FORMALIZATION OF THE ASYMETRY OF THE LATERAL IN SYLLABLE ONSET AND CODA POSITIONS IN PORTUGUESE SPOKEN IN THE *CAMPOS NEUTRAIS* IN THE LIGHT OF THE STOCHASTIC OT

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▪ ABSTRACT: The focus of this study is the asymmetry of the lateral liquid in syllable onset and coda positions, since it shows phonetic stability in onset position and variation in coda position. Taking into account that the pre- and postvocalic laterals perform differently in Portuguese and in Spanish, this study aims at analyzing the Portuguese spoken in the *Campos Neutrais*, a region on the Brazil-Uruguay border, because of its contact with Spanish. Its empirical basis, which was taken from Espiga (2001), is the Portuguese spoken in the *Campos Neutrais*, since this author states that, in this region, the lateral in onset position performs as an alveolar whereas it may take five phonetic forms in coda position, i.e., alveolar, velar, labial, glide and phonetic null. The explanation and the formalization of the asymmetry of the lateral liquid have been based on the Stochastic Optimality Theory (StOT), through constraints. Having the mechanism of relational alignment as its background, this study proposes sonority distance constraints adapted from Gouskova (2004). However, differences lie in the fact that this study takes into account the relation between the onset and the nucleus, besides the one between the nucleus and the syllable coda.

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▪ KEY WORDS: Lateral liquid. Syllable onset and coda. Stochastic OT. Portuguese spoken in the *Campos Neutrais*.

Introduction

The lateral liquid is one of the licensed segments to occupy syllable onset and coda positions in Portuguese. Due to the specificity of each syllable constituent, the behavior of this consonant is asymmetric, giving evidence to phonetic stability in onset position and variation in coda position. In search of the explanation and the formalization of this asymmetry, this study focus on the discussion of the pre- and postvocalic lateral in a variant of Portuguese which is in contact with Spanish, in the light of the Stochastic Optimality Theory (Stochastic OT).

The variable behavior of the postvocalic lateral liquid is a characteristic shared by three other consonants which may occupy this position in syllables in Portuguese. Studies of the lateral in syllable coda position, such as the ones carried out by Quednau (1993), Tasca (1999) and Espiga (1997, 2001), have analyzed this variation and described its linguistic and social conditioning, mainly regarding the Portuguese spoken in the south of Brazil. One of the social motivation factors that trigger different phonetic forms of the lateral is language contact, the theme chosen for this paper.

With the support of the Stochastic Optimality Theory (BOERSMA; HAYES, 2001), in order to attribute formal treatment to the phenomenon of the variation of the lateral in syllable coda position due to language contact, as well as of the asymmetry that might happen in the behavior of the segments in syllable onset and coda positions, this study focused on the Portuguese spoken in the *Campos Neutrais*[1] on Brazil-Uruguay border, because of its contact with Spanish. In the Spanish language, the postvocalic lateral tends to take, with significant predominance (ESPIGA, 2001), the phonetic form of an alveolar lateral (e. g., du[l]ce, arbo[l]), whereas, in Brazilian Portuguese (BP), according to Quednau (1993) and Collischonn and Quednau (2008), predominantly, it takes the voiced phonetic form [w], in variation with the velarized form [ɫ] (e. g.: a[w]ma ~ a[ɫ]]ma, fina[w] ~ fina[ɫ]). According to Espiga (2001), in the BP spoken in the *Campos Neutrais*, the postvocalic lateral may take five phonetic forms: alveolar [l], velar [ɫ], labial [l^w], glide [w] and phonetic null. However, in the onset position, the lateral performs as alveolar [l], both in Spanish (e. g.: [l]a.na; cons.te.[l]a.ción) and in Portuguese (e. g.: [l]a.ta; es.tre.[l]a), even in the BP spoken in the *Campos Neutrais*.

1 **Campos Neutrais** is a region which stretches from the *Banhado do Taim*, a swamp area, to *Arroio Chuí*, a narrow river, in the extreme south of Brazil. Two cities, Santa Vitória do Palmar and Chuí, are located in this area. This name was given to the region by the Portuguese and the Spanish in 1777.

The choice of a formal presentation of the phenomenon of the variation of the lateral in syllable onset and coda positions and of the asymmetry among such syllable constituents in the light of the Stochastic OT was based on the reflection upon how languages work and their representations in models of linguistic analysis which operate with constraints rather than rules. In addition, this study also aims at verifying how Stochastic OT depicts relations between input and output in the grammar of speakers of the BP variant under investigation, taking into account markedness and faithfulness constraints, considering its contact with Spanish.

Its empirical basis was taken from Jorge Espiga's doctoral dissertation (ESPIGA, 2001) whose data were treated with methodological accuracy and whose focus is the Portuguese spoken in the *Campos Neutrais*.

Theoretical Fundamentals

The Empirical Basis of the Paper

Even though Portuguese is spoken along the whole Brazil-Uruguay political border, it is heterogeneous Portuguese, which varies according to the border region which is taken into consideration. Since this political border scarcely coincides with the linguistic one between Portuguese and Spanish, the level of contact between both languages has also been variable; in fact, variability is one of the causes of heterogeneity.

In his study, Espiga (2001) focused on the *Campos Neutrais* region and used Phonology and Labovian Sociolinguistics as theoretical references in order to discuss aspects which are inherent to the representation of the postvocalic lateral, to its variation and to the structural conditions of this variation, besides relevant social and extralinguistic conditioning found in this phenomenon. Regarding the syllable coda position, the author describes five possibilities: the alveolar lateral [l], the glide [w], a simple velar allophone [ɫ], a labial coronal allophone [l^w] and phonetic null.

The presence of [l^w], as a form interposed between [ɫ] and [w], was verified in the variation; the intermediate and transitional character of this variant enables it to be included in the telescopic rule whose stages were all mapped in the region under study.

Some basic fundamentals of the Stochastic OT are described below, since it is a theoretical model which is able to account for variable phenomena.

The Stochastic Optimality Theory

The Optimality Theory (OT), a model proposed by Alan Prince and Paul Smolensky in 1993, is a model of linguistic analysis which operates through the interaction of universal constraints. Basically, this model provides mappings from inputs (underlying representations) to outputs (surface realizations) through three components: GEN, which generates a list of candidates for outputs, based on an input; CON, which forms a set of violable constraints, ordered to decide the "best" candidate for output; and EVAL, which chooses the optimal candidate, based on the constraints. In this theoretical approach, linguistic processing is parallel, i. e., from an input, several candidates for outputs are analyzed simultaneously. The optimal candidate will be the one that obeys the top-ranked constraints; the number of violations this candidate incurs to the low-ranked constraints is not taken into consideration.

Tableau (1) provides an example:

Tableau 1 – Quasi

/*input*/	Constraint 1	Constraint 2
☞ *output* 1		****
output 2	*!	

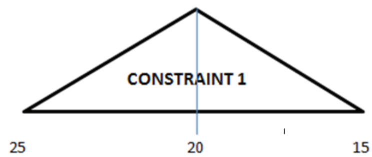
Source: Made by the authors.

On the tableau of the previous example, the first column shows the given input and the candidates for output (outputs 1 and 2). The other columns show the constraints in a dominance hierarchy – where constraint 1 dominates (>>) constraint 2 – and the violation marks incurred by every candidate for output (*). The exclamation mark also shows that the candidate for output 2 incurred a crucial violation; thus, there is no way for it to be optimal. The pointing finger marks the candidate for output 1, which was the optimal one, i. e., the winning candidate.

This type of relation among constraints is called strict dominance, a fundamental notion in the OT. For instance, if there is a rank Constraint 1>> Constraint 2>> Constraint 3, the candidate which violates constraint 1 is automatically eliminated.

In the proposal of the Stochastic OT (BOERSMA; HAYES, 2001), the grammar components (CON, GEN and EVAL) perform the same functions of the Classic OT. However, constraints are attributed numerical values which order these constraints in a hierarchy. Every constraint gets two numerical values or weights: the ranking value and the disharmony value. The former represents the center point of the range, which is a scale with 10 points. For instance, if the central value of a constraint is 20, it means that the range of this constraint is from 15 to 25, according to the representation in (2), adapted from Azevedo (2011).

Figure 1 – Example of range of values to a constraint

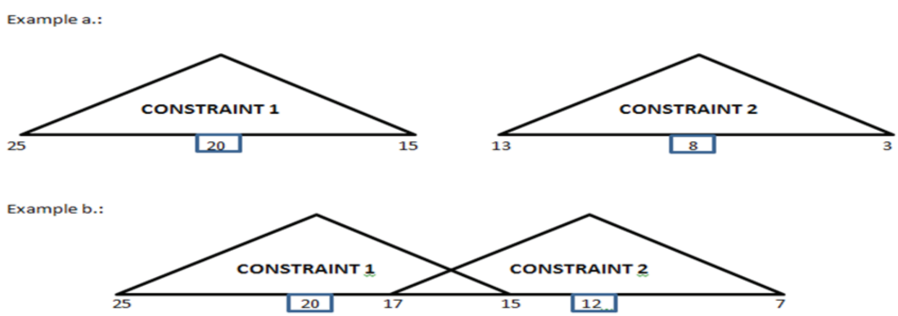


Source: Made by the authors.

Thus, the central value of the constraint does not change (in the example above, it is always 20), but the value of the selection point, when linguistic production is carried out, might be any value within the range (it might be 15, 16, 17... 25).

An important issue of Stochastic OT is related to the fact that it comes along a learning theory and is associated with an algorithm called *Gradual Learning Algorithm* (GLA). Grammar is considered stochastic because, whenever a group of candidates is evaluated, noise is temporarily added to the ranking value of every constraint, so that grammar can yield variable outputs in case the central value of some constraint is close to the one of another constraint. Representations, adapted from Azevedo (2011), are shown as examples in (3).

Figure 2 – Example of ranking between constraint



Source: Made by the authors.

In example (3a), it may be observed that the difference between central values 20 (constraint 1) and 8 (constraint 2) is higher than 10 (20 – 8 = 12). It means that, regardless of the value of the selection point attributed to constraints 1 and

2 by the simulation, they always keep the same hierarchy, i. e., Constraint 1>> Constraint 2. Example (3b) shows that the proximity between the central values of the constraints, i. e., 20 (constraint 1) and 12 (constraint 2), enables them to invert their positions in the hierarchy if the selection point of constraint 2 is higher than the value of constraint 1.

The algorithm is responsible for guiding the learner's linguistic system through a constraint demotion, as proposed by Tesar and Smolensky (1998). However, the difference is that the GLA demotes and promotes constraints (BOERSMA; HAYES, 2001). This proposal accounts for the variation yielded by learners: according to Alves (2009), in the light of the fundamentals of this algorithm, learners get an input-output mapping, one at a time; what determines optimal output is the current state of the grammar.

The GLA is sensitive to the learner's errors, i. e., it is error-driven (BOERSMA; HAYES, 2001). Thus, it changes the values of the constraints when the output of its grammar has a different pattern from the one found in the environment language (error). It is through values attributed to constraints that the GLA represents variable or categorical outputs. Central values whose distance from each other is higher than 10 points represent the categorical result, since different moments of linguistic production do not cause overlapping in the range of these constraints (see (3a)). However, when the central values of the constraints are separated by less than 10 points, there could be range overlapping, a fact that could change the ordering of the constraints and, as a result, the optimal candidate, thus, characterizing variation in the outputs (see (3b)).

A very important remark must be made regarding result interpretation when dealing with probability: the central value never changes but the selection point does; this variation is likely to occur when values are closer to the central value, i. e., if the value range of a constraint varies from 0 to 10 (central value = 5), the values of the selection point are likely to be close to 5, rather than closer to the limits of the value range (0 or 10). This concept enables the algorithm not only to show variable candidates (e. g.: [sa**w**] or [sa**l**]), but also to capture the difference of probability in which they may show up[2].

Therefore, since this study takes into account the phenomenon of variation, it carries out an analysis based on the presuppositions of the Stochastic OT, connected to the GLA, proposed by Boersma and Hayes (2001), which is able to deal with the variable outputs found in the data on Portuguese spoken in the *Campos Neutrais*.

[2] In order to carry out these ideas more precisely, the value ranges of the constraints have been explained as a probabilistic distribution (BOERSMA, 1997, 1998; HAYES; MACEACHERN, 1998) – normal distribution (the Gauss curve).

Methodology

Data of the Analysis

In this study, empirical data taken from Espiga's (2001) doctoral dissertation were analyzed, as previously mentioned in Section 1. They come from the BDS Pampa Project – *Banco de Dados Sociolinguísticos da Campanha Sul-Rio-Grandense*, a database which belongs to the Post-graduate Program in Languages at UCPEL, a higher education institution in the south of Brazil.

The sample collected by Espiga (2001) comprised 2,963 data on the lateral in the coda position, which were submitted to the VARBRUL[3] system. Five variants of the postvocalic /l/ were analyzed. The author shows the distribution of the variants mapped in the scope of the variation; it shows all stages of the telescopic rule in the region, as depicted in Table 1 (ESPIGA, 2001, p.109):

Table 1 – Distribution of the variants of the postvocalic lateral in the *Campos Neutrais* region

	[l]	[ɫ]	[lʷ]	[w]	ø	Total
N	1297	701	903	41	21	2963
%	44	24	30	1	1	100

Source: Espiga (2001, p.109).

Percentages are the values used for the final analysis in the Stochastic OT model. Such values in Table 1, which were described in its last line (%), were produced by programs IVARB, TVARB and MVARB. The number of occurrences for every variant can be found in the line above the percentage, i. e., line N. The last column (total) depicts the sum of the occurrences of all variants (2,963), resulting in 100% frequency.

Even though Table 1 only shows the data on the variants in coda position, this study does not deal only with the lateral in this syllable position; it aims at differentiating the behavior of the lateral liquid in coda position from the one observed in syllable onset position. In onset position, the lateral liquid keeps its phonetic form as alveolar, both in Spanish ("**l**ejos") and in BP ("**l**ei"); consequently, it is also kept in the BP spoken in the *Campos Neutrais*.

3 The VARBRUL system was proposed by Cedergren and Sankoff (1974).

Therefore, this study aims at formalizing the asymmetry between onset and coda, considering the behavior of the lateral liquid in the variant of BP spoken in the *Campos Neutrais*.

The Formalization of the Constraints

The proposition of constraints was based on the search for carrying out the best analysis for every phonetic form that can represent the postvocalic lateral in the syllable margins by exploring constraints committed to universal grammar, i. e., constraints found in the grammar of any language, but differentiated by their ranking. Therefore, the harmony scale with points along it, dorsal > labial > coronal (PRINCE; SMOLENSKY, 2004), seemed to be adequate to establish the differences of points of articulation between lateral liquids [l, ɫ, l^w], which are the focus of the analysis. Since this study shows the behavior of the lateral in syllable coda and onset positions, the harmony scale with points is used so that the asymmetry between the limits of the syllables can be respected.

According to the Sonority Cycle (CLEMENTS, 1995), sonority is maximally increased in the relation onset towards the syllable nucleus whereas it decreases slightly from the nucleus to the coda. It means that there is clear interlinguistic preference for syllables that start with less sonorous segments in the onset – in the case of the laterals, the alveolar segment would be the most harmonic [l], by comparison with the other possibilities [ɫ, l^w, w] – whereas the preference is for lower differences in sonority in the relation nucleus-coda. In this case, the most harmonic segment would be the glide [w], then, the labial [l^w], the dorsal [ɫ] and, finally, the coronal [l].

Therefore, in this study, differences in the point of articulation among the variants found in the dialect spoken in the *Campos Neutrais*, are given by the constraints *lateral{dorsal}, *lateral{dorsal, labial} and *lateral{dorsal, labial, coronal}. The representation of the markedness suggests that there is a stringency[4] relation among the constraints; it makes the dominance among points of articulation dorsal >> labial >> coronal emerge in the analysis as subsets of violation, in which more marked structures lead to the demotion of the other constraints in the hierarchy.

Based on the reflection on the asymmetries among all different possibilities in syllable onset and coda, it was also necessary to establish and define sonority

4 The stringency relation expresses the markedness relation which exists among the members of a scale, whose formalization is based on the order in which every member is acquired. Therefore, the subsets can show that the most harmonic forms are acquired first. (A detailed discussion of the stringency relation can be found in Alves, 2008; McCarthy, 2002; and Prince, 1997 a, 1997b).

distances, not only between the onset and the nucleus but also between the nucleus and the coda, with the help of a sonority scale. Bonet and Mascaró's scale (1996) was adapted and then used for characterizing the existing asymmetries between the syllable coda and onset, as well as establishing the most harmonic segments, according to a given syllable position.

Constraints of sonority distance were based on Gouskova's (2004) relational alignment mechanism which tries to establish a relation of sonority distance between the coda and the onset of the next syllable or between complex onsets and codas, with a sonority scale. In this study, however, the aim is to depict the most harmonic distances between the onset and the nucleus, as well as between the nucleus and the coda. Thus, in Bonet and Mascaró's (1996) scale:

(4)

0	1	2	3	4	5
OCCLUSIVES –	STRONG-r, FRICATIVES -	NASALS -	LATERALS -	WEAK-r, GLIDES –	VOWELS

and, in the sonority scale which was adapted to consider the variants of the alveolar lateral [l] ~ [ɫ e l^{w}], the following representation arises (5):

(5)

0	1	2	3	4	5	6	7
OCCLUSIVES –	STRONG-r, FRICATIVES -	NASALS -	**ALVEOLAR LATERAL –**	**DORSAL LATERAL –**	**LABIAL LATERAL** -	WEAK-r, GLIDES –	VOWELS
				LATERALS			

Thus, the variants of the laterals found in the region of the *Campos Neutrais* can be accounted for, as shown by Espiga's (2001) data.

Based on the same values of sonority previously established, the distance between the onset and the nucleus, as well as between the nucleus and the coda, was differentiated by positive and negative values[5]. Since the data refer to a border region between Portuguese and Spanish, it may be stated that the nucleus will always be vocalic (ALARCOS LLORACH, 1994; HARRIS, 1983; BISOL, 2005; CÂMARA JÚNIOR, 1975), getting 7 in the scale. As a result, the relation of distance between the onset and the nucleus and between the nucleus and the coda of the syllable under study was established as follows:

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[5] Positive and negative values have been chosen by the authors of this text to show that, from the onset to the nucleus, there is a difference between a lower value and a higher value (e.g..: alveolar[**onset**] – vowel[nucleus] = 3 – 7 = -4), a fact that makes the result become negative. From the nucleus to the coda, this difference results from a lower value subtracted from a higher one; thus, the result is always positive (e.g..: vowel[nucleus] – alveolar[coda] = 7 – 3 = + 4).

(6)

Sonority distance from the onset to the nucleus (e.g.: **la**.ta)
Lateral alveolar [l] (value = 3) – vowel (value = 7) = Distance = -4
Lateral dorsal [ɫ] (value = 4) – vowel (value = 7) = Distance = -3
Lateral labial [lʷ] (value = 5) – vowel (value = 7) = Distance = -2

Sonority distance from the nucleus to the coda (e.g.: a.ni.m**al**)
Vowel (value = 7) – lateral alveolar [l] (value = 3) = Distance +4
Vowel (value = 7) – lateral dorsal [ɫ] (value = 4) = Distance +3
Vowel (value = 7) – lateral labial [lʷ] (value = 5) = Distance +2

Since this study deals with sonority distances among the nucleus and the syllable onset and coda positions, this constraint was chosen to be represented as "Dist_{ONC}[6]", unlike the constraints Dist found in Gouskova (2004). Likewise the treatment given to point constraints (*lateral{ dorsal, labial, coronal}), constraints DIST_{ONC} also carry a stringency relation; in the analysis, less marked structures emerge first.

The representations followed for faithfulness constraints in this study are among the three basic constraints of faithfulness listed by McCarthy and Prince (1995, 1999): MAX – deletion is prohibited; and $\text{IDENT}_{\text{lateral}}$ – change of values typical of laterals is prohibited. The first constraint made structures with deletion be excluded from the possibility of winning the dispute for optimal candidate, since they represent a possible, but scarce, structural variety in the *Campos Neutrais*. It means that, in the organization of constraints, this constraint must always look for the top-ranked positions. The same must occur with the constraint $\text{IDENT}_{\text{lateral}}$, which violates those structures that are not suitable in the presence of lateral liquids, both in coda and in onset. Thus, it shows up on the top of the ranking, since it violates what is less frequent in the situations studied in the *Campos Neutrais*, such as coda [a.ni.maø or a.ni.maw].

The behavior of the onset in Brazilian Portuguese and Spanish is the same: however, regarding coda, Spanish has a more marked characteristic by comparison with BP, in relation to the presence of the lateral. The data collection carried out in the *Campos Neutrais* – a Brazilian region that shares borders with native Spanish speakers –, highlighted the prevalent presence of the marked (alveolar [l]) in coda due to language contact (see Table 1). This unexpected situation prevents

[6] ONC = Onset/Nucleus/Coda.

It is important to point out that distances among onset dorsal lateral *[ɫa.ta], labial lateral * [lʷa.ta] and glide *[wa.ta], with the nucleus, do not occur in the region of the *Campos Neutrais*, as shown in Table 1; therefore, these distances were removed from the analyses shown in the tableaux – since they would be playing a redundant role – so that the constraint that involves the distance *onset* alveolar lateral and nucleus [la.ta] can be shown.

the stringency relation from capturing it, a fact that triggered the proposition of a conjoined constraint which relates the constraints of the point of articulation with the sonority distance (*$DIST_{ONC(2)}$&*lateral{d,l,c}), so that the behavior of the lateral in coda in BP and Spanish can be differentiated.

Therefore, the constraints which are responsible for the representation of the data are the following[7]:

(7)

$IDENT_{lateral}$
MAX
*$lateral_{\{dorsal\}}$ *$lateral_{\{dorsal,\ labial\}}$ *$lateral_{\{dorsal,\ labial,\ coronal\}}$
*$DIST_{ONC(-4)}$, *$DIST_{ONC(4)}$, *$DIST_{ONC(3,4)}$, *$DIST_{ONC(2,3,4)}$, *$DIST_{ONC(1,2,3,4)}$
*$DIST_{ONC(2)}$&*lateral{d,l,c}

Description and Analysis of Results

The data analysis aims at accounting for the asymmetry which can be found in the behavior of the lateral liquid, in the syllable onset and coda positions, in the variant of BP spoken in the *Campos Neutrais*, in the light of the Stochastic OT.

Regarding the lateral in the syllable coda position, based on Espiga's research (2001), the stages of the telescopic rule in the BP spoken in the *Campos Neutrais* were mapped. In BP, the lateral in postvocalic position usually behaves as a semivowel [saw] whereas in Spanish, in the same syllable position, the alveolar [sal] emerges.

Taking into account the primitive stage of the rule – the variant alveolar [l] –, two other variants were mapped, i. e., the velar [ɫ] and the labial [l^w], as intermediate stages in the vocalization process, a fact that characterizes the origin of the process of linguistic change in the evaluation of the transition stage between the alveolar and the voiced forms. Table 1 (the distribution of variants found in the region of the *Campos Neutrais*) shows that the alveolar lateral [l] predominates with 44%, followed by variants [l^w] and [ɫ], with 30% and 24%, respectively.

On the tableaux yielded by the PRAAT software (below), the hierarchy of the constraints of every possibility for optimal candidate is shown. The tableaux are presented in the order of frequency in which every structure occurs, from the most frequent [l] to the least frequent [w] and [ø]. Tableaux 1(a) and 1(b) show both syllable positions under study: the onset position (1a) and the coda position (1b).

7 Acronyms for constraints on the tableaux depicted in chapter 3 had to be adapted to the space provided by the PRAAT software.

(a) *Tableaux* 1(a) and 1(b) – Distribution of variants in the region of the *Campos Neutrais* [l]

1(a)

/lama/	Ident (lat)	*lateral$_{\{dors, lab\}}$	*DIST$_{ONC(4)}$	Max	*DIST$_{ONC(3,4)}$	*DIST$_{ONC(1,2,3,4)}$	*lateral$_{\{dors\}}$	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST$_{ONC(2,3,4)}$	*lateral$_{\{dor. lab,cor\}}$	*DIST$_{ONC(-4)}$
☞lama										*	*
wama	*!										
lʷama		*!								*	
ɫama		*!					*			*	
ama	*!			*							

1(b)

/alma/	Ident (lat)	*lateral$_{\{dors, lab\}}$	*DIST$_{ONC(4)}$	Max	*DIST$_{ONC(3,4)}$	*DIST$_{ONC(1,2,3,4)}$	*lateral$_{\{dors\}}$	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST$_{ONC(2,3,4)}$	*lateral$_{\{dor. lab,cor\}}$	*DIST$_{ONC(-4)}$
☞alma			*		*	*			*	*	
awma	*!					*					
alʷma		*!				*		*	*	*	
aɫma		*!			*	*	*		*	*	
ama	*!			*							

Tableaux 1(a) and 1(b) show that the most frequent optimal candidate in the *Campos Neutrais,* i. e., the candidate with the alveolar lateral [l], both in the coda (44%) and onset (100%) positions. The tableaux confirm the hint about the fact that faithfulness constraints (MAX and IDENT$_{lateral}$) would be top-ranked in the organization of the hierarchy. Since the most frequent result refers to the presence of the alveolar [l], the constraints that violated different structures should be higher ranked so that they would not win the dispute for the optimal candidate.

On the contrary, the constraint DIST$_{ONC(-4),}$ which reflects the distance between the alveolar lateral [l] and the vocalic nucleus in onset – such as [**l̲**a.ta] – was always found at the end of the hierarchy in the *Campos Neutrais*, since this form showed up in 100% of the data on the lateral in onset. This statement was confirmed by the central value of the constraint (88,983), which is the lowest one, by comparison with the others. It means that, regardless the optimal candidate for the coda, the alveolar form is always the optimal candidate for the onset. Therefore, this is a register of the asymmetry between syllable onset and coda. It also shows that the values offered by the analysis through StOT can provide different information about the phenomenon of variation. In order to let the alveolar lateral in coda [a**l**.ta] emerge, the top-ranked constraints IDENT$_{lateral}$ and *lateral$_{\{dorsal,\ labial\}}$ were decisive.

Taking into account the objective of working on constraints in stringency, it is important to mention the organization of the constraints in the ranking. Considering the relation of the stringency subsets, the least marked constraints must be closer to the bottom of the ranking. For instance, the constraint *lateral$_{\{dorsal,\ labial,\ coronal\}}$ is always below *lateral$_{\{dorsal\}}$ *lateral$_{\{dorsal,\ labial\}}$ in the hierarchy.

Since a variable phenomenon and the emergence of a telescopic rule are being demonstrated, it is worth mentioning the ranking value of the constraints, whose distance is below 10 points. Even though the constraint *lateral$_{\{dorsal,\ labial\}}$, shown on the tableaux as *lat$_{\{d,l\}}$, is top-ranked (central value = 102,066), together with the constraint IDENT$_{lateral}$ (central value = 106,601), their central values show that, in another simulation, they may invert their positions with other constraints and let another candidate for optimal output emerge (see simulations below).

(b) *Tableaux* 2(a) and 2(b) – Distribution of variants in the region of the *Campos Neutrais* – choice of output with the variant [ɫ] in coda

2(a)

/lama/	IDENT (lat)	MAX	*DIST ONC(4)	*DIST ONC(1,2,3,4)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*lateral {dors, lab}	*DIST ONC(2,3,4)	*lateral {dors}	*DIST ONC(3,4)	*lateral {dor. lab,cor}	*DIST ONC(-4)
☞lama										*	*
wama	*!										
lʷama						*!				*	
ɫama						*!		*		*	
ama	*!	*									

2(b)

/alma/	IDENT (lat)	Max	*DIST ONC(4)	*DIST ONC(1,2,3,4)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*lateral {dors, lab}	*DIST ONC(2,3,4)	*lateral {dors}	*DIST ONC(3,4)	*lateral {dor. lab,cor}	*DIST ONC(-4)
alma			*!	*			*		*	*	
awma	*!			*							
alʷma				*	*!	*	*			*	
☞aɫma				*		*	*	*	*	*	
ama	*!	*									

On tableaux 2(a) and 2(b), which show the other possible optimal form in coda, the dorsal lateral [ɫ - aɫ.ma], in 24% of the data, faithfulness constraints keep on the top of the ranking. This hierarchy, in which faithfulness >> markedness, has been fundamental to demonstrate that those forms that carry the lateral consonant, both in coda and onset positions, are optimal.

It is interesting to observe that, in its initial stage, this study used initial weight equal to 100 in all constraints. Taking into account that, after the simulation, constraints had values close to 100, rather than very high values, it may be stated that the algorithm converged towards the final stage. High values represent that, in the search for the target grammar, the algorithm had to promote the constraints several times without reaching the final stage.

Since the data on the *Campos Neutrais* has revealed that the physical proximity between both countries affects the informants' languages, and that it is Spanish which emerges more, concerning the lateral in coda (alveolar lateral), it would be expected that, after the production of 44% alveolar in coda, the dorsal (24%) should show up more often than the labial (30%). It would be the expected ordering if the markedness level related to the point of articulation of the segments is taken into consideration. To this effect, the data showed a break in the decrescent rate of the level of markedness; this fact represents a problem in the formalization of constraints in relation to the stringency. To solve this situation, the conjoined constraint $*DIST_{ONC(2)}$&*lateral{d,l,c}was fundamental, i. e., it did not enable the labial (less marked) to emerge before the dorsal lateral.

The constraint $DIST_{ONC(4)}$, in this simulation, is important to represent the output [ɫ] in coda position. It is the ranking of this constraint, right after the faithfulness constraints $IDENT_{lateral}$ and MAX, that makes the alveolar be declassified, providing space so that the dorsal form [ɫ] can become a candidate for optimal output. As previewed by the first simulation, the constraint that refers to the alveolar lateral in onset [l] – $*DIST_{ONC(-4)}$ – keeps at the end of the hierarchy, so that forms, such as [**l̲**o.do], i. e., with the alveolar form in onset, can emerge in all simulations.

(c) *Tableaux* 3(a) and 3(b) – Distribution of variants in the region of the *Campos Neutrais* – choice of output with the variant [l^w] in coda

3(a)

/lama/	Ident (lat)	Max	*DIST $_{ONC(4)}$	*lateral $_{\{dors, lab\}}$	*DIST $_{ONC(1,2,3,4)}$	*DIST $_{ONC(3,4)}$	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST $_{ONC(2,3,4)}$	*lateral $_{\{dors\}}$	*lateral $_{\{dor. lab,cor\}}$	*DIST $_{ONC(-4)}$
☞lama										*	*
wama	*!										
l^wama				*!						*	
ɫama				*!					*	*	
Ama	*!	*									

3(b)

/alma/	Ident (lat)	Max	*DIST $_{ONC(4)}$	*lateral $_{\{dors, lab\}}$	*DIST $_{ONC(1,2,3,4)}$	*DIST $_{ONC(3,4)}$	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST $_{ONC(2,3,4)}$	*lateral $_{\{dors\}}$	*lateral $_{\{dor. lab,cor\}}$	*DIST $_{ONC(-4)}$
alma			*!		*	*		*		*	
awma	*!				*						
☞al^wma				*	*		*	*		*	
aɫma				*	*	*!		*	*	*	
ama	*!	*									

The labial lateral [l^w], inserted in the telescopic rule between the dorsal lateral and the glide in the syllable coda position, attributes more plainness to the rule, since it imposes simplicity to the derivation between a velar form and a voiced one ɫ > w. However, based on the data, the labial form [l^w] is observed to be more frequent than the dorsal [ɫ] one, even in a region where the influence of Spanish has been strong. Therefore, the conjoined constraint that this study proposed to prohibit the manifestation of the labial had to fall in the ranking, in relation to the previous simulation, so that [a**l^w**.ta] could be obtained as an answer.

Therefore, in this simulation, the constraint IDENT$_{lateral}$ is top-ranked; it eliminates codas, such as the lateral, from the competition for optimal candidate. *DIST$_{ONC(4)}$ is also top-ranked to eliminate the alveolar lateral [l]. *DIST$_{ONC(3,4)}$ decides the dispute and eliminates the dorsal lateral [ɫ], enabling the emergence of the labial lateral.

In agreement with the other simulations, the constraint *DIST$_{ONC(-4)}$ is ranked low and the constraints IDENT$_{lateral}$ and *lateral{d,l} keep structured so that they can eliminate any optimal candidate which is different from the alveolar lateral in onset and enable candidates such as [**<u>l</u>**i.vro] in onset and [pa**<u>lʷ</u>**.co] in coda to win the dispute.

(d) *Tableaux* 4(a) and 4(b) – Distribution of variants in the region of the *Campos Neutrais* – choice of output with the variant [w] in coda

4(a)

/lama/	*DIST ONC(1,2,3,4)	IDENT (lat)	*DIST ONC(4)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*lateral {dors, lab}	MAX	*DIST ONC(3,4)	*DIST ONC(2,3,4)	*lateral {dors}	*lateral {dor. lab,cor}	*DIST ONC(-4)
☞lama										*	*
wama		*!									
lʷama					*!					*	
ɫama					*!				*	*	
ama		*!				*					

4(b)

/alma/	*DIST ONC(1,2,3,4)	IDENT (lat)	*DIST ONC(4)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*lateral {dors, lab}	MAX	*DIST ONC(3,4)	*DIST ONC(2,3,4)	*lateral {dors}	*lateral {dor. lab,cor}	*DIST ONC(-4)
alma	*!		*				*	*	*	*	
awma	*!	*									
alʷma	*!			*	*			*	*	*	
aɫma	*!				*		*	*	*	*	
☞ama		*				*					

(e) *Tableaux* 5(a) and 5(b) – Distribution of variants in the region of the *Campos Neutrais* – choice of output with phonetic null in coda

5(a)

/lama/	*DIST ONC(4)	*lateral {dors, lab}	Ident (lat)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST ONC(3,4)	Max	*DIST ONC(2,3,4)	*DIST ONC(1,2,3,4)	*lateral {dor. lab,cor}	*lateral {dors}	*DIST ONC(-4)
☞lama									*		*
wama			*!								
lʷama		*!							*		
ɫama		*!							*	*	
ama			*!			*					

5(b)

/alma/	*DIST ONC(4)	*lateral {dors, lab}	Ident (lat)	*DIST$_{ONC(2)}$& *lateral{d,l,c}	*DIST ONC(3,4)	Max	*DIST ONC(2,3,4)	*DIST ONC(1,2,3,4)	*lateral {dor. lab,cor}	*lateral {dors}	*DIST ONC(-4)
alma	*!				*		*	*	*		
☞awma			*					*			
alʷma		*!		*			*	*	*		
aɫma		*!			*		*	*	*	*	
ama			*			*!					

Despite the dominance relations the constraints keep among them, it is their ranking values that lead to the conclusion that there has been variation in the final result. It can be observed in all simulations, from tableaux 1 to 5, that the central values of the constraints got so near – differences were below 10 points – that a constraint that was close to the bottom of the ranking could, sometime, dominate the hierarchy. This situation has been used to show the variable results which happened in the region of the *Campos Neutrais* in the case of words with laterals in coda (a**l.**ma, a.ni.ma**l**).

However, according to Boersma and Hayes (2001), even though the selection point may get any value within the range, it is more likely to take weights closer to the central value. It explains why the possibility of variation between the constraint IDENT$_{lateral}$ (central value equal to 106,601) and a constraint similar to the conjoined one (*DIST$_{ONC(2)}$&*lateral{d,l,c}), whose central value is 98,237, is lower than a constraint such as DIST$_{ONC(4)}$, whose central value is equal to 102,350[8].

8 The ranking value of the constraints does not change. What makes the constraints alter their position in the hierarchy is the value of the selection point (disharmony), which should change at every simulation (every moment of linguistic production).

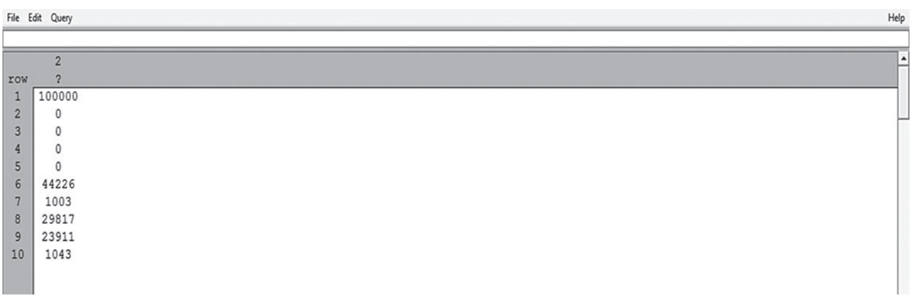
It explains why variable, but less frequent results, such as data on deletion (1%) and vocalization (1%) of coda in the place of the lateral, should emerge as optimal ones, but with lower probability.

When the hierarchy of the constraints resulting from the simulations under study (tableaux 1 to 5) is compared, it may be observed that faithfulness constraints MAX e IDENT$_{lateral}$ kept a high position in all simulations in which the optimal output was a lateral consonant in onset and coda [l, ɫ or l^{w}], unlike what can be observed on *tableaux* 4 and 5, which refer to candidates for deletion and vocalization of the lateral in coda. Hence, faithfulness constraints, mainly the IDENT$_{lateral}$, are important for the choice of the optimal candidate.

In order to get the form with deletion, faithfulness constraints MAX and IDENTlateral had to fall in the ranking and constraint *DIST$_{ONC(1, 2, 3, 4)}$ had to go up, so that the structures with the lateral in coda or vowel could be immediately eliminated. In order to let the form with the vocalization of the lateral in coda (tableau 5b) win, the constraint MAX was decisive, with the help of the *DIST$_{ONC(4)}$ – which prohibits the alveolar lateral – and the *lateral$_{\{dorsal, labial\}}$ – which prohibits the emergence of the dorsal and labial lateral.

Figure 3 (below) represents the probability distribution of outputs; it was carried out by using the command "*to output distribution*s" in the PRAAT software to doublecheck whether the grammar under study is yielding the expected percentage rates.

Figure 3 – Output distributions of the variants in the region of the *Campos Neutrais*



Source: Made by the authors.

According to Boersma and Hayes (2001), this study can submit all candidates to 100,000 evaluations to prove that the grammar under study is yielding the expected percentages. Results in Table 1 show that the values calculated by the algorithm confirm the rate of 100% for the production of the alveolar lateral in onset, expected in all simulations, as well as the other percentages for the structures [l, ɫ, l^w and w], expected in coda. Such evidence highlights the accuracy of the values calculated by the algorithm.

Final Remarks

Regarding the objective of giving formal treatment to the phenomenon of the variation of the lateral in syllable coda position in the *Campos Neutrais* region, with the support of the Stochastic Optimality Theory, it is worth reinforcing that equal treatment is given to the lateral in syllable onset position in Portuguese and in Spanish. However, there are significant differences when the coda position is involved. Taking into account that *Campos Neutrais* is a border region between both languages under study and that there is evidence of language contact in the data, the result of the analysis was relevant. The constraints that were proposed to represent the speakers' grammar were fundamental and able to explain and formalize both the asymmetry between onset and coda, as well as the forms of output in the coda position.

The proposed constraints were fundamental to determine some optimal candidate. The following relations among constraints were relevant to choose different outputs for the postvocalic lateral:

a) output with Alveolar [l] – $\text{Ident}_{\text{lateral}}$ >>$*\text{lateral}_{\{\text{dorsal, labial}\}}$
(Faithfulness >>Markedness);

b) output with Dorsal [ɨ] – $\text{Ident}_{\text{lateral}}$>>$*\text{Dist}_{\text{ONC(4)}}$>>$*\text{DIST}_{\text{ONC(2)}}$&*lateral{d,l,c}
(Faithfulness >> Markedness);

c) output with Labial [**l^w**] – $\text{Ident}_{\text{lateral}}$>>$*\text{Dist}_{\text{ONC(4)}}$>>$*\text{Dist}_{\text{ONC(3,4)}}$
(Faithfulness >> Markedness);

d) voiced output [w] – $*\text{Dist}_{\text{ONC(4)}}$>>$*\text{lateral}_{\{\text{dorsal, labial}\}}$>>$\text{Ident}_{\text{lateral}}$>>MAX
(Markedness >> Faithfulness);

e) output will Phonetic Null [ø] – $*\text{DIST}_{\text{ONC(1,2,3,4)}}$>> $\text{Ident}_{\text{lateral}}$
(Markedness >> Faithfulness).

Hierarchies (a, b, c), which represent the presence of the lateral in coda, show that the Faithfulness constraint $\text{Ident}_{\text{lateral}}$ must be on the top of the ranking so that the other possible forms – [w] and phonetic null – can be excluded from the dispute. On the other hand, in order to keep voiced forms and the ones with deletion, $\text{Ident}_{\text{lateral}}$ had to fall in the hierarchy and let the markedness constraints dominate it (d, e). With outputs in (a, b, c), the Portuguese spoken in the *Campos Neutrais* shows the influence Spanish exerts on it, since, in the other variants of the language, the voiced phonetic form predominates for the postvocalic lateral. It should be highlighted that all constraints which had their positions altered in the hierarchy, so that outputs in variation could be chosen as optimal, had central values whose difference was below 10, a fact that confirms the appropriateness of the analysis carried out in this study.

The schematization of the results clearly shows the differences in the organization of constraints in Spanish (Faithfulness>>Markedness), which mostly has the alveolar lateral in coda (more marked form) by comparison with Portuguese (Markedness>>Faithfulness), which mostly has the voiced form (less marked). As a result, the strong influence of Spanish on the BP spoken in the *Campos Neutrais* can be observed in the light of the Stochastic OT.

To represent the fact that alveolar, dorsal and labial laterals are in variation and that they are much more frequent than the other forms, the GLA provided rather high central values to the faithfulness constraints ($\text{Ident}_{\text{lateral}}$=106.601 and MAX = 100.518), but separated by less than 10 points from the markedness constraints (e. g., $\text{lateral}_{\{\text{dorsal, labial}\}}$ = 102.066), so that, in most simulations (or moments of linguistic production), they could keep high ranking, thus, enabling laterals to emerge in coda.

The generalization power of the theoretical model applied to the analysis carried out in this study was essential not only to capture the variable character of the data collected in the *Campos Neutrais*, but also to distinguish the frequency in which every form shows up. Finally, the same constraints enabled the formalization of the asymmetry among the lateral in onset – which shows the alveolar lateral [l] in 100% of the cases – the variable character of the lateral in coda and the rate in which every form shows up in the syllable coda. Hence, this study highlights the importance of choosing the Stochastic Optimality Theory to formalize the analysis.

NEUSCHRANK, A. et al. A formalização da assimetria da lateral em onset e em coda de sílaba no português dos Campos Neutrais pela OT Estocástica. **Alfa**, São Paulo, v.59, n.1, p.177-199, 2015.

■ *RESUMO: O foco de análise do presente estudo é a assimetria que a líquida lateral apresenta nas posições de onset e de coda de sílaba, uma vez que mostra estabilidade fonética no onset e variação na posição de coda. Como o funcionamento da lateral pré e posvocálica apresenta diferenças no português e no espanhol, este estudo elegeu, como objeto de análise, o português dos Campos Neutrais, na fronteira Brasil-Uruguai, por seu contato com o espanhol. A base empírica é o português dos Campos Neutrais, emprestada de Espiga (2001), já que, segundo o autor, nessa região a lateral em posição de onset se manifesta como alveolar, enquanto pode assumir cinco formas fonéticas na posição de coda: alveolar, velarizada, labializada, vocalizada e zero fonético. A explicitação e a formalização da assimetria da líquida lateral são propostas com base na Teoria da Otimidade Estocástica, por meio de restrições. Com base no mecanismo de alinhamento relacional, o presente estudo propõe restrições de distância de sonoridade* *inspiradas em Gouskova (2004), dela diferenciando-se por ter a particularidade de considerar a relação entre o onset e o núcleo e entre o núcleo e a coda de sílaba.*

- *PALAVRAS-CHAVE: Líquida lateral. Onset e coda silábicos. OT Estocástica. Português dos Campos Neutrais.*

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Received November 2013

Accepted February 2014