# Phonological disorders in the light of constraints

Giovana Ferreira Gonçalves Bonilha (UFRGS – PUCRS – CAPES)
gfgb@terra.com.br

## Abstract

The appearance of Optimality Theory (OT) in 1993 has not yet been able to change the focus of research on phonological disorders since they basically continue to use the model based on rules of autosegmental phonology. Some works, however, have effectively analyzed data of phonologically disordered children by employing the constraint-based model proposed by OT. Among them are Bernhardt & Stemberger (1998), Dinnsen & O´Connor (2001), Barlow (2001) and Lamprecht (1999) - for Brazilian Portuguese data. Although some papers are already employing OT in the description and analysis of data with phonological impairment, it remains necessary to take up some aspects of disordered speech and attempt to clarify them through the theory. The advantages attributed to OT do not appear to lie merely in the rereading fostered by the *tableaux* - which show interactions not yet evidenced by the use of derivational models - but they seem especially to reside in its capacity to explain specific aspects of disordered speech from within its own architecture. From the perspective of OT, the characteristics attributed to disordered speech can be viewed through the workings of the grammatical system itself, expressed by means of functions such as Gen and Eval, of learning algorithms and, basically, of the constraint hierarchies which constitute grammar. The present paper seeks to ponder on how OT understands speech disorders and on the contributions that this constraint-based model can make to the description, analysis and treatment of them. It also seeks to comment on the efficacy of OT in making explicit the implicational relations proposed by Implicational Model od Features Complexity (Mota, 1996). Through the analysis of the data of 25 Brazilian phonologically disordered children, Mota (1996) found implicational relations among the distinctive features which lead to different possibilities in the development of consonantal segments during the acquisition process. Considering the subjects' performance in what concerns the distinctive features involved in each of the consonantal segments observed, the author proposed a table of implicational relationships among features. By means of the application of OT to some aspects of Mota's work, we have tried to demonstrate that the theory is able to effect a rereading of the analyzed data in a more satisfactorily way, allowing for the "visualization" of phonological disorders from "within" the linguistic system. According to Optimality Theory, the hierarchization of features does not occur in a treelike structure, but through the ranking of constraints. From this perspective, it is also necessary to consider other features that militate in the early stages of acquisition, such as [+approximant], [+vocoid] and [dorsal], which would account for the early emergence of the vocalic segments /a/, /i/ and /u/. Therefore, the 0 level proposed by Mota (1996) would be formed by the features [+/-voice], [+/-vocoid], [+/-approximant], [+/-continuant], [coronal], [labial], [dorsal], [+/-anterior] and [+/-sonorant]. This alteration is justified because the demotions of feature constraints such as *[+approximant] and *[dorsal], below the faithfulness constraints, allowing for the acquisition os /a/, for example, are not related to the vocalic segments only. At first, it cannot be conceived that the markedness constraints be related to one only kind of segment; actually, it is the totality of such constraints that forms the segments in OT. Differently from Feature Geometry (Clements & Hume, 1995), Optimality Theory does not need different representations for vocalic and consonantal segments; it can also express, within its own architecture, the complexity of segments as it assumes the existence of conjoined constraints. The difference between normal and disordered acquisition resides, basically, in the late demotion of conjoined constraints acting in the domain of the segment and established during the acquisition process. The data seem to indicate that phonologically disordered children do not present difficulty in the demotion of individual constraints which constitute universal subhierarchies, for they evidence in their system the several distinctive features constituting the segments of Brazilian Portuguese. As it was also observed that the excess of variation presented by the phonologically disordered learner seems to be related to the late acquisition of the segments, since according to the architecture of OT the slow demotion of constraints leads to the construction constraint-sharing strata. The importance that should be given by the analyst to the constraint sharing strata must, therefore, be emphasized although it must be stressed that the best speech therapy is not always the one which seeks to dismember them, for the demotion of fixed constraints, ranked a bit higher, may be more efficient in the treatment, by means of generalization. It must be also stressed that the discussion of certain aspects which characterize disordered speech, and which used to be discussed "on the side of" theoretical models, can now be supported in the own architecture of the theory.

## 1. **Introduction**

Since it emerged, in the 90´s, Optimality Theory (OT) has been used in most research related to phonology. One of the major advantages of using OT instead of the linguistic analysis models based on rules, is that, with this new theoretical model, it is feasible to show interaction between the different levels that compose grammar for the production of a specific surface form. Another important aspect is the proximity between theory and the connectionist paradigm, bringing a new vision to the description and analysis of language acquisition data.

Several works that use OT for research examine the normal phonological acquisition, but there are few studies geared towards the application of theory to data analysis and description that configure phonological disorders (PD). Considering the reduced number of papers produced, one might question whether OT can actually contribute to the description and analysis of phonological disorders and speech therapy.

Why, after a decade, is OT not applied in such therapies? Why is this theoretical model not given priority over analysis based on processes and rules concerning phonological disorders, if there are several studies that use OT in the normal phonological acquisition analysis? Is OT actually capable of explaining the patterns that constitute impaired speech?

This research considers how OT understands speech disorders and the contributions that the application of this constraint-based model can bring to the description, analysis, and treatment of PD.

Despite the fact that some works have been using OT for describing delays in the developmental process, it is necessary to review some aspects of phonological disorders and to try to explain it through that theory. The advantages which can be attributed to OT do not seem to lie only in the revision provided by *tableaux* – which show interactions not yet verified with the application of derivational models – they actually seem to reside in its capacity to explain certain aspects of impaired speech in its own architecture. From an OT point of view, the aspects attributed to disordered speech can be visualized by the operation of the grammatical system, expressed by functions such as *Gen* and *Eval*, in learning algorithms and, fundamentally, in constraints hierarchies.

## 2. Speech disordered acquisition from an OT point of view.

The emergence of OT in 1993 has not yet been capable of changing the focus of research of phonological impairment in Brazil, for it continues to use the model based on rules of auto-segmental phonology. Lamprecht (1999a, 1999b, 2001) is an exception, as the paper refers to the importance of considering the use of OT in the analysis of phonological impairments, highlighting that the difference between normal phonological acquisition and disordered acquisition lies in the fact that children with the latter present the same ranking of constraints, but in later periods of time.

Some studies have effectively analyzed the data of children that present phonological disorders, based on this constraints model, as Bernhardt & Stemberger (1998), Dinnsen & O´Connor (2001), Barlow (2001), Dinnsen & Barlow (1998) and Lamprecht (1999a). OT is revealing the interactions between error´s patterns, which would not be apparent under another theoretical focus.

According to Barlow (2001), the development of any phonological theory depends on its correct application to the acquisition data, normal or disordered. In addition, the outcomes predicted by a theory must be corroborated empirically in phonological therapy. Although a specific theoretical model enables the development and application of therapies that are satisfactory for phonological impairments, it is necessary to investigate if new models can contribute further to the efficiency of treatment. Thus, clinical phonology studies should always follow the new theoretical proposals arising in literature.

## 3. Rethinking some issues

### 3.1 Disordered and normal acquisition: similarities and differences

Phonological theories have contributed substantially towards the development of speech therapy proposals. The use of Natural Phonology, for example, has enabled the description of disordered phonological systems based on the generalization of phonological processes, which can also be said of the using of distinctive features proposed by Chomsky & Halle and of the use of non-linear models. OT, however, in addition to describing the phonological system, as do the other models mentioned, is also capable of explaining the

differences and similarities found in normal and disordered acquisitions. The explanation resides in the architecture itself, in its principles and operation.

The literature has shown that the disordered phonological system constitutes a sub-system of the target language and can be frequently identified by the similarities found with the stages presented in normal language acquisition. One of the differences lies in the fact that these stages seem to "freeze", remaining the same in advanced ages. Lamprecht (1999) distinguishes the importance of understanding this system as part of the Portuguese system, as it questions the assumption, improperly disseminated, about the production of phonologically delayed children.

The fact that disordered speech basically does not constitute a different system from PB, that is, without presenting, for example, syllabic segments and structures that do not constitute the language's phonological system, may be seen by the way that OT explains phonological acquisition.

According to OT, acquisition takes place through the gradual demotion and promotion, considering Hayes & Boersma (1999), of the constraints that comprise universal grammar, whereby this process takes place through the application of a learning algorithm. Considering that the algorithm works based on received input, that is, the adult's speech itself, it is possible to explain why the child with phonological disorder, like the child with normal phonological acquisition, do not present a system with segments and syllables different from those that constitute the phonological system of Portuguese. The constraints are demoted based on the input, thus the production of segments absent in the target system will not take place because the demotion of the constraints that allow its production will not be triggered.

This seems to suggest that the choice of the optimum candidate to compose the sub-optimum / optimum candidate pairs, which will activate the demotion process, seems to take place. If the optimum candidate had not been identified, according to the input received from adult speech, one would expect that the markedness constraints responsible for the production of syllabic segments and structures absent in the Portuguese system could be demoted.

It is worth noting, however, that according to Leonard (1995), it is possible that phonologically delayed children produce some segments that are not part of the target

language's system. Processes of this type, nonetheless, are rarely verified, according to Lamprecht (1999), after fifteen years of experience with phonologically impaired data analysis, children do not seem to violate constraints that are higher ranked in the hierarchy of the target language.

In addition to explaining why the disordered system can be considered a sub-system of the target language, OT intrinsically brings to its model the fact that children's production presents a systematic characteristic. This is guaranteed by the proposal that grammar, in any stage of acquisition, is expressed by ordered constraints, which can have their positions interchanged in the hierarchy. Any constraint ordering will always represent a system.

Lamprecht (1999) states that *a phonologically disordered child has the same linguistic capacity of any other child, and also has the same linguistic knowledge, but uses it in a different way*. From an OT point of view, this statement is confirmed by the potencial universal constraints that compose a grammar.

Despite constructing a sub-system of the target language, phonological disorder is not characterized strictly by the fact that the child presents, in a more advanced age, patterns found in earlier ages. The child presents overlapping stages and also the production of structures that are not witnessed in stages of normal acquisition.

OT can explain these three categories just by considering the ranking of constraints. For *delayed development*, it is possible to consider that some markedness constraints are not being demoted or are being demoted slowly by the learner; *variable development* can be explained by the "incorrect demotion of constraints", that is, constraints that require lots of analysis of sub-optimal / optimal pairs end up being demoted in initial stages and constraints that should be demoted in these stages remain ranked upward in the hierarchy. It may also be suggested that there is some problem in the demotion of conjoined constraints. The last category, *different development*, seems to implicate the constraints demotion that are not demoted in normal acquisition, or their incorrect positioning in the hierarchy.

It is also important to state that phonologically delayed children, according to Ingram (1976), present a greater variability in production than children with normal acquisition.

According to Bonilha & Matzenauer (2003), the variation in phonological acquisition, as stated by OT, can be explained through constraints that share a stratum. Constraints that share strata have a relation of potential dominance, for they are floating constraints.

Therefore, OT would suggest that phonologically delayed children have in their hierarchy a greater number of constraints that share strata or a larger amount of constraints within these strata. This would explain the greater variability presented by these subjects.
It is highlighted that the construction of the strata that are shared by constraints, as well as any ranking alteration, takes place through the application of the learning algorithm. In this case, the problem would not be the establishment of sub-optimal / optimal pairs, but the analysis process of the pairs that are responsible for the constraints demotion.

Considering that the majority of children with disordered speech presents a delayed phonological system, demonstrating that reordering constraints take place more slowly, it is expected that constraints share strata for a longer period of time, that is, the over-construction of strata that are shared by constraints seems to be a consequence of the slow reordering of constraints. In this sense, the permanence of processes found in the initial stages and variability are complementary and evidenced through a unique OT mechanism.

### 3.2 Ability of OT to evaluate and analyze speech disorders

It is necessary to discuss the adequacy of OT concerning the procedures of disordered speech analysis. The correlation, proposed by the current work, between the procedures required by Grunwell (1985) and the mechanisms provided by OT should be noted as (1):

(1)

*(i)* *Description of child's speech* → the constraint hierarchy itself describes the child's linguistic system, through the specific ordering presented.

*(ii)* *Differences between normal pronunciation patterns and the disordered speech patterns* → the differences are explained by the constraint hierarchy: normal patterns constitute a type of ordering, the disordered speech pattern another type.

*(iii)* *Communication implications of child's patterns*: the lack of phonological contrast, that is, the substitutions produced emerge from the ranking between markedness constraints and faithfulness constraints.

*(iv)* *Description of the developmental stage in which the child's speech patterns are located in relation to normal acquisition*: the stages can be compared based on the constraint hierarchy. The production of the phonologically delayed child will reflect a constraint that can be verified in a *stage "x"* of normal acquisition, for example.

*(v)* *Offering of a model that identifies the different types of disordered pronunciation patterns* → the specificities found in the disordered speech hierarchy can lead to early diagnosis: an excessive amount of strata that are shared by constraints, demotion of constraints that remain higher ranked in target language and a constraint ordering that does not correspond to the child's age.

*(vi)* *Description of patterns that should be changed* → comparison between the constraint ordering presented by the child and the constraint ordering to be achieved indicates what patterns should be changed, that is, what constraints should be re-ranked.

*(vii)* *Description and evaluation of changes made after a period of treatment* → comparison between the hierarchies presented by the learner before and after a period of treatment will make apparent the advances that have taken place.

Note that all required procedures are contemplated by OT only when the constraint ranking is considered. Speech therapy, under this theoretical model, should be conducted based on inputs that provide the creation of sub-optimal / optimal pairs capable of triggering the reordering of constraints that are "wrongly" positioned in the hierarchy.

The analysis shows the organization of the phonological system presented by the child. Therapy aims to reorganize this system, not the reorganization of a rules system, as in former models, but of a constraint hierarchy.

Mota (2001) refers to the four basic phonological change mechanisms which should be induced by a speech therapy: *stabilization* – for a variable pronunciation to become stable, *creating instability* – to break stable inadequate patterns, *innovation* – acquisition of a new pattern and *generalization*.

For OT, *stabilization* is related to the deconstruction of strata that are shared by constraints. The demotion process should be activated sufficiently so that a specific constraint, with variable ordering, takes a permanent position in the hierarchy.

To *create instability* implies the exchange of ordering between constraints that present a dominance relation. According to the learning algorithms proposed by the theory, it is a process that will require, at first, a greater clinical intervention, for it will be necessary to consider a greater amount of sub-optimal / optimal candidate pairs for the constraint to be reranked. Note that the process of creating instability, unquestionably implies the existence of the stabilization stage, because the demotions will comprise strata that are shared by constraints through the gradual analysis of candidates pairs. The third referred process – *innovation* – will also require stability, due to gradual constraint demotion. Actually, under OT, three of the four basic mechanisms of phonological change have involved the deconstruction of strata that are shared by constraints. Thus it is necessary to emphasize its operation, as it seems to play a crucial role in the delayed phonological system.

Regarding the fourth mechanism, also distinguished by Stoel-Gammon & Dunn (1985), the application of therapy should be capable of making the child acquire segments that were not focused in the treatment sessions. Considering that OT also uses distinctive features in its analysis, like elements of markedness and faithfulness constraints, therapy that aims at the promotion of a feature constraint, as *[dorsal], for example, will imply the acquisition of several segments that present it. The *tableau* in (2) can be taken as an example, as it certifies the process of blocking [+ voice] obstruents at the beginning of syllables.

(2)

| /amigo/ | *[+voice, -sonorant] | Max I/O | Ident I/O [voice] | *[-voice, -sonorant] |
|---|---|---|---|---|
| amigu | *! | | | |
| ☞amiku | | | * | * |
| amiu | | *! | | |

When stimulating the demotion of *[+voice,–sonorant], the analyst will be encouraging the acquisition of other [+voice] stops of Portuguese. One of the main

advantages of proceeding with therapy based on the data evaluation provided by the distinctive features is, therefore, kept within OT.

Furthermore, although OT uses the terminology of distinctive features in some of its markedness and faithfulness constraints, it presents advantages in its analysis when it considers the interaction of distinctive features with other phonological units, such as the syllable, for example.

Other generalizations can also be predicted by OT: *(i) the production of a specific sound in words different from those used in therapy* – it is noted that, most likely, some productions in distinct words do not take place due to the militance of conjoined constraints, features constraints, as well as of positional faithfulness constraints, it being necessary for the therapist to be alert to the diversity of contexts involved, so that difficulties can be overcome through the analysis of other sub-optimal / optimal pairs candidates; *(ii) the performance of one sound in different syllabic positions from those presented in therapy* – if markedness constraints related to distinctive features are ranked higher, hindering the performance of a segment, the demotion of this constraint will imply the performance of the segment in onset, complex onset, and coda, for example, because syllabic structure constraints as NoCoda and NotComplex (onset) were already demoted in the learner's hierarchy.

Mota refers to two other types of generalization that seem to pose more challenging questions for OT, although solutions should arise with effective data analysis originated from delayed speech. The first generalization is the one that is extended to other classes of sounds, the second is the generalization based on implicational relations, which could be explained through the universal sub-hierarchies proposed by Prince & Smolensky (1993).

### 3.3 Generalizations based on implicational relations

Mota, analyzing data from 25 phonologically disordered Brazilian children, verified markedness implicational relationships among distinctive features that conduct to different possibilities in the development of consonant segments during the acquisition process.

The data analyzed showed that, basically, all subjects presented examples of the four classes of sounds concerning the articulation mode. Only 4 subjects did not present any production of fricatives and 6 subjects did not present the production of liquids. On

Table 01, according to Mota, there is a list of the non-production of segments by the subjects analyzed.

**TABLE 01** – Number of subjects that did not acquire the segments

| Segments | Number of participants in which they are absent |
|---|---|
| /p, t, m, n, ñ/ | 0 |
| /d/ | 01 |
| /b/ | 02 |
| /k/ | 03 |
| /g/ | 05 |
| /v, z/ | 07 |
| /f/ | 08 |
| /s, l/ | 09 |
| /ʒ/ | 12 |
| /ʃ/ | 13 |
| /r/ | 16 |
| /ɾ, R/ | 18 |

Considering the performance of the subjects regarding the distinctive features involved in each of the consonant segments observed, the author proposed a table of markedness implicational relationships among features.

**Table 02** –Marked and unmarked features according to sound classes

| unmarked features | marked features | sound class |
|---|---|---|
| [-voice] | [+voice] | stops |
| [-voice] | [+voice] | fricatives |
| [-continuant] | [+continuant] | obstruents and sonorants |
| [+anterior] | [-anterior] | fricatives, nasals e liquids |
| [-approximant] | [+approximant] | sonorants |
| [coronal] | [dorsal] | obstruents and sonorants |
| [labial] | [dorsal] | stops |

Considering the implicational relationship among features shown in Table 02, the production of a marked feature of the pair - [-continuant], [+continuant] -, for example – implies the acquisition of the unmarked member. It can also be inferred that the consonant system of the PB presents four marking levels, as we can see in (3):

(3)

(i) Totally unmarked segments: /p, t, m, n/;

(ii) Partially marked segments: /b, d/, for presenting [+voice]; /k/, [dorsal]; /f, v, s, z/, [+continuant]; /ñ/, [-anterior]; /l/, [+approximant];

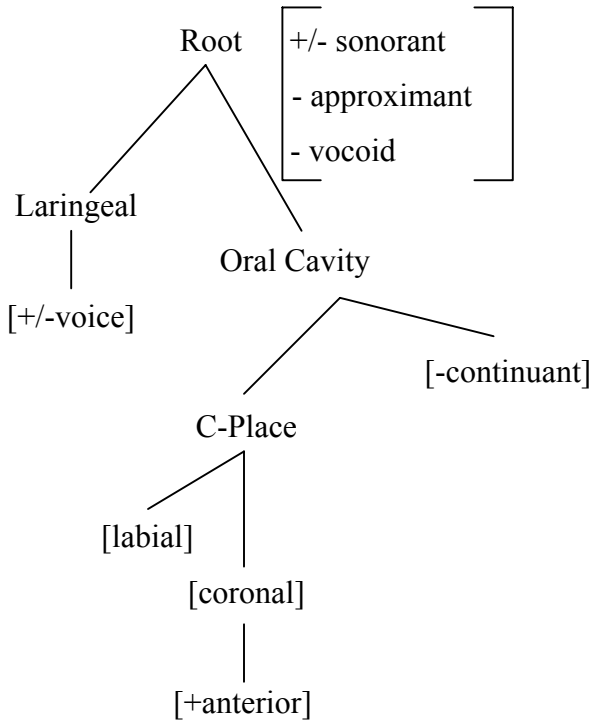
(iii) Marked segments: /g/, for presenting [dorsal, +voice]; /ʃ, ʒ/, [+continuant, -anterior]; /ʎ/, [+approximant, -anterior]; /r/, [+approximant, +continuant];

(iv)Very marked segments: /R/, for presenting the features [+approximant, +continuant, dorsal];

According to the analyzed data, Mota proposed that phonologically disordered children initiate the acquisition process, as children with normal development, with the following features because they are all considered as unmarked features: [+/-voice][1], [-vocoid], [-approximant], [-continuant], [coronal], [labial], [+anterior], [+/-sonorant].

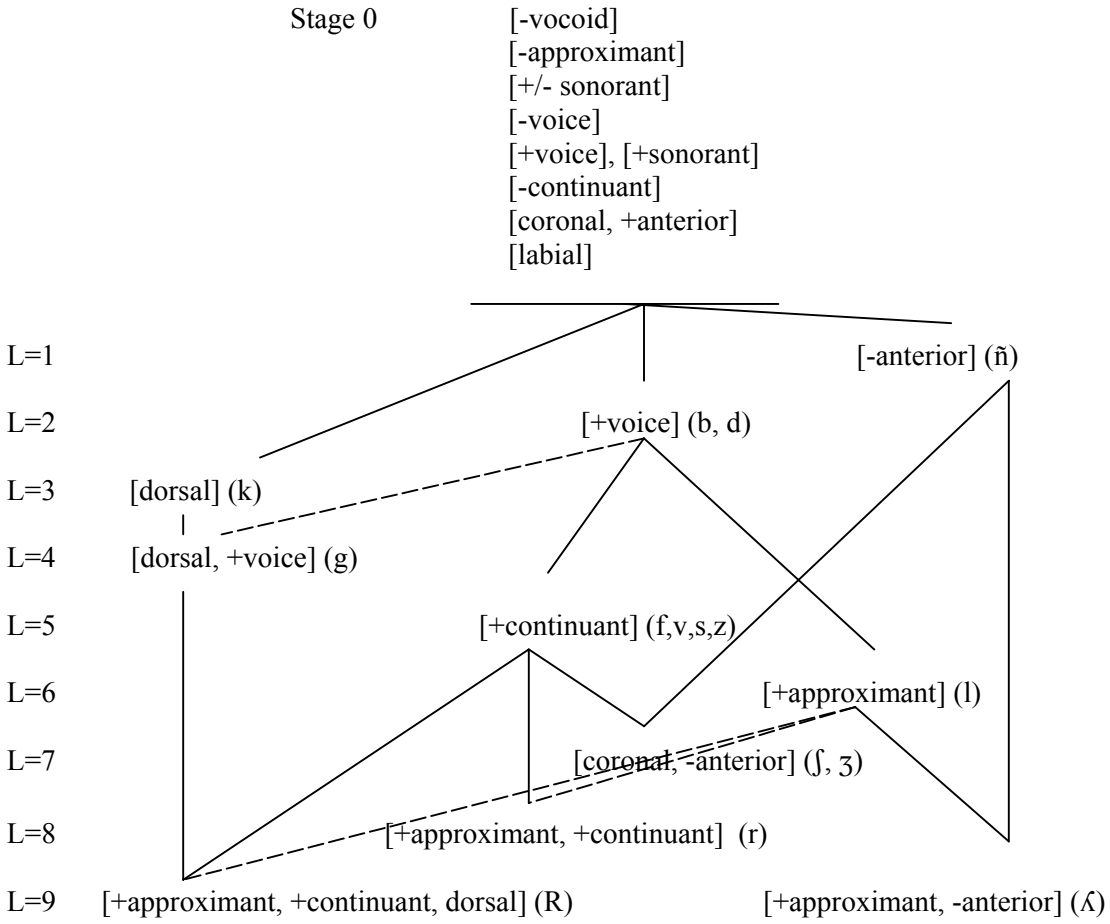
Observe in (4) the disposition of features in the Feature Geometry.

(4)



The feature configuration proposed in (4) allows /p/, /t/, /m/ and /n/ to be the first segments to arise, for they do not present any marked feature. This configuration will constitute stage 0 of the Implicational Model of Feature Complexity in Calabrese (1995).

(5)




The data analyzed by Mota testifies that acquisition takes place in a differentiated manner for the subjects analyzed, that is, starting from level 0, different paths will be taken by the learner in the acquisition of marked values.

According to Mota, phonologically delayed children do not present difficulties in the unmarked features, for these are established in Universal Grammar, but in the acquisition of segments that involve one of more marked features.

It is worth noting that, under OT, the hierarchy among features does not take place through geometry, but through the constraint ordering. Hence, it would also be necessary to

[1] The feature [+voice] is atributed to [+sonorant] segmentse and [-voice] is atributed to [-sonorant] segments.

consider other features operating at the beginning of acquisition, which would be able to handle the early emergence of vowel segments. So, the Stage 0, proposed by Mota (1996), would present the following features: [+/-voice], [+/-vocoid], [+/-approximant], [+/-continuant], [coronal], [labial], [dorsal], [+/-anterior] and [+/-sonorant].

This alteration is justified because the demotion of features constraints such as *[+approximant] and *[dorsal] below faithfulness constraints, allowing the acquisition of /a/, for example, is not related only to vowel segments. At first, it is not conceivable that markedness constraints are oriented solely towards one type of segment. It is actually the set of these constraints that constitutes the segments in OT.

OT, contrary to Feature Geometry, does not need differentiated representations for vowel and consonant segments. It can also express, within its own architecture, the complexity of segments when postulating the existence of conjoined constraints related to features. According to the tree configuration, it is necessary to explain, outside the model, that [g] is not performed because [+voice] is only established for vowels, not for consonants.

Based on Mota's proposal, with the alteration of features that constitute the level 0 here proposed, it would be feasible, in general terms, to consider that the initial hierarchy would be constituted according to (6), already presenting the first demoted constraints.

(6)

{Markedness}>>{Faithfulness}>>{*[+voice], *[-voice], *[+vocoid], *[-vocoid], *[+approximant], *[-approximant], *[-continuant], *[+continuant], *[coronal], *[labial], *[dorsal], *[+anterior], *[-anterior], *[+sonorant], *[-sonorant]}

Considering OT's proposal, it would be possible to suggest that the constraints demoted in (6) present dominance relations through the existence of universal sub-hierarchies. These relations support the unmarked aspect of some segments, ensuring that, despite different inputs, the order of acquisition between some segments is the same for distinct languages. It is possible to postulate the existence of sub-hierarchies, based on the order of segmental acquisition. Observe in (7) examples of those universal sub-hierarchies.

(7)

a) {*[dorsal]>>*[labial]>>*[coronal]}

b) {*[+continuant]>>*[-continuant]}

c) {*[-anterior]>>*[+anterior]}

Note that the proposal of existence of universal sub-hierarchies could be questioned by the fact that, in the first productions, the feature [dorsal] is already present in the production of the vocalic segment /a/, like the feature [+continuant], for example. However, the first consonants to be acquired present the features [coronal] and [labial], therefore there is no breaking in the universal sub-hierarchy. This sub-hierarchy seems to emerge in the production of segments of later acquisition that involve conjoined constraints features, like /k/, for example, with the combination [dorsal, -voice] that is acquired later, despite the constraints *[dorsal] and *[-voice] having already been demoted. Note that [p] and [t] are performed in previous stages, involving the demotion of conjoined constraints such as [*[labial] & *[-voice]]$_{(seg)}$ and [*[coronal] & *[-voice]] $_{(seg)}$.

The data analyzed by Mota supports the militancy of the sub-hierarchies in the process that involves conjoined constraints related to features. Out of the 25 subjects considered for the research, 21 presented the three C-Place, where 4 subjects acquired only two C-Place: coronal and labial.

It may be possible to postulate that conjoined constraints related to features are constituted by features that are ranked higher in the universal sub-hierarchies. See the examples of conjoined constraints based on segmental markedness.

(8)

a) /p, t, m, n/ - non-marked segments: at first, conjoined constraints which could lead to their acquisition are not certified, because they only involve unmarked features: *[-sonorant], *[-voice], *[coronal], *[labial], *[-approximant], *[-continuant], *[-vocoid].

b) /b, d/, /k/, /f, v, s, z/, /ñ/ e /l/ - partially marked segments: conjoined constraints which lead to the acquisition of these segments present one constraint that is ranked higher in the universal sub-hierarchies: {*[+voice]>>*[-voice]},

{*[dorsal]>>*[labial]>>*[coronal]}, {*[+continuant]>>*[-continuant]}, {*[-anterior]>>*[+anterior]}, {*[+approximant]>>*[-approximant]}.

c) /g/, /ʃ, ʒ/, /ʎ/ e /r/ - marked segments: conjoined constraints that lead to their acquisition present two constraints that are ranked higher in the universal sub-hierarchies.

d) /R/ - very marked segment: the conjoined constraint [*[+approximant] & *[+continuant] & *[dorsal]] $_{(seg)}$ is constituted by three constraints that are ranked higher in their respective sub-hierarchies.

Therefore, (8) confirms the proposal that phonologically delayed children present difficulties in the conjoined constrains comprised of constraints that are ranked higher in the universal sub-hierarchies. It is worth noting that segmental markedness, according to the present proposal, emerges from the conjoined constraints. Unmarked segments do not activate them.

It would also be possible to suggest, according to Bonilha (2003, 2004), that conjoined constraints are acquired. Therefore, constraints like [*[dorsal] & *[+voice]]$_{(seg)}$ and [*[labial] & *[+voice]]$_{(seg)}$ are not part of UG. The universal sub-hierarchies of distinctive features seem to emerge in the activation of these potential conjoined constraints.

Barlow (2001) highlights that, under OT, adults and phonologically delayed children have the same constraint table. It is noted that the hypothesis that conjoined constraints are acquired does not go against the proposal that grammar is composed of universal constraints. It can be understood that conjoined constraints are potentially universal. Therefore, adults and children – with normal acquisition or disordered acquisition – present the same potential constraints.

Mota's analysis (1996), according to OT, makes it evident that phonologically delayed children do not present problems in the demotion of isolated markedness features, nor in the universal sub-hierarchies, because the marked features are expressed in different segments. The problem seems to lie in the demotion of the conjoined constraints. For some

reason, probably related to its processing system – here it can be thought of the learning algorithm[2] -, the child presents difficulties in the demotion of conjoined constraints.

The disordered system will be characterized by presenting conjoined constraints found in the child's grammar up to an age where it would be expected that these constraints would have been "eliminated". Bonilha (2003, 2004) considers that, after the demotion process has been applied, conjoined constraints are separated, delinked, not being part of the language's hierarchy, as they have no role in the grammar. Observe tables 03, 04 and 05.

**Table 04** – Violated constraints by *katu* < *gatu*

| suboptimal< optimal | loser-marks | winner-marks |
|---|---|---|
| katu < gatu | *[-voice], *[-continuant], *[dorsal], *[-vocoid], *[-sonorant], *[-approximant] Ident [voice] | *[+voice], *[-continuant], *[dorsal], *[-vocoid], *[-sonorant], [-approximant], [*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$ |

**Table 05** – Mark cancellation process

| suboptimal< optimal | loser-marks | winner-marks |
|---|---|---|
| katu < gatu | *[-voice], ~~*[-continuant]~~, ~~*[dorsal]~~, ~~*[-vocoid]~~, ~~*[-sonorant]~~, ~~*[-approximant]~~ Ident [sonoro] | *[+voice], ~~*[-continuant]~~, ~~*[dorsal]~~, ~~*[-vocoid]~~, *[-sonorant], ~~*[-approximant]~~, [*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$ |

**Table 06** – Mark-data pair after mark cancellation process

| suboptimal< optimal | loser-marks | winner-marks |
|---|---|---|
| katu < gatu | *[-voice], Ident [voice] | *[+voice], [*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$ |

First, the survey of constraints violated by each element of the informative pairs created by GEN is performed, according to Table 03. After surveying these constraints, we proceed to the mark cancellation process, that is, constraints violated by both elements of

[2] The algorithm of Tesar & Smolensky (2000) does not consider the creation of constraints, for it assumes that

mark-data pairs are not considered in the demotion process. Only after mark cancellation the demotion process will take place, having constraints violated on Table 6 as basis.

From a hypothetical hierarchy presented by the learner - {[*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$}>>{Ident I/O[voice]}>>{{*[+voice]>>*[-voice]}, {*[+vocoid]>>*[-vocoid]}, {*[+approximant]>>*[-approximant]}, {*[+continuant]>> *[-continuant], {*[dorsal]>>*[labial]>>*[coronal]}, {*[-anterior]>>*[+anterior]}, {*[+sonorant]>>*[-sonorant]}}-, when performing the analysis of the informative pair *katu*<*gatu*, it can be verified that *[+voice] and *[-voice, dorsal, - sonorant] should be dominated by the constraint violated by the loosing candidate that is ranked higher in the hierarchy – Ident [voice] – so that *gatu* can be chosen as optimal. Considering that *[+voice] occupies a low strata in the current learner's hierarchy, only *[+voice, dorsal, - sonorant] should be demoted, according to (9).

(9)

{Ident I/O[voice]}>>{{*[+voice]>>*[-voice]}, {*[+vocoid]>>*[-vocoid]}, {*[+approximant]>>*[-approximant]}, {*[+continuant]>> *[-continuant], {*[dorsal]>>*[labial]>>*[coronal]}, {*[-anterior]>>*[+anterior]}, {*[+sonorant]>>*[-sonorant]}}>> [*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$

Following Bonilha's proposal, [*[+voice]&,*[dorsal]&,*[-sonorant]]$_{(seg)}$ will only be present in the learner's hierarchy while it is ranked higher, because after its demotion below faithfulness constraints, it will be a mere repetition of its constraints, disappearing from the grammar.

## 4. Conclusion

Similarly to MICT, through a constraint hierarchy, OT is capable of making the segment ordering evident, in normal acquisition and in delayed acquisition. However, it is necessary to search not only for a formal model that enables data description and analysis, but also to think of how OT could effectively explain the reasons for this ordering. Should conjoined constraints comprised of only one marked feature be demoted first? Is there a dominance relation between the constructed conjoined constraints?

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all constraints come "ready" to UG, in opposition to conceiving them as potentially universal constraints.

How is OT being certified in this study? OT is a phonological theory not only capable of describing but also of explaining some aspects related to disordered speech. One of the model's advantages lies in the fact that the "answers" always seem to converge to a unique point: constraint ranking and, consequently, learning algorithm.

Through the application of OT to some aspects of Mota's work, I tried to demonstrate that the theory is capable of analyzing data that had already been analyzed in a satisfactory manner. On the contrary, its analysis via OT enables the "visualization" of phonological disorder in the linguistic system.

It is worth noting that the discussion of certain aspects that configure disordered speech, previously discussed "next to theoretical models", can now find backup in the theory's architecture itself.

Speech disorder research should always require constant questioning concerning the limitation of current models, emphasizing the utilization of tools proposed by new theoretical models in the search for description, analysis and proposal of more effective therapies.

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