FRENCH FRONT ROUNDED VOWELS ACQUIRED BY BRAZILIAN PORTUGUESE SPEAKERS

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▪ ABSTRACT: The French vowel system differs from the Portuguese one in terms of front rounded vowels – /y/, /ø/, /œ/ – found in French phonology, whose system has ten vowels, while the Portuguese one has seven vowel segments. The focus of this study is the acquisition of French front rounded vowels by Brazilian Portuguese (BP) native speakers. With the support of the Stochastic Optimality Theory (St OT) and the assumption that a foreign language acquisition process involves mainly the organization of a new grammar, this study was based on an empirical basis taken from Alcântara (1998). It aims to describe and formalize the emergence of vowels /y/, /ø/, /œ/ in the phonology of French as a foreign language acquired by BP native speakers, in the light of Markedness and Faithfulness constraints, which integrate the Optimality Theory (OT), in the different stages that characterize the learning process of the L2 vowel system.

▪ KEYWORDS: french acquisition front rounded vowels; foreign language acquisition; Stochastic Optimality Theory.

Introduction

The focus of this study is the acquisition process of French front rounded vowels – /y/, /ø/, /œ/ – by Brazilian Portuguese (BP) native speakers. It is assumed that acquisition of a segment inventory, either vowels or consonants, of a foreign language mainly implies the organization of a new grammar, although involvement in learning new

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phonetic forms is also recognized.[1] The interest of the study lies in the fact that both vowel systems in French and Portuguese differ because, in French phonology, there are these three front rounded vowels. As a consequence, Portuguese phonology has seven vowel segments, while French phonology contains ten vowels.

Due to the relevance of the internal structure of vowel segments in the analysis proposed by this study, the vowel systems of both languages are shown in (1), in Chat 1, with the characterization of distinctive features that define them.[2]

(1)

Chart 1 - Portuguese and French Vowel Systems

(a) Portuguese vowel system

[+High]	[-Low]	i		u	[+High]	[-Low]	i	y		u
[-High] [+ATR]		e		o	[-High] [+ATR]		e	Ø		o
[-High] [-ATR]		ɛ		O	[-High] [-ATR]		ɛ	Œ		O
	[+Low]		a			[+Low]			a	
		[Cor]	[Dors]	[Dors] [Labial]			[Cor]	[Cor] [Labial]	[Dors]	[Dors] [Labial]

(b) French vowel system[3]

Source: Authors' elaboration.

Examination of the systems exposed in (1) enables to observe that the presence of three more vowels in French phonology implies relations among vowel segments, differently from what occurs in Portuguese phonology. It also requires representation and employment of a larger number of co-occurrences of features for the characterization of the ten-vowel system.[4]

Based on Alcântara's finding (1998) which shows that acquisition of French front rounded vowels is complex for Brazilian students and that there is ordering in the incorporation of such vowels into the foreign language system, whose process is mediated by employment of forms that correspond to unrounded vowels, this study aims to describe and formalize the emergence of vowels /y/, /ø/, /œ/ in the phonology of French as a foreign language acquired by BP native speakers, in the light of assumptions of the Stochastic Optimality Theory (St OT). Explanations for this fact are sought in

[1] In this paper, both terms "foreign language (FL)" and "second language (L2)" are equivalent. There is no distinction between "acquisition" and "learning" of a L2, either.

[2] Following Clements & Hume (1995), when dealing with vowels, the [Labial] feature is used as equivalent to the [+ Rounded] feature, found in Chomsky & Halle (1968).

[3] French front vowels, the focus of this study, are circled between slashes (/ /).

[4] While the vowel /i/ ([cor]), for example, in Portuguese is related to the high dorsal-labial vowel /u/ and to other coronal vowels (unrounded), the same vowel /i/ ([cor]) in French is related to the high dorsal-labial vowel /u/, to the other coronal (unrounded) vowels and to the high coronal-labial vowel /y/.

Markedness and Faithfulness constraints, which are part of the Optimality Theory (OT), for the emergence of forms in variation that characterize the learning process of L2 vowel systems. Among studies that have already addressed the acquisition process of French front rounded vowels as a second language by BP native speakers, there was lack of approach and formalization with a view of grammar based on the notion of distinctive features as part of universal constraints, and with a view of its formalization in the light of assumptions of the St OT. It was one of the reasons to conduct the study reported by this paper.

Theoretical support

In this section, the focus of the study is detailed and assumptions underlying the St OT, the theoretical model chosen to support and formalize the data analysis, are introduced.

Empirical Basis

The empirical basis of this study is the three French front rounded vowels (/y/, /ø/, /œ/), especially as part of the acquisition process of phonological grammar in a foreign language. Data are borrowed from Alcântara's study (1998), whose objective was, in the light of the Constraint-Based Theory of Phonological Markedness and Simplification Procedures, by Calabrese (1995), to describe and analyze the existence of an order in the acquisition process of French front rounded vowels by BP speakers, as well as the presence of different simplification procedures during their acquisition. The investigation also discussed the structural conditions of the emergence of different phonetic forms used to represent French vowels, since it controlled, as an extralinguistic variable, the level of foreign language learners. Alcântara (1998) explained late acquisition of French front rounded vowels by BP native speakers, in comparison with front unrounded vowels, and described the order of their emergence: /y/ > /ø/ > /œ/. However, she neither explained nor formalized – due to his theoretical apparatus – the motivation for this ordering and the reason why unrounded vowels occupy the phonetic-phonological space of front rounded vowels up to their acquisition. The theoretical approach adopted by this study can support an analysis that fills this gap.

In the talk of BP native speakers who were learning French, Alcântara (1998) registered different variants they used to represent the three front rounded vowels: instead of /y/, they used [ju], [u] and [i]; instead of /ø/, [ew], [e], [o] and [ɐ]; and instead of /œ/, [ø], [ɛ], [ɔ], [o] and [ɐ]. In this study, only prevalent forms were taken, while variants, whose occurrence was peripheral, were not considered. Thus, the use of nine forms was analyzed: for the high vowel /y/, the phonetic forms [y], [u] and [i] were computed; for the high-mid vowel /ø/, the phonetic forms [ø], [e] and [o] were taken; and for the low-mid vowel /œ/, the phonetic forms [œ], [ɛ] and [ɔ] were examined.

The Stochastic Optimality Theory (St OT)

The St OT, as a model of linguistic analysis, brings new perspectives to problems which could not be solved by previous models. Among advantages of the model, there is the possibility of supporting an explanatory analysis, which goes beyond mere data description. Such a model can enable formal analysis, hypothesize a set of grammatical principles, discuss well-formedness linguistic constraints and allow the incorporation of analytical perspectives of current linguistic theories.

It is a model that allows to explain, through grammar formalized by universal constraints, how optimal candidates for output in linguistic production are chosen, that is, how the input is mapped into the output. It is a model which operates primarily through three universal components (CON - a set of constraints, GEN - output candidates set generator, EVAL - assessment of output candidates) and which has particular characteristics that differentiate it from previous models. It is noteworthy that, in the OT, the mapping between input and output occurs through universal and violable constraints, which can belong to two families: Faithfulness and Markedness. Since the grammar of each language is characterized by a particular ranking of constraints, acquisition of a linguistic system implies the acquisition of the ranking of constraints that identifies it.

OT is a theory that refers to grammatical systems, determining which analysis of an input best satisfies a set of conditions in conflict. To resolve such conflicts, grammar ranks constraints in a hierarchy of strict dominance, in which each constraint that is high in the hierarchy takes precedence over all constraints ranked below. By comparing alternative pairs of analysis, the grammar imposes a harmonic order on the possibilities of analysis in the underlying form. The chosen output is the most harmonic of all, since it is the optimal one.

The difference between the Classic Optimality Theory and the St OT lies in the fact that, linked to an algorithm called the Gradual Learning Algorithm (GLA), in the latter, constraints operate with numerical values (weights) and, at each evaluation of the candidate group, a noise is temporarily added to the ranking value of each constraint, so that the grammar can produce variable outputs if the central value of any constraint is close to that of another constraint.[5]

Variation that occurs in languages is not only a characteristic of the acquisition process, but unquestionable in linguistic systems, in the use of language by adult speakers, resulting from linguistic and social factors. Thus, every theoretical model must be able to explain and formalize the phenomenon of linguistic variation. If, in a parallel representation model, constraints are thought of as values organized in a hierarchy, in order to result in a grammar of language, it is necessary to represent that grammar in variation. The GLA (BOERSMA; HAYES, 2001) can account for variability in the search for the construction of a hierarchy of constraints for the language.

[5] In the *tableaux* shown by this paper, weights of constraints correspond to the values listed in the column called Ranking Value.

GLA is implemented in PRAAT[6] and each round of the algorithm represents a simulation of language use, which may imply a new developmental stage in the learning course.

Each constraint actually has two numerical values: the value that corresponds to the central point of the range of values, the ranking value, and the 'selection point value', a value assumed within the range of values, which corresponds to the value displayed at the time of evaluating the candidates. The central value represents the center of a range of values, in a scale composed of 10 points. For example, if the central value of the constraint is 30, it means that the range of values to be assumed by this constraint can range from 25 to 35.

The central value of the constraint does not change at each new moment of production of grammar, in the different simulations or rounds of the program (in the example given, it is always 30), but the value of the selection point, at each moment of linguistic production, can be any value within the range (such as 25, 26, 27 ... 35). Together with this operation, at each evaluation of the group of candidates, a noise is temporarily added to the ranking value of each constraint, so that grammar can produce variable outputs if the central value of any constraint is close to that of another constraint. In other words, there is the possibility of variation if the central value of two or more constraints is below 10 points apart.

Thus, it is through values provided to the constraints that the GLA represents both variable and categorical outputs. Central values far apart (with distances above 10 points) represent the categorical result, for different times of linguistic production do not cause crossing in the range of values of constraints. However, when the distance between central values of constraints is below 10 points, there is the potential possibility of crossing the range of values, which could change the order of constraints and consequently change the optimal candidate, featuring, then, variation in outputs.

It is noteworthy that, when values of the selection point change, there is greater probability that values closer to the central value are assumed. Thus, if values of a constraint range from 0 to 10 (central value = 5), it is more likely to occur selection point values close to 5, than close to the limits of the range of values (0 or 10). It is through this concept that the algorithm is not only able to demonstrate optimal variable candidates (e.g. *édit[æ]rs ~ édit[ɔ]rs ~ édit[Ɛ]rs*), but also to capture the difference in the probability of emergence between them.[7]

Thus, the St OT, which is linked to a learning algorithm, has relevant characteristics to the assessment of linguistic data, such as the ability to cope with the gradual nature of acquisition and the ability to explain forms of output in variation, which is advantageous to the analysis.

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[6] Available at: http://www.praat.org/. Access on: 27 Jul. 2021.

[7] To capture this conception more precisely, the range of values of the constraints is explained as a probabilistic distribution (BOERSMA, 1997, 1998; HAYES; MACEACHERN, 1998) - normal distribution (Gaussian curve).

Methodology

Data Analysis

Data described and analyzed from the standpoint of the St OT, in agreement with the reference in the section showing the empirical base of the study, are part of the corpus studied by Alcântara (1998) in the light of Calabrese (1995). Alcântara (1998) researched the acquisition process of French front rounded vowels – /y/, /ø/, /œ/ – in a formal learning context with BP native speakers. Informants were twelve senior college students attending the Languages course (Portuguese/French) in a university in southern Brazil. Data were collected when students read three authentic texts in French.[8]

In this study, corpora of three advanced students were analyzed.[9][10] A quantitative analysis of the data was conducted, expressed as percentages, and solely forms of predominant use were registered, in agreement with the Empirical Basis of the study:

(a) for high vowel /y/ → use of phonetic forms [y], [u] and [i];
(b) for high-mid vowel /ø/ → use of phonetic forms [ø], [e] and [o];
(c) for low-mid /œ/ vowel → use of phonetic forms [œ], [ɛ] and [ɔ].

Percentages of use of the different forms in the representation of French front rounded vowels by Brazilian students, according to two levels of language proficiency (beginner and advanced), are demonstrated in Table 1.

[8] In the study conducted by Alcântara (1998), informants' selection criteria included: (a) to be a college student in a Languages Course, specializing in French; (b) to be a BP native speaker; (c) to have systematic contact with French, but solely in a formal context; (d) to acquire French by using the "Archipel" communicative method (ALCÂNTARA, 1998, p. 39). Informants were between 19 and 39 years old.

[9] Alcântara (1998) justifies the choice of this variable because the acquisition process of a foreign language (FL) is gradual and time of language use and exposure is a factor that contributes to the mastery of the new linguistic system. The level 'beginner' corresponds to less than one year of study of the French language in a system of education whose schedule is 8 hours of classes per week and the 'advanced' level corresponds to more than three years of study of the target language. Alcântara's study (1998) also contemplated two 'intermediate' levels, corresponding to the periods from 1 to 2 years and from 2 to 3 years of L2 study, respectively.

[10] Although the analysis, in this study, focuses solely on the corpora of advanced students, Table 1 shows data on beginners for comparison only.

Table 1 – Percentages of predominant productions of French front rounded vowels by Brazilian students of two levels of proficiency, according to Alcântara (1998)[11]

Target vowels	Level	Shapes		
vowel /y/		**[y]**	**[i]**	**[u]**
	Beginner Level	17.20%	82.26%	0.54%
	Ocorr / Poss	32/186	153/186	01/186
	AdvancedLevel	67.95%	30.77%	1.28%
	Ocorr / Poss	106 / 156	48/156	02/156
vowel /ø/		**[ø]**	**[e]**	**[o]**
	Beginner Level	20%	50%	30%
	Ocorr / Poss	08/40	20/40	12/40
	AdvancedLevel	60.98%	31.70%	7.32%
	Ocorr / Poss	25/41	13/41	03/41
vowel /œ/		**[œ]**	**[ɛ]**	**[ɔ]**
	Beginner Level	20.83%	50%	29.17%
	Ocorr / Poss	05/24	12/24	07/24
	AdvancedLevel	43.90%	36.59%	19.51%
	Ocorr / Poss	18/41	15/41	08/41

Source: Author's elaboration based on Alcântara (1998).

Percentage values corresponding to the Advanced Level were used in the final analysis in the St OT model. It is worth mentioning that the percentages of use of forms that represent French front vowels points to an increase in the use of the target forms (of the three vowels under analysis), considering results of both proficiency levels under evaluation, i.e., advanced students were closer to the target performance than beginners.

Percentages of vowel production of advanced learners in line with the target, shown in Table 1, lead to the finding of an order in acquisition: [y] (67.95%)> [ø] (60.98%)> [œ] (43.90%). In addition, percentages in Table 1 evince that beginners, unlike what happens to advanced learners, have no order in the acquisition of these vowels: percentages reaching productions of target shapes can be considered equivalent to the three vowels ([y] → 17.20%, [ø] → 20%, [œ] → 20.83%).

Such results must be collected, formalized and explained in the light of a theoretical model. As previously mentioned, this study has chosen the St OT.

[11] Statistical data analyses were made by the bias of Quantitative Sociolinguistics, through the VARBRUL package, and consider linguistic and extralinguistic factors. Results are pertinent, since they aim to demonstrate the expression of language functioning in a small sample, as a theoretical exercise.

Analysis paths

In the analysis of the acquisition process of French vowels by Brazilian students, this study had to consider three facts: (a) the L1 vowel system (BP); (b) the L2 vowel system (French); and (c) the vowel systems of the interlanguage, that is, of the acquisition stages. As previously mentioned, this study solely considers advanced students' production.

In informants' L1 grammar (BP), considering the representation that native speakers have, it was considered fundamental to carry out target outputs of the seven vowels of the language in stressed syllables, assigning the percentage of 100% to the mapping between the forms: [i] to /i/; [e] for /e/; [ɛ] for /ɛ/; [u] to /u/; [o] to /o/; [ɔ] for /ɔ/; [a] for /a/.

In informants' L2 grammar (French), which is the target of the acquisition, when the phonology and the outputs of native speakers were considered, 100% was assigned to the mapping between both phonological and phonetic forms of the ten vowels in the system: [i] para /i/; [e] for /e/; [ɛ] for /ɛ/; [y] for /y/; [ø] to /ø/; [œ] to /œ/; [u] to /u/; [o] to /o/; [ɔ] for /ɔ/; [a] for /a/.

In the representation of the acquisition process of French front rounded vowels, i.e., of the interlanguage grammar, advanced students' grammar from the study corpus was chosen. This grammar was fed by the percentage of completion of target forms presented by informants, in agreement with data recorded in Table 1.

The three relevant grammars that took part in this investigation into vowel systems (advanced students' BP, French and their interlanguage) were subsequently analyzed considering the St OT assumptions.

Formalization of constraints

In the OT, constraints may belong to two families: Faithfulness and Markedness. As Faithfulness constraints seek to preserve input in output*,* in the case of acquisition of French vowels by BP native speakers, it can be understood that the ones listed in (2) may represent the fragment of the grammar under study:

(2)
(a) IDENT {HEIGHT} (McCARTHY; PRINCE, 1995)
(b) IDENT {PLACE} (McCARTHY; PRINCE, 1995)
(c) IDENT {LABIAL} (McCARTHY; PRINCE, 1995)

Considering that Markedness constraints favor unmarked outputs*,* it may be said that Markedness represents learners' difficulties in the acquisition of a new language. Thus, the relationship between Markedness and Faithfulness is fundamental to the representation and formalization of phenomena that characterize this process. Based on results found by Alcântara (1998) in the light of the Theory of Phonological Markedness

and Simplification Procedures based on Constraints, by Calabrese (1995), this analysis based on constraints found it relevant to use stringency constraints[12] (PRINCE, 1997a, 1997b), which reflected the relationship between height and place of vowels, as follows in (3):[13] [14]

(3)
(a) * {- HIGH, -LOW, -ATR}
(b) * {- HIGH, -LOW, -ATR; -HIGH, -LOW, + ATR}
(c) * {- HIGH, -LOW, -ATR; -HIGH, -LOW, + ATR; + HIGH}
(d) * {-HIGH, -LOW, -ATR; -HIGH, -LOW, + ATR; + HIGH; + LOW}
(e) * {CORONAL / LABIAL}
(f) * {CORONAL / LABIAL; DORSAL / LABIAL}
(g) * {CORONAL / LABIAL; DORSAL / LABIAL; CORONAL}
(h) * {CORONAL / LABIAL; DORSAL / LABIAL; CORONAL; DORSAL}

In addition to explaining the behavior of interlanguage vowels, the relevant contribution of the study to survey constraints that represent this acquisition process is in joint constraints, registered in (4): these constraints must not only show that French front rounded vowels are the last to be acquired by BP native speakers, but also that, among them, there is an acquisition order that predicts the initial emergence of /y/, followed by the emergence of /ø/ and, finally, followed by the appearance of /œ/. Concerning degrees of complexity of the three rounded vowels, in the case of French learners who are BP native speakers, /œ/ is more complex and of later acquisition, while /y/ has earlier and less complex acquisition.

(4)
(a) * {- HIGH, -LOW, -ATR} & * {CORONAL / LABIAL}
(b) * {-HIGH, -LOW, + ATR} & * {CORONAL / LABIAL}
(c) * {+ HIGH} & * {CORONAL / LABIAL}

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[12] For the definition of stringency, we follow Matzenauer and Miranda (2010), that explain that this is a type of subset relation with reference to violations of constraints, being formally expressed as such, according to McCarthy (2008, p. 65-66, our translation): "Constraint R1 is more stringent than constraint R2 if any violation of R2 also implies a violation of R1, and some violations of R1 do not imply violation of R2".

[13] The relation of stringency established between the constraints that refer to the height of the vowels (3 a-d) reflects this harmony scale: a ≻i, u ≻e, o≻ɛ, ɔ; the relation of stringency established between the constraints that refer to the place of the vowels (3 e-h) reflects this scale of harmony: a ≻ɛ, e, i ≻ɔ, o, u ≻œ, ø, y.

[14] The formalization of constraints can be given by a fixed *ranking*, most commonly found in the literature, or by stringency (PRINCE, 1997a, 1997b), as it is being proposed: in relation to stringency, the constraints are in gradual scales, in that the first constituent includes the next and so on, on a Markedness scale. In this analysis, for example, it can be said that there is an implicational relation between the features of height that causes the vowels composed of the feature /+LOW/, which are less marked on the proposed scale, to be violated when a more marked constraint in the hierarchy, such as /+HIGH/ or /-HIGH,-LOW,+ATR/, suffer a violation. For stringency, the constraint that refers to the least marked is always lower in the ranking, that is, it receives from the algorithm the lowest central weights, which is due to the formalization in stringency. This set of constraints is necessary to allow the distinction to occur in the process of vowel acquisition.

The local conjunction mechanism, found in constraints in (4), which, in this case, joins constraints that refer to a place and constraints that refer to the height of vowels, was proposed by Smolensky (1995) and aims to allow constraints that are low in the ranking to have their opposition effects felt again as if they were high in the hierarchy under study.

Conjoined constraints are violated whenever the output segment violates both parts that comprise it. In this analysis, they are important to differentiate acquisition of French front rounded vowels, composed of the coronal/labial feature, from the other high and mid vowels in Portuguese. This mechanism seems to perfectly represent learners' strategy during the developmental process towards the target system. It was used by Alves (2008) in the analysis of English acquisition by BP native speakers and widely defended by Bonilha (2005) in L1 and L2 acquisition processes.[15]

The conjoined constraint allows constraints that compose it, even lower in the ranking, to have an effect that considers them more marked together. It is an alternative to enable, in the analysis proposed for the acquisition of vowel segments, to differentiate high vowels of Portuguese /i, u/, for example, from the high vowel of French /y/. In this case, the conjoined constraint *{+HIGH}&*{CORONAL/LABIAL} is essential to allow the constraint *{+HIGH} to once more have their opposition effects manifested as if high on grammar. Thus, the argument in favor of conjoined constraints is that, even if they are redundant, they are solutions to undo the effects of primitive scales.[16]

Description and Analysis of Results

Having described the role of each constraint in the acquisition process of a mother tongue and a foreign language by BP native speakers who are French learners, data treatment via St OT is described. In this study, given the provisions of the Section on the analysis paths, there were three simulations: L1 acquisition (BP); L2 acquisition (French) and partial acquisition (interlanguage). The third one, with the index of variable outputs found in advanced learners' corpora, agrees with data shown in Table 1.

Regarding L1 acquisition, some authors, such as Levelt (1995), Pater and Paradis (1996) and Smolensky (1996), indicate an initial stage in which Markedness constraints dominate Faithfulness constraints (Markedness >> Faithfulness), that is, in the first stage of L1 acquisition, children produce fewer marked outputs and modify the hierarchy of constraints so that ordering relations between Faithfulness and Markedness are gradually modified. As a result, the most marked structures start to emerge.

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[15] It is shared with Alves (2008) - and also with Smolensky (1997), Fukazawa & Miglio (1998) and Fukazawa (1999, 2001) - the position that is the conjunction operator "&", and not the conjoined constraints *per se*, which is found in the Universal Grammar and, therefore, after reaching the target in the acquisition process, whether of L1 or L2, the conjoined constraints start to occupy a low value in the ranking, once they have been overcome due to Faithfulness constraints, which, according to Bonilha (2005), can be undone.

[16] A more complete and exemplified discussion about the use of conjoined constraint in Portuguese phenomena can be found in Bonilha (2005) and Alves (2008).

In this case, to transform the initial Markedness >> Faithfulness relation into numerical weights, it was necessary to inform the algorithm that marked constraints start, in the hierarchy, with higher weights than those of Faithfulness constraints. Thus, the algorithm was implemented with random weight values, starting from 100 for marked constraints and 0 for Faithfulness ones.

In the case of L2 acquisition, studies conducted by Pater (1997) and by Davidson, Jusczyk and Smolensky (2004) demonstrate that the initial hierarchy towards L2 corresponds to the L1 ranking. Therefore, outputs which indicate a more or less advanced stage in the acquisition of the second language may be pointed out by using the same constraints, but with different orders. This was an important step in the construction of constraint systems used in this analysis to identify stages of BP learners in the acquisition of their mother tongue, the foreign language and the interlanguage, which is the intermediate stage between both other hierarchies.

In this case, regarding the implementation of initial weights related to the conjoined constraints, which are not found in L1, determination of the initial stage in the algorithm was found not to exert any effect on the setting of end-stage grammar (such possibilities have been tested). As a result of this finding, as well as for delimitation purposes, the value of 100 was set for the initial weights of these constraints, as was done with the marked constraints on L1 acquisition.

Simulations considered fundamental to the discussion of the acquisition process of French front rounded vowels by BP native speakers are shown below.

Simulation 1 - Acquisition of BP as L1 (learners' L1)

Since it is also necessary to map the initial stage of the acquisition process of L2 learners' mother tongue, Simulation 1 represents BP acquisition (L1); knowledge of this process regarding L1 is a key step to understand the L2 acquisition process. The system, at this time of the study, was scheduled to respond to an early stage of a baby acquiring BP vowels, as shown in Tableau 1, below.

The algorithm was programmed to reach a target system from which the seven Portuguese vowels (/i, e, ɛ, o, ɔ, u, a/) are acquired. Thus, marked constraints that refer to these vowels must be affected by the algorithm, in order to be removed and reach the lowest positions of the hierarchy in the final stage, inverting the ranking of the initial stage (Markedness >> Faithfulness).

Tableau 1, below, represents the ordering of constraints at the stage in which the Portuguese vowel system already integrates children's phonology.[17]

[17] Due to the large number of constraints, in the *Tableau* their representation is made through the numbers that identify them. The same occurs in the *Tableaux* 2 and 3. In the *tableaux*, the "central value" of each Constraint corresponds to the values that are under the "*ranking value*" column, while the "selection point value" of each Constraint corresponds to the values that are under the "*disharmony*" column. "*Plasticity*" is a numerical value through which the algorithm will adjust the *ranking* of the constraints; this value is provided during the computer simulation, through the PRAAT *Learn* function.

Table 1 – Acquisition of Brazilian Portuguese as L1[18]

	ranking value	*disharmony*	*plasticity*
(1) *{coronal/labial; dorsal/labial; coronal; dorsal}	100.000	101.001	1000000
(2) *{-high,-low,-ATR;-high,-low,+ATR;+high;+low}	100.000	99.733	1000000
(3) *{coronal/labial}	100.000	98.849	1000000
(4) Ident{place}	73.107	76.631	1000000
(5) Ident{height}	77.994	76.457	1000000
(6) *{-high,-low,-ATR}	65.732	66.509	1000000
(7) *{coronal/labial; dorsal/labial}	57.239	59.136	1000000
(8)*{-high,-low,-ATR;-high,-low,+ATR}	48.931	49.948	1000000
(9) Ident{labial}	42.161	43.571	1000000
(10) *{-high,-low,-ATR;-high,-low,+ATR;+high}	41.956	42.555	1000000
(11) *{coronal/labial;dorsal/labial;coronal}	41.956	40.770	1000000

r/i/co	1	2	3	4	5	6	7	8	9	10	11
☞ r[i]co	*	*								*	*
r[o]co	*	*		*!	*		*	*	*	*	*
r[u]co	*	*		*!			*		*	*	*
r[a]co	*	*		*!	*						
r[e]co	*	*			*!			*		*	*

p/u/lo	1	2	3	4	5	6	7	8	9	10	11
☞ p[u]lo	*	*					*			*	*
p[i]lo	*	*		*!					*	*	*
p[o]lo	*	*			*!		*	*		*	*
p[a]lo	*	*		*!	*				*		
p[e]lo	*	*		*!	*			*	*	*	*

m/e/do	1	2	3	4	5	6	7	8	9	10	11
☞ m[e]do	*	*						*		*	*
m[E]do	*	*			*!	*		*		*	*
m[o]do	*	*		*!			*	*	*	*	*
m[a]do	*	*		*!	*						
m[i]do	*	*			*!					*	*

b/o/lo	1	2	3	4	5	6	7	8	9	10	11
☞ b[o]lo	*	*					*	*		*	*
b[e]lo	*	*		*!				*	*	*	*
b[O]lo	*	*			*!	*	*	*		*	*
b[a]lo	*	*		*!	*				*		
b[i]lo	*	*		*!	*				*	*	*

f/E/rro	1	2	3	4	5	6	7	8	9	10	11
☞ f[E]rro	*	*				*		*		*	*
f[O]rro	*	*		*!		*	*	*	*	*	*
f[e]rro	*	*			*!			*		*	*
f[i]rro	*	*			*!					*	*
f[a]rro	*	*		*!	*						

[18] Note that, in this *Tableau*, the Constraint (4) is ranked above the Constraint (5), although it has a greater weight ("central value" - *ranking value*) than that: this is possible because the distance between their weights are less than 10 points, which allows for variation between them. This occurrence in *Tableau* 1 is due to the fact that, in this simulation (which represents a production by the speakers), the Constraint value (4) was changed within the range of 10 points, presenting "selection point value" (*disharmony*) higher than that of Constraint (5) - the selection point is the assumed value, within the range of values, which corresponds to the value displayed at the time of evaluating the candidates.

g/O/la	1	2	3	4	5	6	7	8	9	10	11
☞ g[O]la	*	*				*	*	*		*	*
g[E]la	*	*		*!		*		*	*	*	*
g[o]la	*	*			*!		*	*		*	*
g[i]la	*	*		*!	*				*	*	*
g[a]la	*	*		*!	*				*		

m/a/la	1	2	3	4	5	6	7	8	9	10	11
☞ m[a]la	*	*									
m[i]la	*	*		*!	*					*	*
m[u]la	*	*		*!	*		*		*	*	*
m[e]la	*	*		*!	*			*		*	*
m[O]la	*	*		*!	*	*	*	*	*	*	*

Source: Authors' elaboration.

Even in the representation of the BP vowel system acquisition process, consisting of seven vowels (/i, e, ɛ, o, ɔ, u, a/) - Tableau 1 -, observing the objective of this study, constraints considered relevant were included for the treatment of front rounded vowels found in French. Thus, taking into account the three marked constraints which occupy the highest positions in the ranking, two of them (*{CORONAL/LABIAL} and *{CORONAL/LABIAL, DORSAL/LABIAL, CORONAL, DORSAL}) refer to those coronal/labial vowels of French (/y, ø, œ/), which must have been acquired when French is fully acquired. Thus, both constraints remain in the highest position in the hierarchy registered in Tableau 1, with ranking value that is far from those of the other constraints. The inclusion of these constraints among those that formalize acquisition of Portuguese vowels allows the possibility to follow the movement they do in the complex event of French acquisition by Brazilian learners. It is observed that they retain the initial weight given to the algorithm (100.00), indicating that, for BP, they have no functionality.

It should be highlighted that, for the outputs with the seven vowels of BP to be chosen, while remaining faithful to their inputs, IDENT{HEIGHT} and IDENT {PLACE} constraints appear in a dominant relation with respect to the marked constraints. The performance of the IDENT {LABIAL} Faithfulness constraints also stands out: inversely to the other Faithfulness constraints (IDENT{HEIGHT} and IDENT{PLACE}), the constraint that refers to the roundness of the lips has a low position in the ranking. Such behavior shows the difference in the status of the roundness of the lips, in Portuguese, by comparison with those with height and place. This behavior is different from what should occur in the full acquisition of French: lip rounding is an existing parameter in the differentiation of vowels in this language, since it introduces a distinctive character for the coronal vowels and, therefore, must assume a position closer to the other Faithfulness constraints, as shown in Tableau 2.

Simulation 2 - Acquisition of French as L1 (learners' L2)

Since French grammar is the target of Brazilian learners under study, Simulation 2 mapped the process of French acquisition as a mother tongue, represented in Tableau 2.

Simulation 2 allows to verify the capacity of the algorithm OT-GLA to converge in a grammar that reflects also a categorical output standard, with the ten vowels of the French phonological inventory, that is, the seven vowels which are also found in Portuguese and the three coronal/labial vowels (/i, e, ɛ, o, ɔ, u, a, y, ø, œ/).

Table 2 – Acquisition of French as L1

	ranking value	*disharmony*	*plasticity*
(1) *{coronal/labial;dorsal/labial;coronal;dorsal}	100.000	102.586	1000000
(2) *{-high,-low,-ATR;-high,-low,+ATR;+high; +low}	100.000	101.680	1000000
(3) Ident{place}	79.102	78.910	1000000
(4) Ident{height}	78.794	77.722	1000000
(5) *{-high,-low,-ATR}	64.244	64.116	1000000
(6) *{coronal/labial}	64.410	62.655	1000000
(7) Ident{labial}	57.070	56.046	1000000
(8) *{coronal/labial;dorsal/labial}	42.930	42.181	1000000
(9) *{-high,-low,-ATR;-high,-low,+ATR}	43.638	40.292	1000000
(10) *{coronal/labial;dorsal/labial;coronal}	30.281	29.271	1000000
(11) *{-high,-low,-ATR;-high,-low,+ATR;+high}	30.281	26.920	1000000

ét/y/de	1	2	3	4	5	6	7	8	9	10	11
☞ ét[y]de	*	*				*		*		*	*
ét[u]de	*	*	*!					*		*	*
ét[i]de	*	*	*!				*			*	*
ét[a]de	*	*	*!	*			*				
ét[e]de	*	*	*!	*			*		*	*	*

affr/Ø/se	1	2	3	4	5	6	7	8	9	10	11
☞ affr[Ø]se	*	*				*		*	*	*	*
affr[e]se	*	*	*!				*		*	*	*
affr[o]se	*	*	*!					*	*	*	*
affr[a]se	*	*	*!	*			*				
affr[i]se	*	*	*!	*			*			*	*

édit/œ/rs	1	2	3	4	5	6	7	8	9	10	11
☞ édit[œ]rs	*	*			*	*		*	*	*	*
édit[O]rs	*	*	*!		*			*	*	*	*
édit[E]rs	*	*	*!		*		*		*	*	*
édit[i]rs	*	*	*!	*			*			*	*
édit[a]rs	*	*	*!	*			*				

l/i/vre	1	2	3	4	5	6	7	8	9	10	11
☞ l[i]vre	*	*								*	*
l[y]vre	*	*	*!			*	*	*		*	*
l[u]vre	*	*	*!				*	*		*	*
l[a]vre	*	*	*!	*							
l[e]vre	*	*		*!					*	*	*

c/u/teau	1	2	3	4	5	6	7	8	9	10	11
☞ c[u]teau	*	*						*		*	*
c[i]teau	*	*	*!				*			*	*
c[y]teau	*	*	*!			*		*		*	*
c[a]teau	*	*	*!	*			*				
c[e]teau	*	*	*!	*			*		*	*	*

pur/e/	1	2	3	4	5	6	7	8	9	10	11
☞ pur[e]	*	*							*	*	*
pur[Ø]	*	*	*!			*	*	*	*	*	*
pur[o]	*	*	*!				*	*	*	*	*
pur[a]	*	*	*!	*							
pur[i]	*	*		*!						*	*

b/o/me	1	2	3	4	5	6	7	8	9	10	11
☞b[o]me	*	*						*	*	*	*
b[e]me	*	*	*!				*		*	*	*
b[Ø]me	*	*	*!			*		*	*	*	*
b[a]me	*	*	*!	*			*				
b[i]me	*	*	*!	*			*			*	*

fen/E/tre	1	2	3	4	5	6	7	8	9	10	11
☞fen[E]tre	*	*			*				*	*	*
fen[O]tre	*	*	*!		*		*	*	*	*	*
fen[œ]tre	*	*	*!		*	*	*	*	*	*	*
fen[i]tre	*	*		*!						*	*
fen[a]tre	*	*	*!	*							

p/O/rte	1	2	3	4	5	6	7	8	9	10	11
☞p[O]rte	*	*			*			*	*	*	*
p[E]rte	*	*	*!		*		*		*	*	*
p[œ]rte	*	*	*!		*	*		*	*	*	*
p[i]rte	*	*	*!	*			*			*	*
p[a]rte	*	*	*!	*			*				

t/a/ble	1	2	3	4	5	6	7	8	9	10	11
☞t[a]ble	*	*									
t[i]ble	*	*	*!	*						*	*
t[u]ble	*	*	*!	*			*	*		*	*
t[e]ble	*	*	*!	*					*	*	*
t[O]ble	*	*	*!	*	*		*	*	*	*	*

Source: Authors' elaboration.

Regarding French as L1, Tableau 2 shows a hierarchy marked by the dominance of Faithfulness constraints (IDENT{HEIGHT} and IDENT{PLACE}) over Markedness constraints, now also including the Faithfulness constraint IDENT{LABIAL}. It is noteworthy that IDENT {LABIAL}, despite being below the other Faithfulness constraints, assumes a weight that brings it closer to the highest positions, a fact that does not occur in Portuguese and shows the difference in status of this constraint in both grammars.

It is also relevant that the Markedness constraint *{CORONAL/LABIAL, DORSAL/LABIAL, CORONAL, DORSAL}, which is at the top of the ranking, appears with central weight equal to 100 (the same initial central weight given to the algorithm), representing an algorithm strategy to demonstrate the redundancy it offers to the grammar. It is the Markedness constraint that, in the stringency relation, gathers all vowel places (see (3g) of the Section referring to constraint formalization).

The idea is that constraints in stringency make it clear that, in that set, there is an intrinsic hierarchy that makes the 'less marked' constraints be demoted first and, therefore, in the ranking, it must be below the other constraints. In this sense, the constraint *{CORONAL/LABIAL}, which represents the most marked feature of place, and the constraint *{- HIGH, -LOW, -ATR}, which represents the most marked feature of

height, must always appear with weight superior to the rest of the set constraints and, so on, successively. It is shown in Tableau 2 and in Tableau 1, as well.

Thus, in the acquisition of French vowels, as occurs in the full acquisition of BP vowels, grammar assumes a representation in which faithful outputs are admitted, categorically (Faithfulness >> Markedness). In other words, the GLA algorithm linked to the OT was able to converge into categorical grammars that express the target system to be reached by the learners.[19]

Simulation 3, which represents the interlanguage, that is, the partial acquisition of the French vowel system by BP native speakers, is described below.

Simulation 3 - Partial acquisition of French (Interlanguage)

In the third and final simulation shows the constraint hierarchy of interlanguage, which represents the grammar of BP native speakers who are learning French. As previously mentioned, data under study refer to the ones of advanced learners (see Table 1, in the Data Analysis Section). Taking into account that what is being formalized is grammar in development, as the front rounded vowels of French are still in the stage of acquisition, variable outputs are shown. However, weights of Faithfulness constraints IDENT{HEIGHT} and IDENT{PLACE} continue with central values slightly larger than the ones of Markedness constraints, since the Data Analysis Section registers data on advanced learners demonstrate to be closer to the French system than to the BP system, with the highest rate of production of front rounded vowels in accordance with the target L2.

[19] Note that the central values of the constraints that are decisive for the choice of each candidate have a difference of more than 10 points, which does not allow changing their position in the *ranking* (it is emphasized that it is always necessary to look at the constraints relevant to the decision of each vowel, one by one, as if each one were a *tableau*).

Table 3 – Acquisition of French as L2 - Interlanguage (Advanced Level)

	ranking value	*disharmony*	*plasticity*
(1) *{-high,-low,-ATR; -high,-low,+ATR; +high; +low}	100.000	101.666	1000000
(2) *{coronal/labial; dorsal/labial; coronal; dorsal}	100.000	97.704	1000000
(3) Ident{place}	93.746	95.705	1000000
(4) *{-high,-low,-ATR}&*{coronal/labial}	94.083	95.509	1000000
(5) *{+high}&*{coronal/labial}	92.402	92.990	1000000
(6) *{-high,-low,+ATR}&*{coronal/labial}	92.876	91.612	1000000
(7) *{coronal/labial}	79.361	81.386	1000000
(8) Ident{height}	77.994	74.787	1000000
(9) *{-high,-low,-ATR}	65.732	64.553	1000000
(10) *{-high,-low,-ATR; -high,-low,+ATR}	48.931	47.515	1000000
(11) Ident{labial}	48.606	47.008	1000000
(12) *{coronal/labial; dorsal/labial}	50.794	44.914	1000000
(13) *{-high,-low,-ATR; -high,-low,+ATR; +high}	41.956	42.364	1000000
(14) *{coronal/labial; dorsal/labial; coronal}	41.956	40.276	1000000

ét/y/de	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞ ét[y]de	*	*			*		*					*	*	*
ét[u]de	*	*	*!									*	*	*
ét[i]de	*	*	*!								*		*	*
ét[a]de	*	*	*!					*			*			
ét[e]de	*	*	*!					*		*	*		*	*

affr/Ø/se	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞ affr[Ø]se	*	*				*	*			*		*	*	*
affr[e]se	*	*	*!							*	*		*	*
affr[o]se	*	*	*!							*		*	*	*
affr[a]se	*	*	*!					*			*			
affr[i]se	*	*	*!					*			*		*	*

édit/œ/rs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞édit[œ]rs	*	*		*			*		*	*		*	*	*
édit[O]rs	*	*	*!						*	*		*	*	*
édit[E]rs	*	*	*!						*	*	*		*	*
édit[i]rs	*	*	*!					*			*		*	*
édit[a]rs	*	*	*!					*			*			

l/i/vre	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞ l[i]vre	*	*											*	*
l[y]vre	*	*	*!		*		*				*	*	*	*
l[u]vre	*	*	*!								*	*	*	*
l[a]vre	*	*	*!					*						
l[e]vre	*	*						*!		*			*	*

c/u/teau	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞ c[u]teau	*	*										*	*	*
c[i]teau	*	*	*!								*		*	*
c[y]teau	*	*	*!		*		*					*	*	*
c[a]teau	*	*	*!					*			*			
c[e]teau	*	*	*!					*		*	*		*	*

pur/e/	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☞ pur[e]	*	*								*			*	*
pur[Ø]	*	*	*!			*	*			*	*	*	*	*
pur[o]	*	*	*!							*	*	*	*	*
pur[a]	*	*	*!					*						
pur[i]	*	*						*!					*	*

b/o/me	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☛b[o]me	*	*								*		*	*	*
b[e]me	*	*	*!							*	*		*	*
b[Ø]me	*	*	*!			*	*			*		*	*	*
b[a]me	*	*	*!					*			*			
b[i]me	*	*	*!					*			*		*	*

fen/E/tre	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☛fen[E]tre	*	*							*	*			*	*
fen[O]tre	*	*	*!						*	*	*	*	*	*
fen[œ]tre	*	*	*!	*			*		*	*	*	*	*	*
fen[i]tre	*	*						*!					*	*
fen[a]tre	*	*	*!					*						

p/O/rte	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☛p[O]rte	*	*							*	*		*	*	*
p[E]rte	*	*	*!						*	*	*		*	*
p[œ]rte	*	*	*!	*			*		*	*		*	*	*
p[i]rte	*	*	*!					*			*		*	*
p[a]rte	*	*	*!					*			*			

t/a/ble	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☛t[a]ble	*	*												
t[i]ble	*	*	*!					*					*	*
t[u]ble	*	*	*!					*			*	*	*	*
t[e]ble	*	*	*!					*		*			*	*
t[O]ble	*	*	*!					*	*	*	*	*	*	*

Source: Authors' elaboration.

Tableau 3 demonstrates the choice of outputs in a stage in which informants still exhibit variable outputs in productions of French front vowels.[20] The outgoing production moment shows, for the vowels /y, ø, œ/ of French, as well as for the vowels /a, e, ɛ, i, o, ɔ, u/, an optimal and faithful candidate. With these results, constraints assumed weights that explain how informants are acquiring the successive stages shown in the Data Analysis Section, i.e., explain the intermediate hierarchies involved in the acquisition process of French front rounded vowels and how they are built. It is relevant to observe that central values of the constraints that relate to the possibility of choosing outputs with front rounded vowels, which are higher in the hierarchy, show distance of less than 10 points, which demonstrates that they can change their position, indicating that there may be variation in the option of outputs.

It is worth mentioning that, according to Tableau 3, the output form with the rounded coronal vowels [y, ø, œ] is selected, due to the relation that, at this speech moment represented by Simulation 3, the Faithfulness constraint IDENT{PLACE} has especially with the conjoined constraints: *{-HIGH,-LOW,-ATR}&*{CORONAL/LABIAL} (Constraint n°4); *{-HIGH,-LOW,+ATR}&*{CORONAL/LABIAL} (Constraint nº6) and

[20] The possibility of occurring variable outputs, in *Tableau* 3, is interpreted by the central values (*ranking values*) of the constraints: as already explained, whenever the central value of two or more constraints has a difference of less than 10 points, there is the possibility of changing its position in the ranking and, consequently, of changing the choice of the most harmonious candidate and, thus, of variation between the forms of *output*.

{+HIGH}&*{CORONAL/LABIAL} (Constraint n°5): in this manifestation, the constraint IDENT{PLACE} occupied the highest place in the ranking. However, other *outputs* without front rounded vowels may also be chosen at this stage of L2 development, because the distance from the central values of the constraints is less than 10 points, which foreshadows the possibility of variation between the choices of output forms (see Tableau 3).

It should be highlighted that, in addition to demonstrating that outputs are variable, the algorithm allows to demonstrate which outputs are more frequent, considering weights of constraints. The fact that the Faithfulness constraint IDENT{PLACE} has a central weight (ranking value) equal to 93.746, surpassing the central weight of the constraints *{-HIGH,-LOW,+ATR}&*{CORONAL/LABIAL} (92.876) and {+HIGH}&*{CORONAL/LABIAL} (92.402) states that, for these outputs with vowels [y, ø], there are, as the most frequent optimal, faithful candidates, i.e., the Faithfulness constraint dominates the Markedness constraint more frequently. This is different from what happens with the output [œ], which is also an optimal result, since its central weight (94.083) is close to the one of the constraint IDENT{PLACE} (93.746), but must appear in its less marked forms with more frequency than the faithful form.

Therefore, it was due to the action of the GLA algorithm, which conferred close central weights between the proposed Markedness and Faithfulness constraints, that result was able to represent variable outputs. The presence of conjoined constraints was also fundamental, which were inserted in the list of constraints with the idea that they can be activated in the acquisition process of a foreign language. Without these constraints, it would not be possible to illustrate that, for BP native speaker to learn French front vowels, the promotion and demotion of vowel place and height constraints, by themselves, would not account for this intermediate process, that is, the manifestation of interlanguage. It is the height of Markedness constraints, in co-occurrence with the place constraint *{CORONAL/LABIAL}, in a high position in the ranking, that confers this effect.

The fact that the learners resort to the production of vowels of the same height as the front rounded vowels, but with a different place, substituting them, seems to indicate that the learner's awareness regarding the height of these three front vowels of French is already manifested, as summarized in (5), in agreement with data shown in Table 1, in the Data Analysis Section.

(5)
(a) for the high vowel /y/ → forms of *output* [y], [u] and [i];
(b) for the high-mid vowel /ø/ → forms of *output* [ø], [e] and [o];
(c) for the low-mid vowel /œ/ → forms of *output* [œ], [ɛ] and [ɔ].

In both Simulations 1 and 2, the conflict between constraints of Markedness and Faithfulness was limited to a game among height identity, place identity and labial identity *versus* the opposition to place and height features, representing the idea that

vowels are being acquired, respecting hierarchies that assume the organizations shown in (6a), with reference to height, and in (6b), with reference to place.

(6)
(6a) /œ, ɛ, ɔ >> ø, e, o >> y, i, u >> a/ → marked hierarchy relative to Height
(6b) /œ, ø, y >> u, o, ɔ >> i, e, ɛ >> a/ → marked hierarchy relative to Place

What was not explicit in Simulations 1 and 2, since the objective was to demonstrate the complete acquisition, that is, only the adult stage of the use of Portuguese and French, respectively, is that it is believed that, until it reaches a categorical result, height and place Markedness constraints come together, that is, they form a 'conjoined constraint', in order to explain that the constraints, in production, are gradually activated, as in stages or phases, which combine what is less complex in the articulation and in the phonological use of the segments, so that there is an increasing approximation to the target language.

In this sense, from the GLA, in the complete acquisition, the 'conjoined constraints are removed until they are not part of the grammar of the language; therefore, they integrate the learning process. This situation is explained by this study in the acquisition of French as a FL, especially in the union between height features, with the place constraint (coronal/labial), which characterizes French front vowels /y, ø, œ/. Thus, the closer the informants get to the target language, the lower the conjoined constraints are in the ranking.

Figures in Table 1 (Data Analysis Section) demonstrate (7) different percentages of suitable use of French front rounded vowels by Brazilian advanced learners.

(7)
/y/ → 67.95% of correct answers
/ø/ → 60.98% of correct answers
/œ/ → 43.90% of correct answers

Despite the fact that the moment of linguistic production, shown in Simulation 3, has motivated an organization among the constraints that led to the demotion of Markedness conjoined constraints *{-HIGH,-LOW,-ATR}&*{CORONAL/LABIAL}; *{-HIGH,-LOW,+ATR}& {CORONAL/LABIAL} and *{+HIGH}&*{CORONAL/LABIAL} on the Faithfulness constraint IDENT{PLACE}, this study highlights that this fact can be modified, allowing the emergence of unrounded vowels to replace front rounded vowels. It should also be highlighted that, at the same time, the algorithm has not neglected to make clear the probability that [y] emerges more times than the high-mid vowel [ø], and that this vowel is used more frequently than the vowel [œ]. This fact is demonstrated in the weight of conjoined constraints and in their distances from the constraint IDENT{PLACE} (central value: 93.746). Central values of constraints highlighted in (8) are to be observed.

(8)
/œ/ →*{-HIGH, -LOW, -ATR}&*{CORONAL/LABIAL} → central weight of 94.083;
/ø/ →* {- HIGH,-LOW, +ATR}&*{CORONAL/LABIAL} → central weight of 92.876;
/y/ →* {+HIGH}&*{CORONAL/LABIAL} → central weight of 92.402

These constraint weights, which represent a moment of the learners' interlanguage, can express an ordering in the acquisition of French front rounded vowels by Brazilian learners: /y/> /ø/ > /œ/. This is the order of emergence of such vowels, according to the study conducted by Alcântara (1998).

Considering informants' results of each front vowel of French, it may be observed that:

a) the constraint *{-HIGH,-LOW, -ATR}&*{CORONAL/LABIAL}, which is violated by the vowel [œ], has a central weight greater than the Faithfulness constraint of place, indicating that, more frequently, it presents results that are not faithful, that is, informants opt for less marked outputs in this learning stage;
b) the constraints *{-HIGH, -LOW, +ATR}&*{CORONAL/LABIAL} and *{+HIGH}&*{ CORONAL/LABIAL}, violated by the vowels [y, ø] have central weights below the Faithfulness constraint of place, presenting faithful results more intensively;
c) the distance of the Markedness constraint violated by the mid vowel /ø/ *{-HIGH, -LOW, +ATR}&*{CORONAL/LABIAL} with respect to the Faithfulness constraint is equal to 0.87, while the distance of Faithfulness constraint violated by the high vowel of French /y/ *{+HIGH}& *{CORONAL/LABIAL} with respect to the Faithfulness constraint is equal to 1.34, showing that the faithful results for the high vowel appear in higher indices, with respect to the other French vowels, considering that the Faithfulness constraint is more distant, with less possibility of varying with the conjoined Markedness constraints *{+HIGH}&*{CORONAL/LABIAL}.

It is interesting to highlight the difference in central weight assumed between the constraints of IDENT{HEIGHT} and IDENT{PLACE}. As the height relation is already established for the informants, the Faithfulness with respect to height is maintained even if a less marked result might emerge as an optimal output, as in Simulation 3. It is observed, once again, that both Markedness constraints that are higher in the ranking, with central weight equal to 100.00, are redundant in the analysis, being unnecessary in the formalization of this grammar fragment. It was decided to maintain these constraints solely as a contribution to the theoretical exercise.

With the formalization of grammar via St OT, it could be demonstrated that the complexity of acquiring a foreign language lies in the co-occurrence of features, formalized by the conjunction of place and height constraints. Conjoined constraints have demonstrated, beyond a strategy of the acquisition of French vowels, that the

acquisition of vowels constituted by coronal/labial features succeeds the acquisition of vowels constituted by dorsal/labial features.

It is noteworthy that French acquisition, unlike Portuguese acquisition, must still deal with Identity to the [labial] features, which was demonstrated by the movement of the constraint IDENT{LABIAL} in the acquisition of Portuguese as a mother tongue (Simulation 1) and the acquisition of French as L1 (Simulation 2). Therefore, a striking feature of the stage of learning demonstrated by this study is that, unlike Simulations 1 and 2, the central weight of the Faithfulness constraints (IDENT{PLACE} and IDENT{HEIGHT}) are very near to those that show Markedness constraints. Such behavior expresses that moments of linguistic production are a source of motivation for changing the hierarchy of constraints.

Final Considerations

The objective of describing and formalizing, in the light of assumptions of the St OT, emergence of vowels /y/, /ø/, /œ/ in the phonology of French as a foreign language by BP native speakers, seeking explanations in constraints of Markedness and Faithfulness, which are part of the OT, brought a reflection on the relevant constraints found in this process and its behavior in the grammars of both languages, as well as in learners' interlanguage.

Alcântara's data (1998) showed the existence of an order in the process of acquisition of French front rounded vowels by BP speakers, characterized by: (1st) acquisition of the high, rounded front vowel (/y/); (2nd) acquisition of the high-mid, rounded front vowel (/ø/) and (3rd) acquisition of the low-mid, rounded front vowel (/œ/). The Theory of Phonological Markedness and Simplification Procedures Based on Constraints, by Calabrese (1995), which supported that study, offered an apparatus that explained the motivation for the late emergence of front rounded vowels, in comparison with front unrounded vowels, as well as the reason for using them instead of those in the process of French acquisition as L2 by BP speakers. However, it left the gap in the explanation of the ordering in the acquisition of French vowels, that is, it did not explain why there is this order in the emergence of rounded vowels: /y/ > /ø/ > /œ/. The analysis conducted with St OT, proposed by this study, was able to fill this gap, based on the conjunction of height and place constraints, and did so with a differentiated view of grammar and acquisition of a foreign language, sustained by the notion of distinctive features as part of universal constraints.

The formalization offered by the conjunction between constraints was a contribution of this study, which managed to capture the complexity of the acquisition of L2 segments from the co-occurrence of features. The representation of the strategy used by learners in an acquisition stage results from the combination of the distinctive features that define the vowel systems.

The proposed approach has enabled to formalize differences presented by the Portuguese and French vowel systems, particularly through the behavior of Faithfulness constraint IDENT{LABIAL}: in French, contrarily to Portuguese, rounding has a distinctive character; this fact was represented by the different position, in the ranking, that the constraint showed in the representation of Portuguese grammar (Simulation 1) and in the representation of French grammar (Simulation 2) - the constraint IDENT{LABIAL} received from the algorithm numerical weights that could promote it when the grammar of the language is compromised with the Faithfulness of the [labial] feature, as it happens in French, and remove it, when there is no distinctive impairment with regard to the [labial] feature, which is the case of BP.

In addition, considering that it was necessary to map the initial stage of the acquisition process of Portuguese, the learners' mother tongue (Simulation 1), and the acquisition of French as the mother tongue (Simulation 2), before the formalization of the interlanguage stage (Simulation 3), another relevant characteristic could be highlighted in regard to constraint hierarchy: while the acquisition, either of BP or of French, there is a categorical dominance of Faithfulness over Markedness (Faithfulness >> Markedness), on the developmental stage, this relation is variable due to the distance of less than 10 points in the central values, that constraints present. With regard to interlanguage, there is a promotion of conjoined constraints, as a strategy that integrates the learning stages of a foreign language.

Observations regarding the relevant constraints to explain the motivation of ordering in the emergence of rounded vowels (/y/ > /ø/ > /œ/), in French acquisition by BP native speakers, as well as referring to the formalization of phonological grammars, in the light of the St OT, reinforce, with data not yet explored, the relevance of the theoretical model to explain the process of language acquisition, which is done in the wake of authors like Alves (2008), McCarthy (2008) and Boersma (1997). It is a contribution to the theoretical reflections that support studies in the field of acquisition of the phonological component of languages. There is also a special contribution to the field of studies of L2 acquisition: with the use of the learning algorithm that integrates St OT, the grammar of the interlanguage was characterized by means of simulation that required information articulated with the acquisition process, as L1, both the learners' language and the target language. To scholars, this approach can offer clarification and formalization of a view of the interlanguage grammar, indicating a differentiated way to explain the nature of the interlanguage phenomenon.

ALCÂNTARA, C.; MATZENAUER, C.; CARNIATO, M.; QUINTANILHA-AZEVEDO, R. Vogais arredondadas do francês por falantes do português brasileiro. **Alfa**, São Paulo, v.65, 2021.

- *RESUMO: O foco do presente estudo está na aquisição das vogais frontais arredondadas do francês por falantes nativos do português do Brasil (PB). Com o suporte da Teoria da Otimidade Estocástica e com o pressuposto de que a aquisição de uma língua estrangeira*

implica sobretudo a organização de uma nova gramática, este estudo objetiva, com base empírica emprestada de Alcântara (1998), descrever e formalizar a emergência das vogais /y/, /ø/, /œ/ na fonologia do francês como língua estrangeira em falantes nativos do PB, buscando-se explicações para a presença de formas em variação nesse processo. A análise via TO Est foi capaz de explicar e de formalizar a ordenação /y/ > /ø/ > /œ/ na construção do sistema vocálico do francês por aprendizes brasileiros, com uma visão de gramática sustentada na noção de traços distintivos como parte de restrições universais, por meio da conjunção das restrições de altura e de ponto dos segmentos vocálicos. Além disso, permitiu formalizar o diferente papel que o arredondamento vocálico desempenha nas gramáticas fonológicas do português e do francês.

- *PALAVRAS-CHAVE: aquisição de vogais do francês; aquisição de LE; Teoria da Otimidade Estocástica.*

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