilation and nasal deletion, illustrated two forces at work in creating the optimal output. However, using rewrite rules and derivations does not reveal that two processes are working together in order to create the output; but

[7] However, because of articulatory features, the lateral will continue to remain as classified as such. This point is not directly of interest, as their concern resides more in classification than acoustic or phonological for this particular point.

instead, it appears that two independent processes are working independent of one another in order to create the output. A better model that illustrates that these processes are interwoven and working together is applied below, using Optimality Theory, rather than rules and processes that occur independently.

In this final chapter, the constraints on Brazilian Portuguese syllable phonotactics will be ranked and that ranking will be investigated to determine whether or not the native speaker of BP transfers their L1 ranking into their L2 English. First, a brief introduction to Optimality Theory is given and the constraints used in the analysis are introduced. Then a ranking for the syllable phonotactics of BP is introduced, and finally it is compared to the inter-language of the BP speaker's English.

6.1 OT: Introduction and Constraints

6.1.1 Introduction

Optimality Theory (Prince and Smolensky 1993; Prince and McCarthy 1993) is a relatively recent theoretical framework within generative phonology in which the surface forms of language reflect resolutions of conflicts between competing constraints (Kager 1999). The ranking of constraints provides an understanding of the phonology of the particular language. The higher the constraint is ranked the stronger it is, and the lower it is ranked the weaker the constraint is in the language.[8] Constraints are cross-linguistic and universal, and the ranking is language specific.

6.2 The Constraints and Their Ranking in Brazilian Portuguese

In this section, the constraints used in the analysis are introduced. A definition of each constraint is given as well as its ranking in contrast with other constraints that play a role in the syllable structure in BP. First, two faithfulness constraints are introduced. The function of a faithfulness constraint is to ensure that the language retains segments in the output that appear in the input, as well as disallowing new segments in the output that were not in the input, essentially retaining the correspondence of segments that appear in both the input and output forms.

(17) **DEP-IO** Output segments must have input correspondents (no epenthesis)
(McCarthy and Prince 1995)

This constraint states that all segments in the output must have a corresponding segment in the input, and that any segment in the output not in the input is a violation of this constraint. The next constraint also deals with faithfulness between input and output.

(18) **MAX-IO** Input segments must have output correspondents (no deletion)
(McCarthy and Prince 1995)

[8] For more information regarding Optimality Theory consult Prince and Smolensky 1993; Prince and McCarthy 1993a and 1993b; Archangeli 1997; and Kager 1999.

MAX-IO states that all segments in the input must also be in the output form, and any segment in the input that is deleted is a violation of this constraint. Here is an example regarding the interaction between the two constraints.

Tab. 1 (*gnomo* 'gnome')

/gnomo/	MAX-IO	DEP-IO
a. ☞ gi.nɔ́.mu		*
b. gɔ́.mu	*!	

In tableaux 1, the correct output form violates DEP-IO, but because it is lower ranked and the other output candidate violates the higher ranked MAX-IO, (a) is the optimal output. Now let's use the same example and introduce a few syllable well-formedness constraints. The function of well-formedness constraints are to enforce the language's permissible syllable constructions from the input forms into the output forms.

The next constraint deals with the onset of the syllable. The onset of the syllable is the consonant or string of consonants that precede the nucleus or sonority peak (typically a vowel) of the syllable (see §1.1 and §3.4 for the syllable structure of BP).

(19) ***σ[Obs + [-Appx]**: Obstruents plus non-approximants (obstruents and nasals) are not permissible in onsets

This constraint states that the only consonant cluster permissible in the onset of BP consists of an obstruent plus an approximant, and that obstruent plus nasal and obstruent plus obstruent clusters are prohibited. This constraint is important for breaking up impermissible consonant clusters such as **gn* in *gnomo*.

Tab. 2

/gnomo/	*σ[Obs + [-Appx]	MAX-IO	DEP-IO
a. gnɔ́.mu	*!		
b. ☞ gi.nɔ́.mu			*
c. gɔ́.mu		*!	

In tableaux 2, *σ[Obs + [-Appx] and MAX-IO both dominate DEP-IO. This ranking selects the optimal output form, which, through epenthesis, creates the typologically ideal CV syllable. Epenthesis comes at the expense of DEP-IO, but because it is low ranked, and it causes the satisfaction of *σ[Obs + [-Appx], the violation is tolerated.

As was previously mentioned, BP prefers a simple unmarked CV syllable construction, and the only consonants allowed in the coda are [s] or [r]. In the world's languages, the most unmarked syllable type is CV and the constraint in (20) retains the ideal typological syllable structure by stating that syllables must be open, and coda consonants are disallowed.

(20) **NOCODA (*C]σ)** Syllables are open (Prince and Smolensky 1993)

We know that this is not always the case in BP, but BP does prefer the CV syllable typology. The next constraint to be introduced also deals with the coda of the syllable, and it states that consonant clusters are not allowed in the coda, or only one consonant is permissible in the coda.

(21) ***COMPLEXCODA (*CC]σ)** Codas must be simple (Prince and Smolensky 1993)

We would expect to find *COMPLEXCODA dominating NOCODA, because as was mentioned earlier, BP allows the coda position of a syllable to be filled, even though it is very restrictive with regards to which consonants are permissible in the coda position. Here is the ranking of *COMPLEXCODA against NOCODA.

Tab. 3 (*pesti* ‘plague’)

/pɛ́sti/	*COMPLEXCODA	NOCODA
a. ☞ pɛ́s.ti		*
b. pɛ́st.i	*!	*

Tableau 3 illustrates that BP allows certain consonants in the coda position but no clusters (see §2.3). If /pɛ́sti/ ‘plague’ is syllabified so that the final vowel acts as its own syllable by syllabifying all the preceding consonants in the coda of the preceding syllable, as in (b), the phonotactics of the language are violated. Furthermore, this type of construction would violate general conceptions of syllabification by not complying with the unmarked CV syllable construction, because we have maximized the coda position of the first syllable, while leaving the onset of the following syllable empty. Candidate (b) above would lose regardless of the ranking, but complex codas are fixed and simple codas are not because BP allows [s] and [r] in the coda. Now, using the previous example, /pɛ́sti/ ‘plague’, we shall rank all five constraints against one another.

Tab. 4

/pέsti/	MAX-IO	*σ[Obs + [-Appx]	*COMPLEX CODA	DEP-IO	NOCODA
a. pέ.si.ti.				*!	
b. pέ.si	*!				
c. pέ.ti	*!				
d. pέ.sti		*!			
e. ☞ pέs.ti					*
f. pέst.i			*!		*

In tableaux 1 it was determined that MAX-IO dominated DEP-IO, and because the ranking holds across the language, MAX-IO dominates DEP-IO in tableaux 4. Output candidate (e) is optimal as it satisfies the higher ranked constraints. Output form (a), the output form that fosters the ideal syllable typology, CV, loses because it violates DEP-IO, which dominates NOCODA. Furthermore, the other output forms lose either because they contain a non-permissible onset or coda cluster, or because a segment was deleted, violating MAX-IO.

Next, another well-formedness constraint is introduced. All languages have onsets and none disallow them. Not all languages allow onsetless syllables; however, BP does, making this constraint low ranked in BP.

(22) **ONSET** Onsets are obligatory (Prince and Smolensky 1993)

Tab. 5 (*tabuada* 'multiplication table')

/tabuada/	MAX-IO	DEP-IO	ONSET
a. ta.bu.tá.dʌ		*!	
b. ☞ ta.bu.á.dʌ			*
c. ta.bu.dʌ	*!		

In tableau 5, both MAX-IO and DEP-IO outrank ONSET, as (b), the optimal output candidate violates ONSET but satisfies both MAX-IO and DEP-IO, illustrating that ONSET is low ranked. By epenthesizing a consonant to create a syllable onset, satisfying ONSET, we violate DEP-IO, the higher ranked constraint. Finally, in (c), it is noticed that if the onsetless syllable is deleted altogether, MAX-IO, the highest ranked constraint, is violated.

Now we can address the topic of regressive nasalization and nasal consonant deletion. As it was previously mentioned, BP does not allow nasal consonants in the coda position of the syllable in the output. Therefore, the nasal consonant regressively assimilates its nasalization onto the previous vowel and is deleted. However, this results in the violation of markedness constraint:

(23) ***Vnasal**: Vowels must not be nasal (Kager 1999)

This constraint states that vowels are not to be nasal, regardless of whether or not they are followed by a nasal consonant. The next constraint states that if a vowel precedes a nasal consonant, then the vowel must be nasalized.

(24) ***VoralN**: Before a tautosyllabic nasal, vowels must not be oral (Kager 1999)

That is, a vowel must not remain oral when followed by a nasal consonant. The nasal feature of the nasal consonant must regressively assimilate onto the previous vowel. This constraint is important in English, where, when a nasal consonant is preceded by a vowel, that vowel gains the nasal feature of the following nasal consonant, such as [sæ̃nd] 'sand'. The next constraint is another MAX-IO faithfulness constraint.

(25) **MAX-IO (N)**: If the feature [+nasal] is in the input form then it must also be in the output form. (McCarthy and Prince 1995)

The purpose of this constraint is for the feature [+nasal] to be retained in the output form if it is present in the input form. The next constraint is another faithfulness constraint that states that if a segment in the input is nasal then it must remain nasal in the output form, and if a segment in the input form is non-nasal then it does not become nasal in the output form.

(26) **IDENT-IO (Nasal)**: Corresponding segments in the input and output must have identical values for [nasal] (McCarthy and Prince 1995)

Here is the ranking for regressive assimilation of nasality onto the preceding vowel and nasal consonant deletion.

Tab. 6 (*transpor* 'to transpose, transport')

/transpor/	*COMPLEXCODA	MAX-IO (NASAL)	MAX-IO	IDENT-IO (NASAL)	*Vnasal
a. trãns.por	*!			*	*
b. trans.por	*!				
c. tras.por		*!	*		
d. ☞ trãs.por			*	*	*

Tableau 6 displays the ranking for regressive nasalization and nasal consonant deletion. Suboptimal output candidates (a) and (b) lose on a violation of *COMPLEXCODA because they retain the nasal consonant in the coda, creating a complex coda in the output. Candidate (c) satisfies *COMPLEXCODA because of the deletion of [n] but loses on MAX-

IO (NASAL), as the feature [nasal] is lost from the input to the output. Output (d) is optimal because it satisfies the two highest ranked constraints *COMPLEXCODA and MAX-IO (NASAL). These constraints illustrate that in BP, the nasal consonant must be deleted to avoid complex coda consonant clusters, and that the feature [nasal], which is realized now on the vowel, must be retained in the output from the input. The optimal output satisfies all these criteria, even though it violates, MAX-IO, IDENT-IO (NASAL) and *Vnasal.

The next phonological process to be discussed is lateral gliding. Earlier, it was discussed that, in BP, if a lateral occurs in the coda position it is glided.

(27) **MAX (LATERAL)**: If the feature [+lateral] appears in the input form then it must also appear in the output form (McCarthy and Prince 1995)

This constraint states that if a segment in the input has a positive value for the feature [lateral] then it must retain that value in the output, thus lateral gliding will violate this constraint.

The motivation behind lateral gliding cannot be understood using only the constraints introduced so far. Lateral gliding occurs because [l] is not permissible on the surface in the coda position and must be glided and syllabified into the nucleus. The lateral is not deleted altogether, as that would incur a violation of MAX-IO, instead it surfaces as a glide. Thus, a coda condition constraint must be introduced, because as it stands now, with using only NOCODA and *COMPLEXCODA, there is no reason for [l] to be forced into the syllable nucleus. Having an [l] in the coda position, is no worse than [s] or [r] according to NOCODA by definition, and as long as [l] surfaces by itself, no violation of *COMPLEXCODA is incurred. Thus, there is generalization that is being missed when only these two constraints are used in conjunction. The generalization is that BP allows only [s] and [r] in the coda position, and any other segment that occurs in the coda underlyingly undergoes some phonological process to satisfy this coda condition. It has been previously mentioned that BP allows only [s] and [r] in the syllable coda, and thus a coda condition constraint stating such must be introduced.

(28) **CODACOND**: Only [s] and [r] are permissible in the syllable coda[9]

[9] See Itô and Mester (1999) for an analysis whereby CODACOND is essentially an alignment constraint.

Tab. 7 (*fácil* 'easy')

/fãsil/	CODACOND	MAX-IO	DEP-IO	MAX-IO (LATERAL)
a. fã.sil	*!			
b. ☞ fã.siw				*
c. fás.il	*!			
d. fá.si		*!		*
e. fá.si.li			*!	

Tableaux 7 shows the ranking for lateral gliding in BP. Suboptimal output candidates (a) and (c) lose on a violation of CODACOND, as the lateral [l] occurs in the coda position, and candidate (d) loses on MAX-IO, as there is no corresponding segment in the output for the input [l]. Candidate (e) loses on the account of DEP-IO being ranked higher than MAX-IO (LATERAL). Optimal candidate (b) wins on the satisfaction of MAX-IO, as the lateral surfaces as [w] and the segment is not lost, and there are no consonants in the coda, satisfying CODACOND.

What tableaux 7 illustrates is that BP wants to satisfy potential violations of CODACOND by gliding [l] to [w] and syllabifying it into the nucleus but not deleting it, as that would incur a violation of MAX-IO. This is all done at the expense of low ranked MAX-IO (L).

CODACOND can also be implemented in the nasalization analysis, instead of using *COMPLEXCODA. The advantage of CODACOND over using NOCODA and *COMPLEXCODA is not only that CODACOND is a combination of both markedness constraints, but also that CODACOND captures the generalization missed by the two constraints. In both nasalization and lateral gliding, a constraint, that of CODACOND, is forcing a simplification of the coda, either through nasal deletion, leaving only [s] in the coda of /ns/ clusters, or lateral gliding, which syllabifies /l/ into the nucleus as [w], satisfying CODACOND. Furthermore, BP wants to retain some feature of the original segment, either the nasalization realized on the vowel, or the glide that is syllabified in the nucleus, which was [l] in the underlying representation.

6.3 Interlanguage Constraint Ranking

This next section will compare the constraint ranking of the interlanguage English to both English and BP, using the same constraints introduced in §6.2. The ranking of faithfulness and markedness constraints with regards to their presence in the interlanguage, English and BP, is discussed, as well as how the interlanguage constraint ranking compared to both the target constraint ranking of English and the native constraint ranking of BP. First, the nasalization process is discussed (§6.3.1), then lateral gliding (§6.3.2) and finally epenthesis (§6.3.3).

6.3.1 Interlanguage Nasalization

In (§2.5) regressive assimilation of nasality and nasal deletion in BP was discussed. The [nasal] feature of a nasal consonant spreads onto the preceding vowel and the nasal consonant is deleted, in some cases to prevent a complex coda. Examples of this are found in (4), which illustrated that this process only occurred when the nasal was in the coda position.

In (§6.2) regressive assimilation of nasality and nasal deletion in BP was explained using a constraint-based approach. The constraint ranking formulated in the above analysis illustrated that there were two important processes occurring during the assimilation and deletion. First was the elimination of the complex coda /ns/ by the high ranking *COMPLEXCODA (or now CODACOND), which forced the deletion of [n]. The second was that even though the nasal [n] was deleted, its feature [nasal] must be retained in the output, which surfaced on the vowel, motivated by MAX-IO (NASAL). These two constraints were ranked against MAX-IO, IDENT-IO (NASAL) and *Vnasal. Tableaux 6 illustrated this ranking for the form *transpor* 'to transpose, transport.'

In English, regressive assimilation of nasality also occurs, but the nasal consonant is retained in the output. This was illustrated in (14), which introduced a contrastive analysis of English and the interlanguage English collected in the data. A ranking for English is introduced here and then followed by the interlanguage ranking. The tableaux below illustrates that if *COMPLEXCODA is dominant in English, as it is in BP, then the coda is forced to be reduced as it is in (c), which thus produces the incorrect optimal output form. This is not the case in English as complex syllable margins are permissible.

Tab. 8 'plant' (English output using BP ranking)

/plant/	*COMPLEX CODA	MAX-IO (NASAL)	IDENT-IO (NASAL)	*Vnasal
a. plant	*!			
b. ☞ plãnt	*!		*	*
c. ☹ plãt			*	*
d. plat		*!		

The ranking here is similar to the BP ranking in tableaux 6. Tableaux 8 illustrates that another constraint is present, working to retain [n] in the output and that *COMPLEXCODA must be low ranked as suboptimal candidate (c), which according to the ranking in tableaux 8, is just as optimal as the correct candidate (b). The ranking in tableaux 8 effectively eliminates (8a), the input faithful candidate, because English wants to regressively assimilate nasality, motivated by high ranking *VoralN, and (8d) loses on the fact that English wants to retain the [nasal] feature in the output. The conflict between (8b) and (8c) arises because the feature [nasal] remains in both output candidates, and the only difference is the presence of [n] in candidate (b) and the absence of [n] in candidate (c). This means that a constraint forcing input segments to remain in the output is present. A constraint of this type was introduced earlier in (18), MAX-IO, which states that input segments must have output correspondents. Introducing this constraint, with *VoralN, high into the ranking above will effectively eliminate (8c) as a possible output, as [n] is lost from the input to the output, and choose (b) as optimal.

Tab. 9 ‘plant (reranking)’

/plant/	*VoralN	MAX-IO	MAX-IO (NASAL)	IDENT-IO (NASAL)	*Vnasal	*COMPLEX CODA
a. plant	*!					*
b. ☞ plãnt				*	*	*
c. plãt		*!		*	*	
d. plat			*!			

Thus far, the constraint ranking for regressive assimilation of nasality in English has been introduced and compared to the ranking for the same process in BP. The difference lies in the fact that BP wants to satisfy *COMPLEXCODA or CODACOND and thus deletes the nasal consonant with nasality assimilated so that it can surface. However, in English, if *COMPLEXCODA were ranked in the tableaux it would be ranked low, beneath MAX-IO, as English would rather have a complex syllable margin than lose a segment in the output. The constraint *VoralN motivates the assimilation and MAX-IO either retains the segment in English or *COMPLEXCODA or CODACOND motivates the nasal consonant deletion in BP. In BP MAX-IO was ranked below *COMPLEXCODA or CODACOND.

Next the interlanguage constraint ranking for nasalization is formulated and compared to the rankings in English and BP. In (§5.2), it was discussed that the native speakers of BP generally transfer this process into their interlanguage English. The forms used in the analysis below are from (14).

In the interlanguage English, the native BP speakers regressively assimilated the nasality and then deleted the nasal consonant. This is identical to the process in BP. What this illustrates is that the markedness constraint, *COMPLEXCODA or CODACOND, are transferred in the interlanguage with a dominant ranking, forcing the deletion of the nasal, while the constraint MAX-IO (N) motivates the assimilation. The ranking should then be identical to the ranking in BP for regressive assimilation of nasality and nasal deletion. The interlanguage output form of /plant/ is [plãt]. This is illustrated through the same ranking as in Tableaux 6.

Tab. 10 ‘plant (interlanguage form)’

/plant/	*COMPLEX CODA	MAX-IO (NASAL)	MAX-IO	IDENT-IO (NASAL)	*Vnasal
a. plant	*!				
b. plãnt	*!			*	*
c. ☞ plãt			*	*	*
d. plat		*!	*		

The English optimal output form (10b) loses on the violation of high ranking *COMPLEXCODA, and candidate (10c) wins on the satisfaction of *COMPLEXCODA. The optimal interlanguage output form violates MAX-IO, but MAX-IO is ranked low, illustrating that in the interlanguage it is better to violate MAX-IO, while satisfying the higher ranked *COMPLEXCODA. The two typologies are illustrated in (29).

(29) Typologies of BP, English and IL English
BP: *COMPLEXCODA, CODACOND » MAX-IO
English: MAX-IO » *COMPLEXCODA

Figure (29) shows the distinct rankings between English and BP. In BP, the markedness constraints, *COMPLEXCODA or CODACOND, dominate the faithfulness constraint MAX-IO. This illustrates that BP would rather syllabify according to the phonotactics of the language than to remain faithful to the input form. In English, according to the typology in (29), it is more optimal to remain faithful to the input than to satisfy certain markedness constraints.

The discussion thus far proposes that the process of regressive assimilation of nasality and nasal deletion in BP is transferred into the in interlanguage along with the native BP constraint ranking. This deviates from native English in the sense that the faithfulness constraint MAX-IO is violated in the interlanguage.

6.3.2 Emergence of the Inactive Constraint: MAX-IO (OBS)

There are two important components omitted in the above section (§6.3.1). Firstly, a possible output candidate has not been evaluated by the above ranking in Tableaux 10, and secondly, a typology, that of the interlanguage English, has been omitted in (29).

The unevaluated candidate absent from Tableaux 10 is that of [plã], which according to the ranking, if CODACOND was transferred into the interlanguage phonology, as it should be, would prove to be more optimal than the optimal candidate [plãt], Tab. 10c. Thus, a constraint that ensures the retention of [t] in the output but does not effect the loss of [n] must emerge into the ranking. This constraint could most aptly be formulated as MAX-IO (OBS), which is introduced and defined below:

(30) **MAX-IO (OBS)**: Every obstruent (oral stop, fricative, affricate) in the input must be retained in the output.

The emergence of this constraint in the interlanguage retains the [t] and has no effect on the retention or loss of [n]. The interaction of this constraint with *COMPLEXCODA and CODACOND, along with MAX-IO (NASAL), which retains the feature [nasal] from the input to the output, selects the optimal candidate exhibiting a simplification of a complex coda, while retaining the feature [nasal] and the segment [t].

Tab. 11 'plant (refined interlanguage form)'

/plant/	MAX-IO (OBS)	*COMPLEX CODA	MAX-IO (NASAL)	CODA COND	MAX-IO	IDENT-IO (NASAL)	*Vnasal
a. plant		*!		*			
b. plãnt		*!		*		*	*
c. ☞ plãt				*	*	*	*
d. plat			*!	*	*		
e. plã	*!				*	*	*

The emergence of MAX-IO (OBS) in the interlanguage eliminates the otherwise optimal candidate (e). Because the only consonants that occur in the coda position of the input in BP are /s r n l/, the retention of [t] in the coda is never attested. This follows Broselow (1998), whereby the interlanguage output does not necessarily reflect the phonological system of the native language. Outputs exhibiting non-native like forms is often the result of basic faithfulness constraints acting upon input forms divergent of input forms present in the native language. Thus, unmarked outputs, with features attributable to both the native and target languages, surface.

The typology for the interlanguage ranking differs from the BP ranking with the emergence of MAX-IO (OBS). Inputs present in the target language that do not appear in the native language often cause constraints, otherwise inactive in the native language, to become active in the interlanguage. Constraints in OT do not operate on a binary system like distinctive features do, rather all constraints are present in an OT grammar, and with those higher-ranked having a greater influence on the output selection.

6.3.3 Lateral Gliding in the Coda Position

In (§3.4) lateral gliding in BP was discussed, and it illustrated that when a lateral, namely [l], occurred in the coda position, it was glided and syllabified into the nucleus of the syllable. The force behind lateral gliding is the high ranking of CODACOND in BP.

The constraint ranking motivating this process was presented in tableaux 7, where CODACOND, primarily, forces the lateral to glide to [w] and be syllabified in the nucleus. This alternation occurs at the expense of a violation of MAX-IO (LATERAL).

This process, which occurs in BP, does not occur in English, where it is better to retain the feature [lateral] in the output from the input than to incur a violation of CODACOND. This is plausible in the sense that English is much less restrictive in the coda than BP. In English, MAX-IO (LATERAL) would dominate CODACOND. This is evident in tableaux 12, which ranks the two constraints against one another using the form [tɐl] 'tall.'

Tab. 12 'tall'

/tɐl/	MAX-IO (L)	CODA COND
a. ☞ tɐl		*
b. tɐw	*!	

Tableaux 12 shows the strict domination of MAX-IO (LATERAL) over CODACOND. Thus, in English it is better to have a segment occupying the coda position than to lose the feature [lateral] in the output. In BP, the opposite was the case where CODACOND dominated MAX-IO (L) forcing /l/ to glide and syllabify into the coda, satisfying CODACOND.

In (§5.3) it was illustrated that this process, generally, is transferred into the interlanguage English. This would mean that the ranking from BP holds in the interlanguage, as opposed to the ranking in English. Thus, CODACOND must dominate MAX -IO (L). This is illustrated in tableaux 12.

Tab. 13 'tall (interlanguage form)'

/tɐl/	CODA COND	MAX -IO (L)
a. tɐl	*!	
b. ☞ tɐw		*

Tableau 13 shows that when CODACOND dominates MAX-IO (L) it is better to glide the lateral than to violate CODACOND. This ranking holds in both BP and the interlanguage English, and the opposite ranking holds in native English. The two typologies are present in (31).

(31) Lateral Gliding Typologies

BP: CODACOND » MAX-IO (L)
English: MAX-IO (L) » CODACOND
IL English: CODACOND » MAX-IO (L)

6.3.4 Epenthesis in Interlanguage English

The last interlanguage process to be discussed is epenthesis to dissolve possible problematic complex syllable margins. Two types of epenthesis are possible, the first entails physically breaking up a non-native consonant cluster. For example, if a tautosyllabic [sɣ] cluster occurred underlyingly in some language X, and that language did not permit such a cluster, then [ə] could be epenthesized as such, [səɣ], which breaks up the cluster. The second type is to force a resyllabification of the adjacent segments in violation by epenthesizing before the cluster. For example, taking the same cluster [sɣ] and epenthesizing [ə] before the [s] creating [əsɣ] where the [s] is syllabified into the coda of the new syllable and [ɣ] remains as the onset of the input syllable. This type of epenthesis is present in Spanish, which has CONTIGUITY-IO, a constraint barring against medial epenthesis or deletion of segments, ranked high.

In BP (§2.1) when words are borrowed that contain impermissible consonant clusters, BP epenthesizes [i] to break up this cluster. This process was evaluated by constraints in Optimality Theory in tableaus 1 and 2. In these rankings, DEP-IO ranked lowest and was dominated by *σ[Obs + [-Appx].

In English complex syllable margins are permissible and thereby DEP-IO and MAX-IO dominate *COMPLEX. This is opposite of BP. In the interlanguage, as discussed in (§5.1), it would be expected that the ranking of *COMPLEX would be high, as it was in the interlanguage account of nasalization, dominating MAX and DEP constraints, as BP would rather satisfy *COMPLEX and violate MAX and DEP constraints. So, in the interlanguage English, this ranking should be transferred. In English, the MAX and DEP constraints are ranked high, and in terms of breaking up complex syllable margins, it is better to have a complex margin than violate the faithfulness constraints. The two typologies are introduced in (32).

(32) Typologies for Epenthesis
BP: *COMPLEX » MAX-IO, DEP-IO
English: MAX-IO, DEP-IO » *COMPLEX

The only time English epenthesizes is in borrowed words, which is the same as in BP. So in both cases the languages are very faithful to their inputs. The question in this section is, however, if the native BP speakers would epenthesize when confronted with non-BP clusters.

Also discussed in (§5.1) is that there was very little epenthesis occurring in the collected data, at least not enough to make a generalization. Possible explanations for this are explained in the conclusion. But to use the input faithful forms as optimal in the interlanguage would comply with the ranking in English but violate the ranking in BP. This counters what was found in (§6.3.1) and (§6.3.2), where the interlanguage ranking was transferred from BP, even though it went against the target English ranking.

7.0 Conclusion

This paper has given a basic introduction to the contrasting phonologies of English and BP, and more importantly discussed the transferring of constraint rankings from a native language to an interlanguage. The BP processes of regressive assimilation of nasality and nasal deletion, lateral gliding in the coda position and epenthesization were discussed, and the rankings motivating these processes, using an Optimality Theoretic approach, were formulated and analyzed. The interlanguage data was collected, analyzed and a ranking for the interlanguage was formulated and then compared to the rankings in BP and English.

Broselow, et. all (1998) argued that second language learners often have a tendency to favor less marked structures in the interlanguage. Particular markedness constraints that are not visible in the native language either surface because of the richness of the target-language input or the development of a phonology that differs from the native language phonology. In terms of this argument applied here, it is evident that for one, BP already has a fairly unmarked syllable structure that motivates certain phonological alternations, and from the data above, it is evident that the rankings were transferred with regards to nasality and lateral gliding. However, there were isolated cases of a more advanced second language learner of English that did not delete the nasal and uttered the complex coda. This may be an example of the richness of the input forms providing an alternative phonology from the native language. For example, BP does not allow the fairly unmarked [t] in the coda position, as English does, but it is more likely for that segment in that position to be produced in the coda in the interlanguage than deleted or vowel epenthesis to syllabify it into the onset. This is evident in Broselow's argument that a less marked interlanguage is favored even though it may differ from the native language. But this is left for future research.

In the cases of regressive nasality and lateral gliding, the rankings were transferred from the native language to the interlanguage according to the acoustic data, with an emergence of MAX-IO (OBS) in the interlanguage. In the case of epenthesis, the expected results were not found and near native-like production was present. There are two possible explanations for this. Either one, complex English onset and coda consonant clusters are easier to produce for native speakers of BP, or, more likely, there was a fault in the data collection. By placing the target forms between two vowels it may have eased the pronunciation, because the vowels could act as the nucleus of a syllable and the exterior most consonants in the clusters could have been syllabified around these vowels. In order to fully validate the analysis, future research with more participants is needed as well as a different method for eliciting the target words in question. However, because of the strong evidence of transference in the limited data of nasalization and lateral gliding, it is evident that the native language ranking is transferred into the interlanguage of the target language.

8.0 References

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