Common, Uncommon and Rare Phonological Disorders: An OT Perspective

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts at George Mason University

By

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Spring Semester 2004
George Mason University
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ACKNOWLEDGEMENTS

This thesis could not have been completed without the guidance of my thesis director, Dr. Steven H. Weinberger. His many insights made this thesis a much better paper than I could have ever done on my own. I am grateful for his patience, enthusiasm, and willingness to listen to all of my ideas.

I would also like to thank Dr. Charles Jones and Dr. Douglas Wulf. They helped me clarify many points in this paper and also offered excellent advice for the editing of this paper.

Also, Ryan Thomas and Lisa Pierce were instrumental in getting me to pursue such a project. Their comments during our thesis sessions were extremely beneficial and helped me work out some of the early problems I had with this project.

All errors are my own.

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ABSTRACT

COMMON, UNCOMMON, AND RARE PHONOLOGICAL DISORDERS: AN OT PERSPECTIVE

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This thesis analyzes phonological disorders with derivational theory and Optimality Theory (OT). Because of its typological nature, OT is shown to be a better theory in which to analyze phonological disorders. Phonological disorders are classified into three sub-types here: common, uncommon, and rare. Within the framework of OT, distinct constraint rankings are proposed for each sub-type. These rankings are also compared with normal acquisition and adult grammar.

CHAPTER 1. INTRODUCTION

A naïve interpretation of phonological disorders would be that they are all similar. However, the data show that all phonological disorders are not the same and that distinctions can be made among children with phonological disorders. Phonological disorders[1] have primarily been analyzed within the derivational model of Chomsky and Halle (1968) in such works as Applegate (1961), Compton (1970, 1976), Gandour (1981), Grunwell (1981), Ingram (1989), Leonard (1972, 1973), Lorentz (1974, 1976), Oller (1972, 1973), Stoel-Gammon and Dunn (1985), Yavas (1998), Yavas and Hernandorena (1991), and Yavas and Lamprecht (1988), to cite a few. More recently, however, Optimality Theory (Henceforth OT) (Prince and Smolensky 1993) has been incorporated into the literature of phonological disorders in the works of Barlow and Dinnsen (1998) (cluster development), Barlow and Gierut (1999) (common error patterns), Barlow (2001a) (assessment and treatment of disorders), Barlow (2001b) (cluster reduction), Pater and Barlow (2003) (cluster reduction), and Stemberger and Bernhardt (1997) (OT implications for speech pathology), and Stemberger and Bernhardt (1999) (phonological development). This paper extends the scope of these latter works by proposing a classification system of phonological disorders within an OT framework.

Phonological disorders have been classified in many different fashions. Rapin and Allen (1987)[2] proposes two categories of phonological disorders: 1) children with articulation and phonology problems; and 2) children with articulation, phonology, and syntactic problems. Prins (1962), as cited in Grunwell (1981), proposes a phonetically-based classification: 1) interdental lisp and low number of manner feature errors; 2) many omission errors, manner and voicing errors, and frequent use of [h] and [ʔ]; 3) frequently substituting a phoneme due to its manner of articulation; and 4) distorting a group of sounds unsystematically (p. 25). Grunwell (1981) proposes a classification based on phonological process: 1) idiosyncratic process (e.g. dissimilation and metathesis); 2) unusual processes (e.g. glottal realizations); 3) persistent processes (e.g. stopping and final consonant deletion); and 4) chronological mismatch (e.g. the use of clusters while other early processes, such as final consonant deletion, persist). Ingram (1989:98)

[1] This paper uses the label "phonological disorder" to be consistent with the speech pathology literature. Other terms such as "expressive phonological impairments" (Bird et al. 1995), "idiosyncratic phonological systems" (Camarata and Gandour 1984), and "deviant phonological systems" (Gandour 1981), to cite a few, have been used and are considered to be synonymous with "phonological disorder". However, it may be prudent to adopt a different label, such as "phonological difference", as a replacement for the label "phonological disorder", since it (phonological difference) does not express a negative or positive view of a child's phonology. "Phonological difference" is neutral. That is, the word "difference" itself has no strong denotations within or beyond the universe of phonology. Terms such as "disorder" and "impairment", however, could imply some type of medical condition.

[2] The specific labels Rapin and Allen (1987) give are "phonological programming deficit syndrome" and "phonological-syntactic deficit syndrome", respectively.

discusses a two-part classification system: 1) “delayed”, which describes a child who does nothing different from children his or her junior, and 2) “deviant”, which describes a child who has phonological processes that “never appear” in normal phonological acquisition.

The most common classification of phonological disorders is the two-part classification of “delayed” and “deviant” discussed in Ingram (1989). “Delay” and “deviant” have gradable definitions where in the most rudimentary sense a “delay” is not as bad as a phonology that is “deviant”. Specifically, researchers distinguish the difference between “delay” and “deviant” by considering evidence from normal phonological acquisition. For example, a child with a delay may substitute the fricatives [θ], [f], [s], and [ʃ] with [t]. This is the common process of stopping (Ingram 1998:39). Children with normal phonological acquisition also have the stopping process, but cease the process at an earlier age than those with disorders (Yavas 1998). Other delayed processes, which occur in normal development, are cluster reduction, and gliding of [l] and [ɹ]. A deviant phonological disorder[3] could be the use of a favorite sound (Grunwell 1981:45), it could be an addition to an adult form as in adding a nasal before every word, or deviance could be the “use of sounds absent from the ambient language” (Yavas 1998:156). Again, these processes “never appear” in normal phonological acquisition, and that is why the processes are considered “deviant” (Ingram 1989:98).

Though “delay” and “deviant” are considered a two-part classification system, not all researchers have the same interpretation. Ingram (1989), for instance, states that if interpreted broadly, the term “deviance” is “a general label for children who require therapy and who have no known organic basis for their difficulties” (p. 89).

Moreover, researchers can view each term of “delay” and “deviant” from different perspectives while still considering them as a two-part classification system. Stoel-Gammon and Dunn (1985) ask “…are the children best described as *delayed* because their pronunciations … [are]…typically found in the speech of much younger children or should they be described as *deviant* because their pronunciation patterns do not occur normally in developing children?” (p. 7). Yavas (1998:155) sums up this problem by saying that the “…distinction between delayed and deviant … is not clearly established” in the field of speech pathology.

In order to clear up the confusion of how phonological disorders should be classified, this paper offers the following three-part classification system:

(1) **a.** Common Phonological Disorders
b. Uncommon Phonological Disorders
c. Rare Phonological Disorders

The category of common phonological disorders includes all the processes under Ingram’s (1989) “delayed” classification, and it includes all the processes in Grunwell’s (1981) “persistent processes”. Cluster reduction, final consonant deletion, unstressed syllable deletion, stopping, fronting, liquid simplification, assimilation, and prevocalic

[3] See Edwards and Bernhardt (1973) and Ingram and Terselic (1983).

voicing, and final consonant devoicing are the types of phonological processes that fall under the category "common" because such processes occur frequently in normal phonological acquisition and in phonological disorders.

Children who are considered to have an uncommon[4] phonological disorder have phonological processes that are not found in normal children. Atypical cluster reduction, initial consonant deletion, glottal replacement[5], backing, fricatives substituted for stops, stops substituted for glides, and sound preference are "error patterns that have never been documented in normal children or that occur infrequently in the normal population" (Stoel-Gammon and Dunn 1985:116-17).

The category of phonological disorders considered to be "rare" includes processes that have not occurred with enough frequency to be included in the other classification categories of phonological disorders. The use of non-English phonemes, non-language sounds, and additional output phonemes not present in the input have not been integrated into any classification systems presented in Grunwell (1981), Ingram (1989), Prins (1962), or Rapin and Allen (1987). In a sense, the category of rare phonological disorders is an extension Grunwell's (1981) "idiosyncratic" category and Ingram's (1989) "deviant" category.

The remaining sections of this thesis are presented in the following way. Chapter 2 gives a brief overview of derivational phonology and OT. Derivational rules, feature notation, constraints, and OT Tableaux will be introduced. Chapters 3, 4, and 5, analyze the phonological behavior of three case studies with derivational phonology and OT. The first case study is from Oller (1973) and explores the phonological process of stopping. The second case study, from Lorentz (1976), examines the phonological process of atypical cluster reduction. The third case study, from Edwards and Bernhardt (1973), investigates the phonological process of using a non-English segment. Respectively, these case studies represent common, uncommon, and rare phonological disorders. However, different phonological processes are only incorporated in this paper to give some context to the classification of common, uncommon, and rare disorders. In fact, this classification is not based on phonological processes or derivational rules at all, but rather constraints, which are the core of OT. Finally, Chapter 6 concludes by comparing the constraint rankings of common, uncommon, and rare disorders. For example, the phonological processes that are included in common phonological disorders such as final consonant deletion and stopping have the same basic constraint ranking where markedness constraints dominate faithfulness constraints. Uncommon phonological disorders have the same type of ranking as common disorders, but the outputs are slightly more marked and slightly more faithful. Rare disorders pattern differently than common

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[4] Stoel-Gammon and Dunn (1985) label such children as "idiosyncratic" (p. 116).

[5] Glottal substitution can be systematic. Applegate (1961) presents a "sub-dialect" of English where a group of brothers, ages 4;0, 5;5, and 8;5 have a systematic use of the glottal stop [ʔ]. The brothers did not substitute the glottal stop for any phoneme. The glottal stop only occurs medially and finally and is only used if the medial or final stop has the same place of articulation as the initial stop. For example: /did/ → [dɪʔ]; /died/ → [daɪʔ]; /paper/ → [peɪʔər]; /daddy/ → [dæʔi]; and /Bobby/ → [baʔi]. These data show the children are adhering to the OCP.

and uncommon disorders in that markedness and faithfulness constraints do not interact. That is, neither constraint type dominates the other in rare phonological disorders. Chapter 6 also compares normal child phonology and adult grammar to common, uncommon, and rare disorders. This comparison shows that the constraint rankings of normal child phonology, common disorders, uncommon disorders, adult grammar, and rare disorders are all different. Moreover, viewing these constraint rankings or lack of ranking as possible patterns of language, a continuum of markedness is presented where normal child phonology is the least marked and rare disorders are the most marked.

CHAPTER 2. DERIVATIONAL THEORY AND OPTIMALITY THEORY

Since the rule-based approach of derivational phonology is the standard theory in speech pathology, derivational and OT analyses will each be introduced and compared. However, in this chapter and chapters to follow, OT will be shown to be a more complete analysis than a derivational analysis.

The rule-base approach states: A → B / X ___ Y (Chomsky and Halle 1968:14). Segment A (the underlying form) changes to segment B (the surface form) in the environment of X and Y. In generative phonology, this type of rule or derivation is associated with phonological processes such as assimilation, insertion, deletion, and so on. Thus, an underlying form changes due to a rule and becomes the surface form. For example, in Japanese the underlying form /t/, when preceding [i], changes to [tʃ]. This rule could be written as:

(2) /t/ → [tʃ] / ___ [i]

Although (2) is fine as a rule, all the segments in (2) are composed of features. Thus, rather than stating that [tʃ] is the only consonant that precedes [i] in Japanese, a rule with feature notation could be written.

(3)

$$\begin{bmatrix} \text{+cons} \\ \text{+alveolar} \\ \text{-sibilant} \end{bmatrix} \rightarrow \begin{bmatrix} \text{+cons} \\ \text{+palatal} \\ \text{+sibilant} \end{bmatrix} \quad / \quad \underline{\qquad\quad} \quad \begin{bmatrix} \text{+vocalic} \\ \text{+high} \\ \text{+front} \end{bmatrix}$$

The rule presented in (3) states that /t/ becomes [+palatal] and [+sibalant] when it precedes an [+high] and [+front] vowel. The line at the far right of rule represents the vowel's location; the slash separates the rule from the environment in which the rule occurs. This type of process is seen in Japanese words such as [tʃizu] "map", [tʃitʃi] "father", and [tomodatʃi] "friend" (Fromkin et al. 2003:333).

This rule-based approach, however, is misleading because even though differences between child and adult forms are seen universally and express language generalizations, such accounts also imply that a child's grammar has more rules than an adult's grammar. That is, if a single child reduces clusters and deletes codas, for example, his or her grammar would be more complex than adult's grammar.

(4) C $\rightarrow$ Ø / ___ # (coda deletion)

(5) /t/ $\rightarrow$ Ø / s__V (cluster reduction)

For considerations of simplicity, however, it seems that something complete (an adult grammar), has more parts or rules than something incomplete (a child's grammar). Disregarding this imbalance and keeping rules out of the primary functions of the theory, OT uses constraints, and re-ranks the constraints as the grammar develops. Therefore, an OT analysis allows children and adults to have the same amount of machinery, but with a different combination of the same number of parts. That is, an adult grammar has the same number of constraints as a child's grammar.

Constraints are divided into two categories — markedness constraints and faithfulness constraints (Prince and Smolensky 1993). Faithfulness constraints require that outputs exactly match the inputs (Kager 1999). Markedness constraints require that an output be "simplified in structure" (Barlow 2001a). In a fully developed adult grammar, faithfulness constraints dominate markedness constraints. In a developing grammar as that of a child, markedness constraints dominate faithfulness constraints. If the processes of coda deletion and cluster reduction were put into an OT framework, the faithfulness constraint MAX-IO (no deletion) (Prince and Smolensky 1993) and the markedness constraints *Complex (no complex segments) (Kager 1999) and NoCoda (no codas) (Prince and Smolensky 1993) would be needed. Within an OT Tableau these constraints would be ranked in the following way.

Tableau 1. /school/

	Markedness Constraints		Faithfulness constraint
/school/	NoCoda	*Complex	MAX-IO
a.? [ku]			***
b. [sku]		*!	
c. [skul]	*!	*!	

In Tableau 1, the symbol "? " marks the optimal output 1a. Furthermore, Tableau 1 shows that the markedness constraints NoCoda and *Complex dominate the faithfulness constraint MAX-IO. The dotted horizontal line between NoCoda and *Complex signifies that neither constraint strictly dominates the other. The solid horizontal line between markedness constraints NoCoda and *Complex and the faithfulness constraint MAX-IO signifies that the markedness constraints dominate the faithfulness constraint. This is made clear by the non-optimal candidates 1b and 1c, where they incur fatal violation (*!) due to the highly ranked constraints NoCoda and *Complex.

An adult grammar would be ranked in the opposite fashion where the faithfulness constraint dominated the markedness constraints. This ranking could be shown in the following form.

(6) Max-IO >> *Complex, *Coda

The opposite rankings in child and adult grammar express one of the most important aspects of OT: constraints can be re-ranked. Furthermore, the re-ranking shows that a developing grammar has no more machinery than an adult grammar. Coda deletion and cluster simplification are not considered rules in which a child would have to learn in the OT model, but are rather part of the universal constraints of language. Thus, the concept of constraints corrects the counterintuitive implication that developing grammars have more rules than adult grammars. In this case, a child does not have two rules, but a different ranking of constraints.

In summary, OT does not look at a grammar's transition from its underlying forms to its surface forms with rule processes as a derivational analysis does. Rather, OT states that languages have constraints, universal constraints, which are seen throughout the world of human languages, and that these ordered constraints, not rules, allow a grammar's underlying forms to surface the way they do (McCarthy 2002).

CHAPTER 3. COMMON PHONOLIGAL DISORDERS

3.1 Introduction

The common phonological process of stopping will be explored in this chapter. Section 3.2 introduces the data; 3.3 gives some background on fricatives; 3.4 offers a generative analysis of stopping; 3.5 presents an OT account of stopping — constraint demotions and promotions, and constraint rankings will be given; 3.6 discusses variability regarding outputs; 3.7 concludes by comparing constraint rankings of normal acquisition with common phonological disorders.

3.2 The common data

Oller (1972, 1973) presents stopping data from a child named Val, who substitutes fricatives with affricates and stops. Val substitutes word-initial fricatives in the following way.[6]

(7) /ʃ/ → [tʃ] / # ___

/s/ → [t] / # ___ (optional)

/s/ → [ts] / # ___ (optional)

/θ/ → [t] / # ___

/ð/ → [d] / # ___

Val has correct production with the following. (The correct productions will be discussed later in the chapter).

(8) /f/ → [f]

/v/ → [v]

/tʃ/ → [tʃ]

/dʒ/ → [dʒ]

[6] No full examples are given in Oller (1973).

3.3 Fricative preliminaries

In general, stops, nasals, laterals and glides are mastered before fricatives by normal children and children with common phonological disorders. For example, normal children master stops such as [p], [b], [k], [g], and [d] by age 3;0 to 4;0, and children master fricatives such as [θ], [ʃ], [v], [ð], [s], and [z] by age 7;0 to 8;0 (Stoel-Gammon and Dunn 1985:31).[7] One major difference between fricatives and other classes of sounds such as stops is that fricatives have the [+continuant] feature.

Based on a study with 90 children ranging in age from 40 months to 120 months, Singh and Frank (1979:263) found that stops replace fricatives more than any other sound. As mentioned earlier, such a process is called stopping, and is employed because stops are less complex than fricatives. Ladefoged (1993:8) describes the manner of articulation of a stop as a "complete closure of the articulator involved so that the airstream cannot escape through the mouth" (p. 8); he describes the manner of articulation of a fricative as a "close approximation of two articulators so that the airstream is partially obstructed and turbulent airflow is produced" (p. 10). Simply put, the "narrowed approximation" of fricatives demands great muscle control, where as stops "involve [a] very straight forward contact of the articulators" (Yavas 1998:138).

3.4 Derivational analysis of Val's common phonological disorder

In general, Val's substitution process in (15) shows that fricatives, which have the feature [+continuant], change to a segment that has a [-continuant] feature. The affricates [ts] and [tʃ] do have [+continuant] segments such as the [s] in [ts] and the [ʃ] in [tʃ]. However, each of these affricates both begin with [t], which is [-continuant]. (15) represents Val's substitution rule.

(9)

$$\begin{bmatrix} \text{-voc} \\ \text{+cor} \end{bmatrix} \rightarrow \begin{bmatrix} \text{-cont} \\ \langle\text{-stri}\rangle \end{bmatrix} \;/\; \# \begin{bmatrix} \underline{\qquad} \\ \langle\text{+ant}\rangle \end{bmatrix} \;\langle\text{opt}\rangle$$

(As presented in Oller (1973:41)

(9) states that [+cor] fricatives such as [ʃ], [s], [θ], and [ð] are substituted with stops or affricates. The feature [+labial] is not used in (15) since Val produces [f][8] and [v] correctly. (Also, the [+cor] phone [ʒ] is missing from the data).

[7] Children do, however, use these segments regularly at earlier ages, but have not necessarily mastered the articulation.

[8] Ingram's (1978:66) normal data comparison of Wellman (1931) and Templin (1957) found that [f] is the earliest fricative acquired. Furthermore, normal children tend not to stop [f]; however, children with

The angled brackets (< >) in (15) express the two variable substitutions of [t] and [ts], for [s][9]. Elements in angled brackets are considered “if and only if all other elements in angled brackets are considered” (Oller 1973:41). Oller (1973) points out that the optional output of [t] requires a two-step process. [t] can only appear in the output unless [ts] appears first. This process is shown in phonemic notation below.

(10) First step: /s/ → [ts] / # ___

Second Step: /ts/ → [t] / # ___

Oller (1973) states that feature notation makes large generalizations (p. 38). The rule given in (9) certainly accounts for all of Val’s substitution process, and Oller (1973) argues that all of Val’s substitutions should be given in one rule because such a rule shows a relationship among all the processes. However, (9) does not explain why affricates were substituted for fricatives, and possibly misses an even larger generalization, such as the relationship between affricates and fricatives in acquisition. Optimality Theory can account for fricatives being substituted with affricates and stops, and can make larger generalizations about Val’s grammar than derivational phonology.

3.5 Val’s stopping in Optimality Theory

This OT analysis of Val’s process extends Oller’s (1973) argument. It is clear that Val stops fricatives, but more can be said within an OT framework. The fact that affricates are present in Val’s outputs, before all of the fricatives are acquired, suggests that Val has demoted such constraints as *Affricate (no affricates), and is on his way to demoting such constraints as *Fricative (no fricatives). A derivational analysis does not lend itself to the concept of constraint demotions or re-rankings since, as far as Oller (1973) is concerned, Val simply shows a substitution process. OT, however, lends itself to such an analysis, and constraint demotions will be discussed here. Furthermore, Val’s variable outputs of [t] and [ts] will also be discussed. Oller (1973) suggests that there is an optional rule that accounts for the variability. Variability can be troublesome for a standard adult OT analysis; however, it will be shown that in the case of developing grammars, variability aids the analysis and does hinder the OT account. The arguments presented for constraint demotion, variability, and the constraint ranking of Val’s stopping process are all centered on evidence that affricates are less marked than

phonological disorders tend to stop [f] (Ingram 1978:79). At the time of the data sample, Val produced [f] correctly, and so it is unknown whether he stopped [f].

[9]Within the angled brackets, the use of the features [-stri] and [+ant], also implies that [s] could become [tʃ] as well as [ts] since booth segments are [+ant]. Oller (1973) does not comment on such a possibility.

fricatives regarding production, and that affricates play a role in the acquisition of fricatives.

3.5.1 Constraint demotion— the role of affricates

Affricates are generally considered to be more marked than fricatives since, typologically, if a language has affricates, it will have fricatives, but not the other way around. This typological claim is most likely due the structure of these segments. Affricates are complex segments and fricatives are not. Specifically, affricates have a branching structure with segments composed of the features [-continuant] and [+continuant]; Fricatives do not branch and have only one [+continuant] segment.

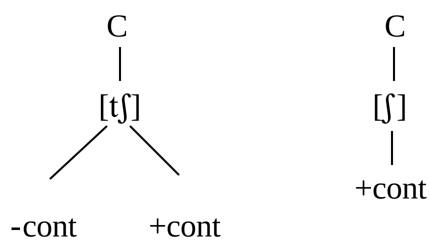

Figure 1. Structure of an affricate and fricative

(adapted from Lombardi (1990:375)

Since affricates are more marked than fricatives, it is plausible to suppose that fricatives will be acquired before affricates. However, acquisition data on affricates and fricatives have shown that all fricatives are not acquired before all affricates. For example, Ingram (1978:70)[10] compared normal affricate and fricative acquisition data from Albright and Albright (1956), Bateman (1916), Chamberlain and Chamberlain (1904-5), Hills (1914), Holmes (1927), Humphreys (1880), Ingram (unpublished diary), Jegi (1901), Leopold (1947), Menn (1971), Moskowitz (1970), Nice (1917), Pollock (1878), Smith (1973), and Wier (1962), and concluded the following order[11] of acquisition of affricates and fricatives.

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[10] A study by Shriberg, Kwiatkowski, and Gruber (1994) concluded the following phoneme acquisition data: Early 8, [m,b,j,n,w,d,p,h]; Middle 8, [t,ŋ,k,g,f,v,tʃ,dʒ]; and Late 8, [ʃ,θ,s,z,l,ɹ,ʒ]
Notice that affricates appear before many fricatives.

[11] Ingram (1978:71) notes that [tʃ] is acquired before the others in the in between set, and though [s] appears early, it "may be articulatorily deficient for several years after its first appearance" (Ingram 1978:68).

(11)	earliest	in between	latest
	[f] [s]	[tʃ] [ʃ] [dʒ]	[θ] [z] [v] [ð]

This discrepancy between typology and acquisition expresses that markedness of language typology, and markedness of production (or articulation) is not one and the same thing. Moreover, this discrepancy goes against the typological claim affricates are more marked than fricatives. Therefore, it is possible that affricates are less marked than fricatives. If affricates are considered less marked than fricatives, and affricates appear before fricatives in acquisition, it can be suggested that affricates are a bridge to producing fricatives.

The idea of affricates being a bridge to the proper production of fricatives can be expressed in terms of OT constraints and constraint violation. Before the constraint *Fricative (no fricatives) (Barlow 1997; Barlow and Geirut 1999) is completely demoted, the constraint *Affricate (no affricates) has to be violated first. That is, just as there is an order of acquisition concerning affricates and fricatives, there also needs to be an order of constraint demotion. Constraints such as *Fricative and *Affricate can be violated at the same time, but the specific argument here is that the constraint *Fricative does not cease to be violated (or completely demoted) until the constraint *Affricate is violated. In other words, all fricatives are not acquired before the affricates are acquired.

Ingram (1978) states that there are five stages in the acquisition of word initial affricates and fricatives.

(12) Stage 1: Fricatives and affricates are avoided.

Stage 2: Fricatives and affricates undergo stopping.

Stage 3: Fricatives and affricates appear, but there are variable outputs.

Stage 4: Most outputs of fricatives and affricates are correct.

Stage 5: Correct production of fricatives and affricates.

(12) expresses that affricates and fricatives are not acquired as a complete set at one point in time, but are rather acquired over a long period of time. Thus, the constraint *Fricative will be violated sometimes and will not be violated other times. (There will be no strict domination where *Fricative is always violated).

Val's data, repeated here for convenience, shows that he is at the third stage of affricate and fricative production presented by Ingram (1978).

(13) a. Incorrect productions

/ʃ/ → [tʃ] / # ___

/s/ → [t] / # ___ (optional)

/s/ → [ts] / # ___ (optional)

/θ/ → [t] / # ___

/ð/ → [d] / # ___

b. Correct productions

/f/ → [f] / # ___

/v/ → [v] / # ___

/tʃ/ → [tʃ] / # ___

/dʒ/ → [dʒ] / # ___

The fricatives [f] and [v] and the affricates [tʃ] and [dʒ] are produced correctly. Also, there is some variability regarding the output of /s/.

Adopting the above stages and using the constraints *Fricative, *Affricate, IDENT-[continuant] (do not change the feature continuant) and MAX-IO (no deletion) the following hypothetical constraint demotions, starting from stage one, can be proposed for Val's complete data sets from (13).

Tableau 2. Hypothetical Tableau for Ingram's (1978) Stage One

/f/,/s/,/tʃ/	*Fricative	*Affricate	IDENT-[continuant]	MAX-IO
a. ? Ø				*

Tableau 2 shows that /f/, /s/, and /tʃ/ were deleted and that there is no strict domination regarding the constraints *Fricative, *Affricate, and IDENT-[continuant]. However, the constraints *Fricative, *Affricate, and IDENT-[continuant] must be ranked higher than MAX-IO (no deletion) since the fricatives and affricates in the input are deleted.

Furthermore, the three constraints *Fricative, *Affricate and IDENT-[continuant] resemble a stratified domination hierarchy in which no constraint dominates the other. Tesar and Smolensky (2000) formally present a stratified domination hierarchy as: "{C1, C2, …., C3} >> {C4, C5, …., C6} >>…" and so on (P. 37). The constraints within the brackets are part of a single stratum and are "collapsed together" and interpreted as a single constraint. A stratum for the constraints *Fricative, *Affricate, and IDENT-[continuant] would be represented as {*Fricative, *Affricate, IDENT-[continuant]} in OT.

Tableau 3. Hypothetical Stopping of /s/ and /tʃ/, and /f/ Ingram's (1978) Stage Two

/s/, /tʃ/	MAX-IO	*Fricative	*Affricate	IDENT-[continuant]
a. ? [t]				*
/f/				
a. ? [p]				*

Tableau 3 shows that the first set of unranked constraints from Tableau 2 has been made smaller in which the constraints *Fricative and *Affricate are ranked equally (no violations incurred for either constraint), and are ranked higher than IDENT-[continuant] (a violation incurred) but are also ranked lower than MAX-IO. It seems that there is a relationship between the two constraints *Fricative and *Affricate. From stage one to stage two, they are the only constraints that have not been violated.

Tableau 4. Val’s data: Ingram’s (1978) Stage Three

/s/	MAX-IO	*Fricative	*Affricate	IDENT-[continuant]
a. ? [t]				*
b. ? [ts]			*	
/f/				
a. ? [f]		*		
/tʃ/				
a. ? [tʃ]			*	

Tableau 4 shows that the constraints *Fricative, *Affricate, and IDENT-[continuant] are now equally ranked low. Recall that in stage one these three constraints were equally ranked above the constraint MAX-IO. Therefore, it is as though the stratum of {*Fricative, *Affricate, IDENT-[continuant]} started from being ranked higher than MAX-IO to being ranked lower than MAX-IO in stage three.

Tableau 5. Hypothetical: Ingram's (1978) Stage four and five[12]

/s/	MAX-IO	IDENT-[continuant]	*Fricative	*Affricate
a. ? [s]			*	
/f/				
a. ? [f]			*	
/tʃ/				
a. ? [tʃ]				*

Tableau 5 shows that the constraint IDENT-[continuant] has broken away from its original stratum and that the two basic strata of constraints — faithfulness constraints and markedness constraints — are collapsed together in the final ranking. The faithfulness constraints MAX-IO and IDENT-[continuant] dominate the markedness constraints *Fricative and *Affricate.

3.5.2 Constraint Ranking of Stopping Process

Stage two (presented above in Tableau (11)) is a straightforward case of stopping and shows that all fricatives become stops. The constraints needed for such a process would be the markedness constraint *Fricative (no fricatives) (Barlow 1997; Barlow and Gierut1999) and the faithfulness constraint IDENT-[continuant] (do not change the feature continuant). The constraint *Fricative would be ranked higher than IDENT-[continuant].

(14) *Fricative >> IDENT-[continuant]

The ranking in stage five would be the reverse. For now, let us assume that stage five represents adult grammar.

(15) IDENT-[continuant] >> *Fricative

[12] Stages four and five have been combined since there is not much difference between them.

Comparing the constraint ranking given in (14) and (15), it is clear that adults are faithful to the feature [continuant], but children acquiring the grammar are not. As presented earlier in the chapter, the primary reason for children's mispronunciations of fricatives is that a [+continuant] segment is more difficult to produce than a [-continuant] segment.

Recall that Val is at stage three and that all of Val's data (incorrect and correct productions) were considered in the constraint demotion described in section 2.5.1 above. (The Tableaux for stages one, two, four, and five were hypothetical, and the Tableaux for stage three was representative of Val's actual productions). However, only the set of fricatives that Val does not correctly produce will be analyzed in this section, since they are the ones that exhibit stopping. They are presented below again for convenience.

(**16**) /ʃ/ → [tʃ] / # ___

/s/ → [t] / # ___ optional

/s/ → [ts] / # ___ optional

/θ/ → [t] / # ___

/ð/ → [d] / # ___

Since Val produces the affricates [tʃ] and [ts], his constraint ranking is not as straightforward as the one given in (14). Tableau 6 below gives a misleading ranking for Val's stopping process since the constraint *Affricate is not included.

Tableau 6. Misleading ranking: MAX-IO >> *Fricative >> IDENT-[continuant]

/s/	MAX-IO	*Fricative	IDENT-[continuant]
? a. [t]			*
? b. [ts]			*
c. [s]		*!	
d. Ø	*!		

As discussed in section 2.5.1, affricates play a crucial role in the acquisition of fricatives, and if Val is at the third stage of affricate and fricative acquisition, the constraint *Affricate must be presented in the tableau. The following introduces the constraint

*Affricate for Val's stopping data.

Tableau 7. *Affricate presented in Val's constraint ranking

/s/	MAX-IO	*Fricative	*Affricate	IDENT-[continuant]
? a. [t]				*
? b. [ts]			*	*
c. [s]		*!		
d. Ø	*!			

The fact that Val uses affricates (violates the constraint *Affricate), which have one branching [+cont] segment, suggests that he is close to producing fricatives correctly. By singling out the features [+cont], [-cont, +cont], and [-cont], this point is elucidated when the optimal affricate ([-cont, +cont]) and stop ([-cont]) outputs are compared with a non-optimal fricative output ([+cont]).

8. Comparison of [+cont], [-cont, +cont], and [-cont]

/s/	[+cont]	[-cont, +cont]	[-cont]
? a. [ts]		*	
b. [s]	*!		
c. [t]			*

In order for Val to produce fricatives in the onset position, he simply needs to tease away the left-edge [-cont] branch of the affricate, which would yield a fricative. This is a type of simplification process is present in language. Lombardi (1990:419) reports that Nisgha, a language of British Columbia, reduces affricates to fricatives when a reduplicative prefix is added.

(17)	pats	pis-pats	'to lift something'
	q'uts	q'as-quts	'to cut something'
	hits	has-hits	'to send something'

Tableau 7 shows a general constraint ranking, but more specificity could be incorporated. Since consonants that have a [+continuant] feature such as affricates are allowed in the grammar, it is misleading to propose the general constraint of *Fricative, which also have a [+continuant] feature as the highest ranked *markedness* constraint as in (8). A finer distinction is made by saying that fricatives are allowed, but never at the left-most edge (onset position) of a word. The branching structure of (22) shows that a fricative segment is embedded within an affricate, and that it is positioned to the right of the stop, not the other way around. In fact, Lombardi (1990) reports that "there are no single [+cont] [-cont] segments" (p. 376).[13] Consequently, it is crucial to adopt the constraint *ONSET/FRICATIVE[14] (no fricatives in the onset) (McCarthy 2002:22). Thus, since onset position is the focus here, the constraint *ONSET/FRICATIVE will

[13] However, in an analysis of cluster reduction, Barlow and Dinnsen (1998:29) found that the cluster /st/ (among others), can have the underlying representation of a single [+cont, -cont] segment, since it was realized as a "null onset".

[14] It would also be possible to use the constraint *Coronal [+cont] as presented in Barlow and Dinnsen (1998). However, it is possible that Val produces fricatives in intervocalic position and not in onset position. Further, since the data only concern onsets, it seems more prudent to focus on the constraint *ONSET/FRICATIVE. Yavas and Hernandorena (1991) shows data where a child produces the affricates [tʃ] and [dʒ] in intervocalic position but not in onset position. Thus, the feature [+cont] is realized intervocalically but not in onset position. Furthermore, the constraint *ONSET/FRICATIVE is directly related to sonority. Following a sonority scale such as Broselow and Finer's (1991), fricatives are more sonorous than stops, consequently making them less preferred in onset position.

take the place of the more general constraint *Fricative.[15]

Tableau 9. *ONSET/FRICATIVE added: A complete tableau[16]

/s/	MAX-IO	*ONSET/FRICATIVE	*Affricate	IDENT-[continuant]
? a.[t]				*
? b. [ts]			*	*
c. [s]		*!		
d. Ø	*!			

Tableau 9 states that the markedness constraint *Affricate and the faithfulness constraint IDENT-[continuant] are violated, but that the faithfulness constraint MAX-IO, and the markedness constraint *ONSET/FRICATIVE are not violated in the optimal outputs of 9a and 9b. Furthermore, MAX-IO dominates *ONSET/FRICATIVE since none of the optimal outputs are deletions. Also, *Affricate and IDENT have no strict domination since each are violated in the optimal output of 9b.

By replacing the constraint *Fricative with *ONSET/FRICATIVE, the distinction between where [+cont] segments are allowed becomes clearer. That is, a violation of *Affricate could assume a violation *Fricative since affricates have a fricative imbedded within them, and vice versa. Val produces a fricative within the fricative [ts]. Since [ts] is an affricate and has a fricative imbedded within it, it could be argued that both constraints *Affricate and *Fricative are violated. Therefore, the constraints *Affricate and *Fricative are not specific enough to disallow fricatives in the onset position. The constraint *ONSET/FRICATIVE clears up this possible ambiguity. It disallows fricatives in onset position, but does not automatically disallow fricatives within an affricate.

3.6 Variability

Tableau 9 does not consider variability. [ts] and [t] are each an optimal output for [s]. This is what is known as "free variation" and is at odds with OT's contention that there should be only one optimal output (Kager 1999:404). However, since OT was originally

[15] The constraint *Fricative could be violated in coda or intervocalic position/s.

[16] Again, recall that the data in this tableau only considers Val's incorrect productions. Tableau 4, which presents stage three of constraint demotion, is different because it incorporates all of Val's data.

developed to be a theory of adult grammar and not a developing grammar, it is possible that free variation does not pose a problem for OT in this regard. Of course, this may be the easy way out. A stronger argument might be that free variation does not pose a problem because the variable outputs in normal or disordered phonology are never more marked than the target segment. If the variables were more marked than the target segment (which would most likely be considered a rare phonological disorder), then constraint rankings would most likely seem bizarre. There are no bizarre processes in common phonological disorders. For example, if a child had the variable outputs of [b], [d], [ʃ], and [z], for [p], there would seem to be an unnatural relationship between stops and fricatives, and the violation of *Fricative would be out of place since fricatives are more marked than obstruents. If this were to actually occur, free variation would certainly question the validity of OT with any grammar. However, *variable* outputs (not single outputs) for one segment in which all variable outputs are more marked than the input has not, to my knowledge, been presented in the literature. Therefore, since the variable outputs are less marked than the target structure, a single constraint ranking can be given since there is at least one constraint which is not dominated. This is the case with Val's constraint ranking regarding his stopping process. The markedness constraint *ONSET/FRICATIVE dominates the constraints *Affricate, *Fricative, and IDENT-[continuant]. Furthermore, as shown in constraint demotions presented in section (3.5.1), the variability of [ts] and [t] does not affect the demotion of the markedness constraints *ONSET/FRICATIVE, *Fricative, and *Affricate.

3.7 Summary of common phonological disorders

It has been shown that an OT analysis of Val's stopping process is more complete than a generative analysis. Within a derivational view, affricates being substituted for fricatives is simply stopping, since affricates have a [-cont] segment at the left edge. An OT analysis also considers such a process to be stopping as well, but since OT is constraint based, the constraint *Affricate is incorporated into the grammar in a more robust way, in that it makes certain predictions about constraint demotions and promotions. Recall that that the constraint *Fricative cannot be completely dominated until the constraint *Affricate is violated. Furthermore, the correct production of the affricate [tʃ] and [dʒ] in the grammar before the correct production of the fricatives such as [ʃ], [s], [θ], and [ð] suggests that the production of affricates aids in the acquisition of fricatives. (This of course, would not be true in a language that only had fricatives and no affricates).

Moreover, it has been shown that Val's stopping process is very common in the realm of phonological acquisition. All the processes included in the common phonological disorder classification simplify either the original syllable structure or original phoneme of the adult grammar.[17] Consonant cluster reduction and final consonant deletion create the basic CV syllable structure. Weak syllable deletion reduces three-syllable words to two-syllable words. Processes such as stopping and fronting

[17] An exception may be prevocalic voicing.

replace marked phonemes, such as fricatives and affricates, with less marked phonemes, such as stops.

When Val's phonological process is compared with that of normal phonological acquisition data, the constraint rankings of markedness and faithfulness constraints are identical.

Tableau 10. Comparison of normal acquisition and common phonological disorders

	Markedness	Segmental Faithfulness
Normal phonological acquisition		*
Val's common phonological disorder		*

Markedness constraints dominate faithfulness constraints in common phonological disorders and in normal acquisition. Even with Val's variable outputs, this ranking still remains since all outputs in normal acquisition and common disorders are equal to or less than the markedness value of the target phone or structure.

CHAPTER 4. UNCOMMOM PHONOLOGICAL DISORDERS

4.1 Introduction

The uncommon process of atypical cluster reduction will be explored in this chapter. Section 4.2 presents the data; 4.3 compares normal cluster reduction with atypical cluster reduction; 4.4 gives a derivational analysis of the cluster reduction; 4.5 discusses the cluster reduction in an OT framework; 4.6 discusses a ranking paradox; 4.7 details sonority and cluster reduction; 4.8 offers hypothetical cluster reductions; 4.9 concludes by comparing uncommon phonological disorders with common phonological disorders.

4.2 The uncommon data

Lorentz (1976) describes a 4;5 year old boy, Joe, who makes the following alterations to /sp/, /st/, /sk/, /sm/, /sn/, and /sw/ consonant clusters.

(18)	/sw/	→	[f]	swoop	[f]oop;	swat	[f]at
		→	[fw]	swim	[fw]im;	swing	[fw]ing
	/sm/	→	[f]ṽ	smoke	[fõwk];	small	[fãl]
	/sp/	→	[f]	spoon	[f]oon;	spot	[f]ot
	/sn/	→	[s]ṽ	snap	[sæ̃p];	snake	[sẽɪk]
	/st/	→	[s]	story	[s]ory;	stand	[s]and
	/sk/	→	[ks]	scan	[ks]an;	scout	[ks]out

(Adapted from Lorentz (1976) and Ingram (1989))

4.3 A comparison of normal and uncommon cluster reduction

Joe's phonology is not considered disordered because he reduces clusters, since all children reduce clusters (Stoel-Gammon and Dunn 1985). Rather, his phonology is considered disordered for two other reasons. First, most children can correctly produce words with [sm], [sn], [sp], [st], and [sk] by the age of four (Ingram 1989:27) and at the time of this study Joe was 4;5. Secondly, and more importantly, normal children usually (but not always) delete the most sonorous segment of the cluster. For example, in /s/ obstruent clusters, the /s/ is deleted (/s/ is more sonorous than unvoiced obstruents); in /s/ nasal clusters the nasal is deleted (nasals are more sonorous than fricatives such as /s/); and in /s/ glide clusters, the glide is deleted (glides are more sonorous than /s/) (Ohala 1996). Children with normal phonology do not change the majority of their clusters to [f] or metathesize segments such as [sk] to [ks]. These processes are "unusual" and/or "idiosyncratic" and are "rarely" seen in normal acquisition (Grunwell 1981).

To help explain the difference between normal child phonology and Joe's abnormal phonology, Table 11 compares normal cluster reduction to Joe's predicted and/or actual cluster reduction.

Table 11. Examples of Normal Child Cluster Reduction

gloss	Normal phonology	reference	Joe's predicted or actual utterance
stig (nonsense)	[tig]	(Ohala 1996: 111)	[s]ig
spoon	[bu]	(Leopold 1939 (Vol 1): 144)	[f]oon
snowing	[no]	(Leopold 1939 (Vol 1):144)	[s]ow
snuf (nonsense)	[suf]	(Ohala 1996:127)	[s]uff
smell	[sel]	(predicted form, Ohala 1996)	[f]ell
swim	[wɪm][18]	(Barlow 1999:1494)	[f]im
swim	[sɪp]	(Ohala 1996:52)	[f]im
swing	[fɪŋ]	(Stoel-Gammon & Dunn:41)	[f]ing

[18] There is variability with the [sw] cluster in normal phonology. Joe only substitutes [f] for [sw].

sweep	[fip]	(Stoel-Gammon & Dunn:41)	[f]eep
sweet	[fwij]	(Ingram 1989:33)	[f]eet
skub (nonsense)	[kub]	(Ohala 1996:127)	[ks]ub

The comparison presented in Table 11 gives a preview of the main points discussed in the OT analysis: cluster simplification strategies and sonority. As will be shown, Joe's phonological process regarding clusters, though uncommon, is still based on language universals such as the SSP (Sonority Sequencing Principle).

4.4 A derivational view of Joe's phonology

For Joe's phonological behavior, Gandour (1981:14-17) and Ingram (1989:113) propose five derivational phonological rules — metathesis, labial assimilation, vowel nasalization, consonant cluster simplification, and glide truncation[19]. Though nasal assimilation and glide truncation are two of Joe's phonological processes, nasal assimilation will not be discussed in this paper, and Joe's glide truncation rule will be discussed in the second half of the chapter. Joe's cluster simplification processes will be the primary focus here.

Hume (2001) defines metathesis as "…the process whereby in certain languages, under certain conditions, sounds appear to switch position with one another. Thus, in a string of sounds where we would expect the linear ordering of sounds to be …xy…, we find instead …yx…." (p. 1). Some examples of Joe's metathesis are: /scan/ → [ks]an; /scout/ → [ks]out; and /school/ → [ks]ool.

Though metathesis is not part of standard English's phonological system, it occurs in other languages. Faroese, a West Nordic language, also has an [sk] that undergoes metathesis (Hume 2001).

(19)	Faroese:	fem. sg.	masc. sg	neut. sg.	Gloss
		baisk	baiskor	baikst	'bitter'
		fɛsk	fɛskor	fɛkst	'fresh'

(as given in Hume 2001:13)

In Faroese and in Joe's phonology, metathesis is used in specific environments. For Joe, [sk] becomes [ks] in syllable initial position, and in Faroese, [sk] becomes [ks] when an [sk] cluster precedes a stop such as [t][20]. (20) shows Joe's metathesis rule, and (21) shows the Faroese metathesis rule.

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[19] Glide truncation is an optional rule under cluster simplification in Ingram (1989:113).
[20] This is only a generalization. Word stress also plays a part in Faroese metathesis. For a more in-depth study of Faroese metathesis see Hume (2001).

(20) s, k → k, s / # ____ (The symbol "#" represents a word boundary)
1 2 2 1

(21) s, k → k, s / ____ [t]
1 2 2 1

Hume (2001) points out that "perceptual optimization" possibly ignites the phonological process of metathesis (p.7). If metathesis did not occur in Faroese, outputs such as *[fɛskt] would appear. It is possible that [kst] is more salient in Faroese than [skt]. Metathesis does split up the two stops — [k] and [t]. Similarly, Joe may use metathesis to make segments more salient. Gandour (1981) states that Joe might have had "perceptual difficulties with the correct placement of sibilants in consonant clusters" (p. 14). Therefore, [ks], since it begins the syllable with a stop, might be more salient to Joe than, [sk], which begins a syllable with a fricative.

Children typically labialize the segments [θ] and [ɹ]. For example, Ingram (1989) reports on a normal child who labializes [ɹ] (p. 42).

(22) rug [wak] 1;9

rock [wak] 1;9

rabbit [wædæt] 1;9

Joe's labial phonological process is more uncommon than (22). He has a labial assimilation rule that changes [s] to [f] when [s] precedes a labio-dental segment such as [p], [m], or [n].

(23) Labial assimilation: s → f / __ [p, m, w]

Some examples of Joe's labial assimilation are in (24).

(24) spinach [f]inach

smell [f]ell

swoop [f]oop

It is important to note that the labial assimilation rule given in (23) is reproduced here from Ingram (1989) and Gandour (1981), researchers who have commented on Joe's phonological processes, and that Lorentz (1976), the original researcher, does not give such a rule. Notice (23) only states that [s] changes to [f]. However, Joe's true phonological process changes [s] to [f], and the segments [p], [m], and [w] do not appear in the output. (23) suggests that the output of [sp], [sm], and [sw] clusters would be [fp], [fm], and [fw], respectively. Therefore, another rule such as cluster reduction is needed to produce the correct output.

The consonant cluster reduction rule in Joe's phonology deletes the oral and nasal stops that follow fricatives.

(25) (as presented in Gandour 1981:16)

$$\begin{bmatrix} \text{p, m, w} \\ \\ \text{t, n} \end{bmatrix}^{21} \rightarrow \varnothing / \begin{bmatrix} \text{f} \\ \\ \text{s} \end{bmatrix} \_\_\_$$

(25) occurs in clusters such as [fp], [fm], [fw], [st], and [sn]. Notice that the clusters [fp] and [fm] are, in a sense, the intermediate stage between input and output. (The [s] in the clusters [st] and [sn] does not change to [f]).

From the rules based on Gandour (1981) and Ingram (1989) presented so far, [st] and [sn] clusters are simplified from a deletion rule given in (25), and [sp], [sn], [sm], and [sw] are simplified with two rules: labial assimilation (as in (23)) and deletion (as in (25)), in that order. Since [sp], [sn], [sm] and [sw] undergo two rules, there must be rule ordering — labial assimilation, and then deletion. However, it is possible that [st] [sn], [sp], [sn], [sm], and [sw] are all derived from one rule. Lorentz (1976) presents one rule that accounts for the clusters [st], [sp], [sn], [sm], and [sw].

[21] I have added the segment [w] here. The deletion of [w] considered to be a glide truncation rule that occurs optionally. However, this paper is specifically looking at cluster simplification. The cluster [fw] does appear, but it is not a cluster simplification.

(26) Lorentz's (1976) Rule

> The manner feature of the fricative is merged with the positional features of the second segment (i.e. [+labial] [p] is merged with [+fricative] [s] which creates the [+labial] [+fricative] segment of [f])

More formally, (26) would be as follows.

(27)

$$\begin{bmatrix} \text{C} \\ +\text{fricative} \end{bmatrix}_{1} \begin{bmatrix} \text{C} \\ +\text{labial} \\ \text{or} \\ +\text{coronal} \end{bmatrix}_{2} \rightarrow \begin{bmatrix} \text{C} \\ +\text{fricative} \\ +\text{labial} \\ +\text{coronal} \end{bmatrix}_{1}$$

(27) is a coalescence rule where two segments become one. A transformation for each cluster is given in Table 19.

Table 12. Joe's Cluster Transformation

Two segment consonant cluster		**New single segment**
First segment of cluster	**Second segment of cluster**	
Fricative	Labial or coronal stop	Labial or coronal fricative
s	t	s
s	n	s
s	p	f
s	m	f
s	w	f

Table 19 might not seem correct since the [s] in the clusters [st] and [sm] does not change. However, the fricative [s] has the same place of articulation as [t] and [n], and so it is still possible to argue that [s] takes the place of the following segments such as [t] and [n]. Of course, it could be argued that the [t] and [n] are deleted in [st] and [sn] clusters. If that were the case, two rules would be given for Joe's simplifications of [st], [sn], [sp], [sm], [sn], and [sw] clusters.

(28) a. [t,n] → Ø / s ___

b. [s] → [s or f] / # _____ [p,m,n,w]

However, Lorentz's original rule given informally in (26) captures more generalization and it does not present any problems for [st] and [sn] clusters. Therefore, (26) stands.

Joe's [sk] to [ks] metathesis rule presented in (20) would most likely be included in (26) if the phoneme [x] (velar fricative) were part of English's segment inventory. Lorentz (1976) states that Joe has a phonetic constraint that disallows [x]. Thus, all of Joe's cluster simplifications, including [sk] to [ks] could be described by one coalescence rule.

(29) The segments in /s/ clusters undergo coalescence if and only if the phonetic constraints of English are not violated — otherwise segments simply switch places (i.e. metathesis).

In this sense, metathesis is not a rule, but is an incompletion of coalescence. However, whether the metathesis rule is incomplete, it still needs to be dealt with. As will be seen in the OT analysis of Joe's phonological processes, the implications of the [ks] cluster is more useful within OT, rather than as an idiosyncratic process in a derivational rule.

4.5 An OT analysis of Joe's phonology

The following constraints will be used throughout the OT analysis of Joe's cluster reduction.

Linearity-IO: A faithfulness constraint that disallows metathesis — reversing of segments (Prince and Smolensky 1993). (LINEARITY-IO can be violated without violating NO-COAL).

NO-COAL: A faithfulness constraint that disallows segments to be fused together ("no-coalescence"). This constraint is a sub-constraint under Linearity-IO. For NO-COAL to be violated, Linearity-IO must also be violated (Prince and Smolensky 1993).

MAX-IO: A faithfulness constraint that states segments that are present in the input must be present in the output. This is a constraint against deletion (Prince and Smolensky 1993).

DEP-IO: A faithfulness constraint that states that segments in the output must be present in the input. This is a constraint against epenthesis (Prince and Smolensky 1993).

***COMPLEX(ONS)**: A markedness constraint that disallows complex onsets (Prince and Smolensky 1993).

OCP: A markedness constraint that disallows two similar segments side by side (Morelli 1999).

SSP: A markedness constraint that states that their should be a rise in sonority towards the nucleus (Ohala 1996; Morelli 1999).

Let us start by looking at the clusters [sw], [sm], and [sp], which undergo clear coalescence and change to [f]. (The clusters [sn] and [st], as pointed out in the previous section may undergo coalescence as well. However, a clearer case is shown with [sw], [sm], and [sp], since each segment has a different place of articulation. [sn] and [st] only have coronal segments).

Tableau 13. Constraint ranking of /sw/

/swoop/	DEP-IO	MAX-IO	*COMPLEX(ONS)	NO-COAL
a. [sw]oop			*!	
b. ? [f]oop				*
c. [s]oop		*!		
d. [səw]oop	*!			

Now that a list of candidates has been presented and the constraints that they violate have been marked, we can compare and rank the constraints left to right from the highest ranked to the least ranked (McCarthy 2002). A solid horizontal line between constraints indicates that the constraint on the left dominates the constraint to the right. A dotted-horizontal line means that domination cannot be determined between the constraints.

Tableau 12 states that NO-COAL is the lowest ranked constraint since it can be violated and still produce the optimal output as in candidate b. DEP-IO, MAX-IO, and *COMPLEX(ONS) are equally ranked since it cannot be determined at this time which one dominates the other.

Although it seems that MAX-IO is violated in the optimal output 20b, Gnanadesikan (1995) states that a violation of NO-COAL, even though there is a one-segment output from a two-segment input, is not a violation of MAX-IO since features of both segments appear in the output. In the optimal output, the [f] carries [+fricative] of the [s] and [+labial] of the [w].

Since coalescence is violated in this instance, coalescence must be less costly than deletion. Moreover, since MAX-IO dominates NO-COAL (considering no violation of MAX-IO), we can either take out DEP-IO from the table, or shade it grey to show that the constraint did not directly shape the output form in any way. (DEP-IO does not have a close relationship to NO-COAL because when NO-COAL is violated, less segments appear. In contrast, when DEP-IO is violated, more segments appear.) By taking away DEP-IO, a more concise ranking can be made, such as:

(30) ***COMPLEX(ONS), MAX-IO >> NO-COAL (symbol >> equals "dominates")

The same ranking could be given for [sm] to [f], and [sp] to [f]; thus, a table is not needed to show the constraint rankings for them.

4.6 Ranking Paradox?

With the constraint ranking in Tableau 12 in place, it looks as though the markedness constraint *COMPLEX(ONS) is the driving force for NO-COAL. The primary gain in all of this is that syllable structure markedness is reduced. A CC structure has changed to a C structure.

This syllable markedness reduction, however, does not always occur, as /sk/ to [ks] shows. The cluster [ks] violates *COMPLEX(ONS), but does not violate NO-COAL. Hence, it seems that there either is a ranking paradox, or that the ranking in (38) is not correct. The following table compares the outputs of [ks] and [f].

Tableau 14. Ranking Paradox?

/Swoop/	*COMPLEX(ONS)	NO-COAL	LINEARITY-IO
? [f]oop		*	*
/Scoot's/			
? [ks]oot's	*		*
[sk]oot's	*!		

For Lorentz (1976), /sk/ to [ks] is simply a case of metathesis[22] and is an exception since /s/ and /k/ cannot fuse. Recall that fusion would create [x], a non-English segment. OT, however, can handle the irregularity of [ks] in a more structured way by

[22] For another OTaccount of metathesis (of Llokano) see (Boersma and Hayes 1999).

incorporating it as a valid and useful part of the child's grammar. Looking for universals one is able to see what the child gains by such a process the output of [ks] over the output of [sk].

One crucial aspect that is missing from the derivational analyses of Lorentz (1976), Gandour (1981) and Ingram (1989) is that [ks][23] adheres to the sonority sequencing principle (SSP), whereas [sk] does not.[24] Recall that Lorentz believes the phonological process of /sk/ to [ks] is due to two things (1) the phonetic constraint in which [x] is disallowed and (2) the phonological rule that states that /sk/ becomes [ks]. However, the mixing of constraints and rules as Kager points out "produce[s] an overlap in theoretical machinery. Since one of the purposes of OT is to reduce "machinery", it is "conceptually and computationally…a much simpler theory than any mixed model" (Kager 1999:56). Furthermore, Lorentz's phonological rule and phonetic constraint are not good reasons for Joe's phonology. Does the metathesis form [ks], or does the phonetic constraint no [x] form metathesis?

4.6.1 Ranking paradox resolved

Understanding that [ks] does not violate the SSP[25] allows to us to clear up the constraint ranking paradox between COMPLEX(ONS) and NO-COAL. (A complete ranking

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[23] Metathesizing /sk/ to [ks] possibly shows that Joe does not treat the /s/ in /s/ clusters as extrasyllabic.

[24](That is, if you consider /k/ and /s/ to have different values, unlike Clements (1992)). I am considering fricatives and obstruents to have different values for sonority. If one does not consider fricatives and stops to have different sonority values, the [ks] would be considered a plateau, since there is no difference in sonority value. See, Morelli (1999) for more on this point.

[25] Although the SSP constraint explains [ks] and the other outputs of [f], the constraint OCP may be active with the outputs of [s] from /sn/ and /st/. It could be argued that with /st/, coalescence cannot truly occur, since the [+coronal] place of the [t] already matches the [+coronal] place of [s]. Thus, we are left to decide which constraint is causing the reduction in /sn/ and /st/. It is possible that the /t/ is being deleted, a violation of MAX-IO, when /st/ is realized as /s/ in the output. However, a true violation of MAX-IO has not been employed in any of the clusters if it is considered that NO-COAL is a non-violation of MAX-IO. The [+nas] feature in the /sn/ cluster fuses with the vowel, so deletion, or total deletion of the [+nas] feature, has not occurred there; and fusion has taken place everywhere else except with the cluster [ks]. As the description of the phonological disorder shows, all /s/ clusters become one segment except [sk], which becomes [ks]. The change from two-segment clusters to a singleton is not a case of simply deleting, but rather fusion. For example, /sw/ becomes [f] leaving the fricative manner of /s/ and labial place of /w/ (this is the same for /sm/ to /f/, and /sp/ to /f/). With /sn/ and /st/ changing to /s/, we see the same process as the other clusters, but less directly since /s/, /n/, and /t/ are all coronals. Nonetheless, the fricative manner of /s/ remains, and the coronal place of /t/ and /n/ are present as well. If deletion (MAX-IO) were to take place within all other clusters, it would be ranked low on the constraint hierarchy. Since a violation of NO-COAL is generally the marked cluster repair mechanism, another active constraint vying to be the repair mechanism, such as the OCP, would most likely be unnecessary. Further, if children with normal phonology do not show two repair strategies for simplifying clusters, it would seem unlikely that Joe would have two repair strategies. Thus, it stands that a violation of NO-COAL is the repair strategy for onset clusters.

cannot be given without both violated and unviolated constraints). The violated constraints of COMPLEX(ONS) and NO-COAL had no counterpart in Tableau (20). Now that *COMPLEX(ONS) and NO-COAL have a counterpart, a new ranking can be given:

(31) SSP>>*COMPLEX(ONS), NO-COAL, LINEARITY-IO

Notice that the violated constraints in (31) could be translated into the rule processes stated by Gandour (1981) and Ingram (1989). The constraint *COMPLEX(ONS) is related to the phonological rule of cluster reduction. The constraint NO-COAL is related to the phonological rule of coalescence. The constraint LINEARITY-IO is related to the phonological rule of metathesis. However, the dominating constraint, SSP, was not presented in the derivational views of Lorentz (1976), Gandour (1981), or Ingram (1989), and is a new addition to the analysis of Joe's phonology. This is not to say the SSP was not available to Lorentz (1976), Gandour (1981), or Ingram (1989), but that a derivational view of phonological process basically only gives a description of the process and does not always pinpoint the underlying universal that charges the phonological changes. Nonetheless, a final constraint ranking is represented in the following Tableau.

Tableau 15. Final Constraint Ranking

All optimal	SSP	DEP-IO	MAX-IO	Linearity-IO	NO-COAL	*COMPLEX(ONS)
/swoop/						
[f]oop				*	*	
/smooth/						
[f]ooth				*	*	

/spoon/						
[f]oon				*	*	
/story/						
[s]ory				*	*	
/scoot’s/						
[ks]oot’s				*		*

4.7 More discussion on sonority and the SSP

The SSP was introduced in ranking (31):

(32) SSP>>*COMPLEX(ONS), NO-COAL, LINEARITY-IO

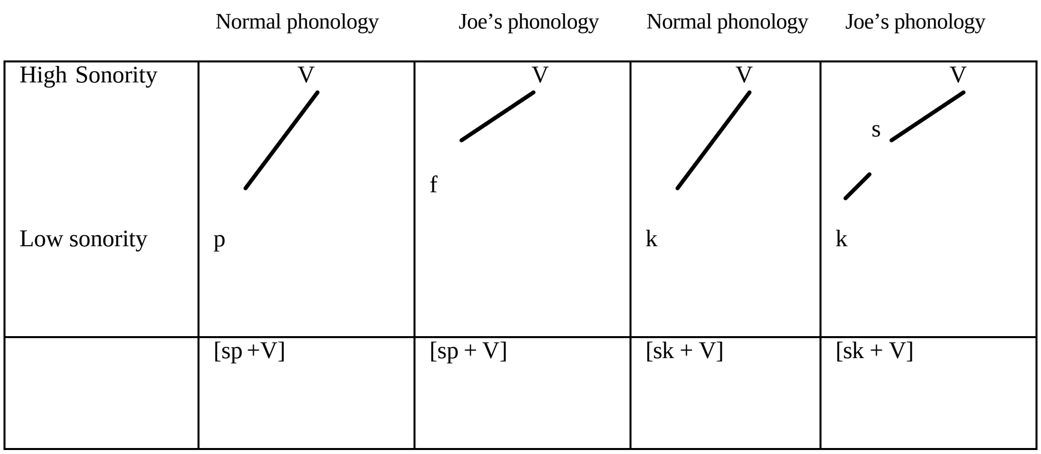
Since the SSP is the highest-ranking constraint, a bigger generalization can be made that all of Joe’s cluster simplifications are due to sonority. The SSP, with regards to onsets, states that there should be steady rise from the rightmost edge of the syllable to the nucleus (Blevins 1996). Further, the greater the rise, the less marked and more basic the syllable is (Clements 1992). Studies such as Ohala (1996) and Gnandesikan (1995) have shown that children with normal phonology abide by the SSP and consequently prefer basic syllables with steep syllable peaks such as [pa], [ta], and [ka]. Joe, too, abides by the SSP in simplifying clusters, but on slightly different terms. First, he allows clusters such as [ks] to appear (note that this does not violate the SSP). Furthermore, his cluster simplifications he allows fricative + vowel syllables to surface, rather than the least marked stop + vowel CV structure. A comparison of Joe's data and that of normal child phonology shows that a distinction between stops and fricatives exists, and that a sonority scale such as (33) is appropriate.

(33) Stops > Fricatives > Nasals > Liquids > Glides > Vowels

[p,t,k] [s,f] [m,n] [l,ɹ] [w,j] [a, i]

With this distinction between stops and fricatives, it is clear that there is a difference in the type of syllable rise or peak between Joe's data and normal phonology.

Table 16. Comparison of Sonority Peaks



(adapted from Ohala 1999:403)

From Table 16 we see that children with normal phonology, when given a choice between a stop and fricative, delete the more sonorous fricative. When Joe has the same choice, he chooses to violate LINEARITY-IO and NO-COAL, and produces [f] and [ks] as the optimal output. Therefore, there is a less steep rise in Joe's phonology than in the phonology of normal children.

If stops and fricatives were considered equal, as Clements (1992) and Morelli (1999) believe, then the cluster acquisition data presented in the literature might be ambiguous at best. However, the data presented here proves that there is in fact a sonority difference between stops and fricatives.[26] Moreover, by primarily producing the fricative [f] and the cluster [ks], Joe's phonology is more marked than that of normal child phonology. [f] and the cluster [ks], in onset position obviously do not create maximal syllables such as [pa], [ta], and [ka].

4.8 Hypothetical cluster reductions in an OT framework

One of OT's concepts is the Generator (GEN), which represents the infinite number of possible output forms. This "property" of the GEN is called "Freedom of Analysis" and states that "any amount of structure may be posited" (Kager 1999:20). Regarding the freedom of analysis, GEN is "quite creative" and hence there are logical hypothetical outputs Joe could have produced but did not (Archangeli 1997:14): (1) He could have chosen to violate LINEARITY-IO without violating NO-COAL; (2) Joe could have violated DEP-IO to repair ill-formed clusters; (3) deletion, or a violation of MAX-IO, could have been the primary repair strategy.

In the repair strategy with a violation of LINEARITY-IO and non-violation of NO-COAL, the clusters would have changed as follows: /sw/ to [ws]; /sp/ to [ps]; /sm/ to [ms]; /sn/ to [ns]; /st/ to [ts]; and /sk/ to [ks]. Half of the set of clusters [ws], [ms], and [ns] violate the SSP, the other half do not. Because of this half-and-half effect it seems that metathesis without fusion is not a good choice. This, I think, also shows Joe's metalinguistic knowledge. It seems he realizes that half of these clusters such as /sn/, /sm/, and /sw/ adhere to the SSP, but that the other half does not. Hence a primary phonological process of metathesis (or violation of the constraint LINEARITY-IO) instead of the phonological process of coalescence (or violation of the constraint No-COAL) would just get him in the same position he started from in which half of the input clusters would adhere to the SSP and the other half would not. That is, if a violation of LINEARITY-IO were violated, the output forms would be:

(34) /sp/ → [ps]

/st/ → [ts]

/sk/ → [ks]

/sn/ → [ns]

/sm/ → [ms]

/sw/ → [ws]

[26] I direct you to (Barlow 1997; Ohala 1996; and Ohala 1999) for more on how sonority shapes cluster outputs in normal phonology.

[ps], [ts], and [ks] do not violate the SSP, but [ns], [ms], and [ws] do.

Joe could have used epenthesis (DEP-IO) as a repair strategy to simplify clusters. Epenthesis, or DEP-IO, is employed in English when two like coronals are present in past tense forms such as /needed/ and /wanted/ (Yip 1988:88). Thus the clusters [sp], [sn], [sw], [sm], [st], [sk], and [sp] could have become [səp], [sən], [səw], [səm], [sət], [sək] and [səp], respectively. With epenthesis he would gain unmarked onsets, but a syllable would have been added, possibly creating more structure than necessary. For example, another syllable would have been added to a word like “spoon” [fun], generating the output, [sə.pun].

A violation of MAX-IO (deletion) would have been the easiest thing to do. In fact, this is what most children do. However, Joe’s data shows that he chooses to violate such constraints as NO-COAL and LINEARITY. Since Joe violates NO-COAL rather the MAX-IO, the output has both unmarked and faithful characteristics. For example, in Joe’s data, [sw]at to [f]at shows more faithfulness than say a child with normal phonology who reduces [sw]at to [s]at; however, at the same time the output does not have a complex cluster, and is therefore unmarked.

4.9 Summary of uncommon phonological disorders

A comparison based on frequency/probability can be made between common and uncommon differences. This comparison is not without premise. Recall that the classification of common, uncommon, and rare is based on real phonological data and not hypothetical data. In the realm of phonological differences, Joe’s data is less likely to appear than common difference data. Therefore, Joe’s output of [f] from the input of [sw] is more marked than the common output of [s]. Also, Joe’s output of [f] is more faithful than the common output of [s] because [f] has features of both [s] and [w]. This idea can be translated into markedness and faithfulness constraints and can be presented in a quasi Tableau. (The symbol * is used to show a violation).

Tableau 17. A Comparison of Normal Reduction and Joe’s Reduction

/sw/	Markedness	Segmental Faithfulness
Normal reduction [s]		*
Joe’s reduction [f]	*	

Tableau 16 states that Joe’s phonology violates markedness more so and faithfulness less so than common phonological differences. The normal output of [s] is not considered to be marked at all, but is considered a violation of faithfulness since one segment has been deleted. Joe's output of [f] is more marked than common output of [s] because [f], being [+cont] and [+labial] is more faithful to each original segment in the [sw] cluster. Simply put, Joe's output is more marked because it is more faithful.

CHAPTER 5.0 RARE PHONOLOGICAL DISORDERS

5.1 Introduction

The rare phonological process of using a non-language sound will be explored in this chapter. Section 5.1 introduces the data; 5.2 gives a derivational analysis of the data; 5.3 discusses markedness and faithfulness; 5.4 introduces constraints concerning fricatives and how those constraints affect markedness; 5.5 explores the constraint *Cor and its affects on neutralization; 5.6 introduces the constraint Fill, and how it can be used for a constraint promotion; 5.7 concludes.

5.2 The rare data

Data from Edwards and Bernhardt (1973) show the use of non-language sounds. Christina, 5;3, changes each affricate or fricative in coda position to an ingressive voiceless nasal snort with heavy frication. One of the original researchers states that "the nasal snort "… was articulated through the nasal cavity with the frication probably coming in the velopharyngeal port itself"[27] (Bernhardt 2004). Since the frication came from the velopharyngeal region the symbol [fŋ], which is designated as a velopharyngeal fricative on the extended IPA chart, will be used. The symbol [↓] will be used to signify ingression and the symbol [̥] will be added signify a voiceless sound, making the complete symbol — [fŋ̊↓]. Christina's substitution process of affricates and fricatives is shown below.

(35) /s/ → [fŋ̊↓] / ___ #

/z/ → [fŋ̊↓] / ___ #

/ʒ/ → [fŋ̊↓] / ___ #

/ʃ/ → [fŋ̊↓] / ___ #

/tʃ/ → [fŋ̊↓] / ___ #

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[27] Bernhardt (2004) does point out that the snort "had no real definable place of articulation". However, since she states that frication most likely came from the velopharyngeal area, the symbol [fŋ], is better than speculative symbols of [χ̃↓] (an ingressive voiceless nasalized uvular fricative), [x̃↓] (an ingressive voiceless nasalized velar fricative), and [ç̃↓] (an ingressive voiceless nasalized palatal fricative), and [R̥̃↓] (an ingressive voiceless nasalized uvular trill). (A velar trill is articulatorily impossible and there is no IPA symbol for a palatal trill.)

/dʒ/ → [fŋ̊↓] / ___ #

5.3 A derivational analysis of Christina's process

A stopping rule for affricates and fricatives is simple. No features are added and the output is less marked than the input. A simple stopping rule for affricates would be:

(36) $$\begin{bmatrix} \text{+cont} \\ \text{+palatal} \end{bmatrix} \rightarrow \begin{bmatrix} \text{-cont} \\ \text{+alveolar} \end{bmatrix}$$

This type of rule is similar to Val's stopping rule in chapter three. Furthermore, Val's rule and the rule given in (36) are "natural" rules. (36), for example, shows a relationship between the input and output and few features need to be specified (Chomsky and Halle 1968:335). Only two features need to be mentioned for the underlying form and surface form: one for place ([+palatal] and [+alveolar]) and one for manner ([+cont] and [-cont]).

Unlike rule (36), however, Christina's rule is not "natural." The features [+ingressive] and [+nasal] are not present in the inputs and are additions to the output.[28] Another strange aspect of Christina's process is that coronal affricates and fricatives change to velar place. As seen with Val, affricates and fricatives typically become alveolar stops, not velopharyngeal fricatives. The feature velopharyngeal will be signified as [+v.phar]. Incorporating all the above features, Christina's process would be the following in feature notation.

(37)

$$\begin{bmatrix} \text{+cont} \\ \text{+cor} \end{bmatrix} \rightarrow \begin{bmatrix} \text{+v.phar} \\ \text{+nasal} \\ \text{+ingressive} \end{bmatrix} \Big/ \quad \underline{\quad} \ \#$$

[28] Bernhardt (2004) points out that Christina's speech therapist had a "nasal tic" at the end of his sentences. It is possible that the therapist's "nasal tic" caused Christina to pick up the [nasal] feature.

Feature notation shows (37) to be a "more radical" rule than (36). (37) requires the use of more features than (36) and is therefore less likely to be seen in language (Chomsky & Halle 1968:338). (37) is not a natural change such as stopping or coda devoicing, for example.

However, Christina's rule would still be considered unnatural if only the feature [+ingression] were added, since ingression is not used in English.

(38)

$$\begin{bmatrix} \text{+cont} \\ \text{+cor} \\ \text{+egression} \end{bmatrix} \rightarrow \begin{bmatrix} \text{+cont} \\ \text{+cor} \\ \text{+ingressive} \end{bmatrix} \Big/ \quad \_\_\_ \ \#$$

Ingram and Terselic (1983) ask:

> If the basic sounds of language are easier to produce than non-language sounds, why would a child use a presumably harder sound as part of her simplifying process?[29] … [T]he nasal snort requires ingressive airflow, whereas all English sounds and most other language sounds are egressive (p. 45).

Ingram and Terselic (1983) further comment that the manner of ingression might have been an easier way than egression for Christina to produce frication (p. 49).

Even though Christina's rule is "unnatural", there are aspects of it that are not all that strange. Ingram and Terselic (1983) note that even though Christina's process is "highly unusual," there is still a "well-defined pattern of articulation" (p. 46). In Christina's case, all affricates and fricatives are replaced with [fŋ̥↓]. Therefore, Christina's process shows order. Furthermore, the place of the nasal has most likely assimilated with velar place, which is where the frication originates. The use of a velar nasal is consistent with ingressive segments, such as clicks, as in the languages of Zulu,

[29] It is not clear why Ingram and Terselic (1983) assume a "simplifying process" here. This paper shows that Christina's process is, in fact, quite the opposite.

Nama, and Xhosa as well.

(39)	Zulu	Nama	Xhosa
	[ìsì:ŋ|é]	[ŋ̥|ʰo]	[ukúŋ̤|ola]
	“kind of spear”	“push into”	“to be dirty”

(UCLA Phonetics Archive web page 2004)

However, any English rule that is associated with clicks is bound to be strange, so the relationship of velar nasals may not be good footing to show normalcy in Christina’s process.

5.4 Markedness and Faithfulness

Markedness and faithfulness are OT’s conceptual anchors. During phonological acquisition, markedness dominates faithfulness (M >> F). This type of relationship between M and F (M >> F) is also seen in second language acquisition, where the L1 is less complex than the L2 (e.g. Korean speakers learning English). Even more generally, languages of the world prefer less complexity (e.g. CV syllable structure, no codas, and no clusters). Furthermore, as seen in common and uncommon phonological disorders, the output is less marked than the input. However, certain rare phonological disorders, such as Christina’s do not follow the basic ranking of M >> F and fitting such disorders into this paradigm is difficult. If the ranking of M >> F is not followed in rare phonological disorders, other rankings such as the following may be present in the grammar.

(40) F >> M

This ranking is, of course, an adult ranking. If it were present in a developing grammar, it would suggest that complex segments are acquired sooner than expected. This is implausible.[30]

(41) Neither (M >> F) or (F >> M) is followed

[30] It is important to remember that Christina did not acquire the segment [fŋ̥↓] from any input.

(41) expresses that there is no tangible relationship between markedness and faithfulness. No relationship exists, because there is no connection between the input and output. Therefore, a ranking regarding M and F cannot be presented. This lack of ranking suggests, for some reason or another, a child's output is neither faithful to the input nor less marked than the input. Christina's output seems to fit this last paradigm.

However, the output needs to be analyzed in some way. It is not enough to say that markedness and faithfulness are disconnected. Relationships can be found within the concepts of markedness and faithfulness without connecting the two. Separating faithfulness and markedness voids the paradigms of M >> F or F >> M. (If the paradigms fit they would not need to be separated.) Outputs can be considered marked (M^{o})[31] or unmarked (UM^{o}), and outputs can be considered faithful (F^{o}) or unfaithful (UF^{o}). By separating markedness and faithfulness, four constraint possibilities, regarding output only, exist.

(42) a. UM^{o} >> M^{o} (unmarked outputs dominate marked outputs)

b. M^{o} >> U^{o} (marked outputs dominate unmarked outputs)

c. UF^{o} >> F^{o} (unfaithful outputs dominate faithful outputs)

d. F^{o} >> UF^{o} (faithful outputs dominate unfaithful outputs)

It seems that Christina's output follows (42b) and (42c) since her outputs are not unmarked or faithful. However, the ranking in (42b) is the crucial ranking here since it, along with her outputs not following the basic pattern of markedness and faithfulness constraints as in (41), shows Christina's disorder to be rare.

In summary, the concepts of markedness and faithfulness are not connected with Christina's output. However, within the concept of markedness, a marked output dominates an unmarked output.

5.5 Fricative constraints and markedness

Even though Christina's output is not faithful or unmarked, a constraint ranking can still be proposed.

As introduced in Chapter Three, two of OT's concepts are the Generator (GEN) and Evaluator (EVAL). Before the optimal output can surface, candidates (possible outputs) must be generated by the generator (GEN), and those candidates must be evaluated by the evaluator (EVAL) with the proper constraint ranking of the language. (Derivational phonology only considers the actual output and does not consider other candidates/hypothetical outputs as OT does.) It also important to note that GEN can give

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[31] The symbol "^{o}" signifies an "output" and has been incorporated so marked outputs and unmarked outputs can be differentiated from the general concepts of markedness and faithfulness. No increased complexity is intended from the symbol's use.

more than one hypothetical candidate and "is free to generate any conceivable output candidate for some input" (Kager 1999:20). A broad interpretation of this would suggest that the candidates do not necessarily have to be related to the input in any way and that the output of [fŋ̥↓] would be a logical possibility among other candidates. This simplifies GEN somewhat, but for now it will suffice. Figure 2 shows the relationship among candidates and constraints within GEN and compares non-optimal outputs with the optimal output of [fŋ̥↓] from an underlying /s/ in coda position.

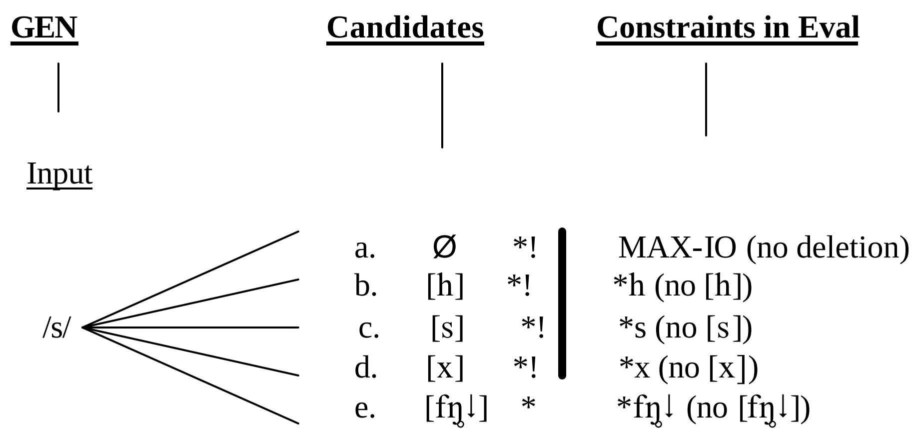

Figure 2. Generator and Eval (adapted from Kager (1999:22)

In Figure 2, a continuum of markedness is shown for possible outputs. Candidate a. is the least marked and candidate e. is the most marked.[32] Candidate a. is the least marked, since it is simply deletion. For example, deletion changes the input [hɪs], to [hɪ], which has an unmarked CV syllable structure. [h], in candidate b., is unmarked as well. Lombardi (2004) notes that of epenthetic consonants, [+phar] consonants are the least marked (p.7)[33]. [s], in candidate b., is slightly more marked than [h], since [s] is one of the fricatives Christina is avoiding. [x] is more marked than both [h] and [s], since it is a non-English phone. (Note that Joe, from chapter four, avoided [x] even when his coalescence process certainly hinted toward such a possibility.) [fŋ̥↓] is, of course, more marked than all the other candidates, since it is not a known sound in any language.

[32] [t] has been kept out of this markedness continuum for simplicity. [t] would most likely fit between [h] and [s].

[33] Lombardi (2004) states that [ʔ] (a glottal stop) is the least epenthetic consonant. Therefore, the segment [h] is used loosely here. If [+phar] segments are the least marked epenthetic consonants, [h] is used in the comparison in Figure 2, since it is [+phar] and [+continuant]. In this view, it less marked than the [+cor] fricative, /s/.

Using the constraints MAX-IO (no deletion), Coda (no coda), *Fricative (no fricatives), *s (no [s]), *h (no [h]), and *fŋ̥↓ (no [fŋ̥↓]), Tableau (27) gives an initial constraint ranking of Christina's grammar. Constraints such as *s, *h, and *fŋ̥↓ are essentially constraints that prohibit fricatives. They have been separated here so the concept of markedness, presented in Figure 2, is clearer.

Tableau 18. MAX-IO >> *Fricative >> NoCoda

		*Fricatives				
/s/	MAX-IO	*h	*s	*x	*fŋ̥↓	NoCoda
a.? [fŋ̥↓]					*	*
b. [x]				*!		*
c. [s]			*!			*
d. [h]		*!				*
e. Ø	*!					

Just as rule (37) is strange, the ranking in Tableau 18 is a strange as well. The more marked segment of [fŋ̥↓] is preferred over the less marked segments of [h], [s], [x], and Ø. In this sense, the child's output of [fŋ̥↓] is more marked than the input of [s] (Mº >> Uº). Candidates b., c., d., and e. have fatal violations of the constraints *h, *s, *x, and MAX-IO, respectively. The constraint NoCoda, presented for candidates a., b., c. and d., has been grayed out to show that that constraint played no part in the ranking of those candidates. If segments are being produced in coda position, as in candidates a., b., c. and d., the constraint NoCoda has been demoted and is insignificant for the optimal output. For candidate e., the opposite is true. The *fricative constraints do not play any part for its output, but the constraint NoCoda is active.

Interestingly, the ranking in Tableau 18 shows that the faithfulness constraint MAX-IO dominates the markedness constraint *Fricative. Taken at face value, this generalization suggests that there is, in fact, a relationship between markedness and faithfulness and that the statements made in section 5.3 are incorrect. However, faithfulness cannot dominate markedness if the output is not faithful. The constraint MAX-IO in Tableau 18 only shows that Christina is faithful to a segment in coda position. It does not show that she is faithful to affricates and fricatives of the input. Because of this, Tableau 18 has not presented the proper highest-ranked constraint.

5.6 *Cor constraint and neutralization

Comparing the features of /s/, the input, with the features of [fŋ̥↓], the output, it is shown that the highest ranked constraint most likely has to with coronal place.

Table 19. Features of [fŋ̥↓] and [s]

	continuant	coronal	v.phar	nasal	loud	ingression
[fŋ̥↓]	?		?	?	?	?
[s]	?	?				

In order for [s] to be produced correctly at a basic level, Christina needs to combine the features [+cont] and [+cor]. The feature [+cont] is not a problem. Therefore, there must be a constraint against coronal fricatives. Christina is not faithful to the place of the input. This is a violation of the faithfulness constraint IDENT-IO(Place) (the place of output must match the place of the input) (Kager 1999:45). The markedness counterpart to this constraint is *Cor (no coronal segment).

Table (19) also shows that the constraint Fill (no non-underlying segments must be inserted) (Bakovic 1995) should be used since features such as [+phar], [nasal], and [ingressive] are present in the output but not in the input.

Dispensing with the constraints *h, *x, *fŋ̥↓, and MAX-IO, for the moment and using the constraints IDENT-IO(Place), *Cor, *Dor (no dorsal segment) and Fill, a clearer constraint ranking can be presented.

Tableau 20. *Cor >> Ident-IO(Place) >> *Dor >> Fill

any [+ cor] affricate or fricative	*Cor	Ident-IO(Place)	*Dor	Fill
a.? [fŋ̥↓]		*	*	***
b. any [+cor] affricate or fricative	*!			

This constraint ranking shows a preference for dorsal fricatives over coronal fricatives. Furthermore, the ranking shows that *Dor >> *Cor. This ranking goes against the universal ranking of *Lab, *Dor >> *Cor, where coronals are the least marked place of articulation (Prince and Smolensky 1993). Again, this demonstrates that marked outputs dominate unmarked outputs (M^{o} >> U^{o}).

Since dorsal codas are preferred over coronal codas, Christina has created total neutralization regarding affricate and fricative codas. In doing so, she decreases the contrast in the language. Typically, however, lexical contrasts are neutralized with unmarked segments. For example, in English, stops can be voiced and aspirated in any position except as the second segment of a cluster.

(43) a. *[sdɪt] *[sbɪt] *[sgɪt]

b. *[st^{h}ɪt] *[sp^{h}ɪt] *[sk^{h}ɪt]

c. [stɪt] [spɪt] [skɪt]

(43a-c) show that stops in English are neutralized when they are the second segment of a cluster.

In Thai, stops can be voiced or aspirated in onset position (e.g. [b] and [p^{h}]), but cannot become voiced or aspirated in coda position (Roca 1993:99-100).

(44) a. [baa] ‘crazy’

b. [p^{h}aa] ‘cloth’

c. [sip] ‘ten’

d. * [sip^{h}]

e. *[sib]

Unlike the examples above, Christina has created neutralization with a marked segment: [fŋ̥↓]. The fact that she has created neutralization with a marked segment is more evidence that this data shows no relationship between markedness and faithfulness (M >> F), since neutralization is typically created by an unmarked segment. For example, if Christina had substituted a [t] (an unmarked segment) for all affricates and fricatives, she would have accomplished true neutralization where the markedness constraint *Fricative dominates the faithfulness constraint Ident-[continuant].

Tableau 21. *Fricative >> Ident-[continuant]

/s/	*Fricative	Ident-[continuant]
a.? [t]		*
b. [s]	*!	

Moreover, just as the ranking *Dor >> *Cor shows Mº >> Uº, the use of the specific segment [fŋ̥↓] also shows Mº >> Uº, but in a stronger fashion. That is, as long as an ingressive sound is used for neutralization in a language that has no ingressive inputs, the ingressive segment is more marked than any input, no matter the place of articulation.

5.7 The Constraint Fill

Ingression is the primary feature that makes Christina's process stand out. Other facts, such as a coronal changing to a velar and a nasal being inserted, are not so remarkable since English has both velar and nasal segments. However, all of these facts are noted within one constraint: Fill. Fill is a faithfulness constraint that disallows non-underlying features to be layered onto inputs (Bakovic 1995). Regarding the segment [fŋ̥↓], Fill incurs three violations: one for ingression, one for nasalization, and one for velarization.

Tableau 22. *Cor >> Fill

/s/	*Cor	Fill
a.? [fŋ̥↓]		***
b. [s]	*!	

The fact that the faithful output incurs no violations of Fill and that there are three violations of Fill in the optimal output suggests that the constraint Fill is crucial to the analysis. For some reason, Christina's grammar can violate Fill freely, and still generates an optimal output.

Fully developed grammars can in fact violate Fill, but not with so much freedom. In Spanish, for example, an underlying /ɾ/ (an alveolar flap) can only be realized as [r] (an alveolar trill) in onset position (Harris 1969).

(45) a. [r]eto "challenge"

b. *[ɾ]eto

With the case of /ɾ/ → [r] / # ____ V, the faithfulness constraint Fill is violated once in that there are multiple taps produced in the output. The manner of trilling has been added (multiple flaps or taps), which was not present in the underlying form. Using the constraints Strong Onsets (onsets should be salient)[34] (Bakovic 1995) and Fill, the following Tableau can be formed.

Tableau 23. Strong Onset >> Fill

/ɾito/	Strong Onset	Fill
a. ? [rito]		*
b. [ɾito]	*!	

The candidate (23b) is not optimal because a flap is not considered to be a salient onset in Spanish. Thus, the constraint Fill is violated to repair the less salient underlying form of /ɹ/.

One or even two violations of Fill seems reasonable in a fully developed grammar. However, three violations of Fill in a fully developed grammar is most likely non-existent because the majority of inputs are not so malformed that three features would need to be added in order for an input to be optimal.

[34] Bakovic (1995) states that this constraint's definition is: "Every syllable must be left-aligned with an oral closure" (p. 6). This paper, however, is using this constraint in the simple sense that a trill is more salient than a tap, and is thus preferred in onset position. Moreover, this constraint is, of course, directly related to Clements' (1992) Dispersion Principle.

5.8 Promotion of Fill and IDENT-IO(Place)

If the constraint rankings of UM^{o} >> M^{o} and M >> F do not apply to Christina's grammar, then it is plausible that she must promote the faithfulness constraint Fill in order to produce affricatives and fricatives correctly. Tesar and Smolesky (2000), however, state that constraints must be demoted not promoted.

Tesar and Smolenky (2000) are shown to be correct regarding Joe's data in chapter four; however, it is argued here that some data types, such as Christina's, theoretically, fair better with constraint promotions.

Using Joe's cluster data of [sp] to [f] and [sk] to [ks] for exemplification purposes, it can be shown that constraint promotions, in fact, fail to re-rank the constraints so that the input matches the output. A correct ranking will be shown in Tableau 24 (a simplified version of Tableau 15 from chapter four). Two hypothetical Tableaux that express constraint promotions will be shown in 25 and 26. Joe could either promote the constraint Linearity-IO or NO-COAL. Tableau 25 shows the promotion of NO-COAL, and Tableau 26 shows the promotion of Linearity-IO. Finally, a proper constraint demotion is shown in Tableau 27.

Tableau 24. Joe's Constraint Ranking

/sp/	SSP	Linearity-IO	NO-COAL
a. ? [f]			*
b. [sp]	*!		
/sk/			
a. [ks]		*	
b. [sk]	*!		

Tableau 24 shows that the faithfulness constraints Linearity-IO and NO-COAL are violated and that the markedness constraint SSP is not.

Tableau 25. Promotion of NO-COAL

/sp/	NO-Coal	SSP	Linearity-IO	NO-Coal
a. [f]	*!			
b. ? [sp]		*		
c. ? [ps]			*	
/sk/				
a. ? [ks]			*	
b. ? [sk]		*		
c. [x]	*!			

The promotion of NO-COAL in Tableau 24 allows the faithful outputs of /sp/ and /sk/, but does not solely guarantee them since [ps] and [ks] could also be optimal outputs with the ranking: NO-COAL >> SSP >> Linearity-IO.

Tableau 26. Promotion of Linearity

/sp/	Linearity-IO	SSP	NO-COAL	Linearity-IO
a. ? [f]			*	
b. ? [sp]		*		
c. [ps]	*!			
/sk/				
a. [ks]	*!			
b. ? [sk]		*		
c. ? [x]			*	

The promotion of Linearity-IO in Tableau 26 allows the faithful outputs of /sp/ and /sk/, but does not solely guarantee them, since [f] and [x] could also be optimal outputs with the ranking: Linearity-IO >> SSP >> NO-COAL.

Tableau 27. Demotion of SSP

/sp/	SSP	NO-Coal	Linearity-IO	SSP
a. [f]		*!		
b. [ps]			*!	
c. ? [sp]				*
/sk/				
a. [x]		*!		
b. [ks]			*!	
c. ? [sk]				*

Tableau 27 shows that the constraint demotion of the constraint SSP guarantees a faithful output.

Since the constraint promotions in Tableaux 25 and 26 fail to guarantee one optimal output, as the ranking in Tableau 27 does, Tesar and Smolensky's (2000) view that constraints need to be demoted, not promoted, holds regarding Joe's data.

However, a constraint demotion does not seem all that intuitive for Christina's data.

As it stands now with Christina's constraint ranking, the constraint *Cor is ranked the highest. Tableau 22 is repeated here for convenience.

Tableau 28. *Cor >> Fill

/s/	*Cor	Fill
a.? [fŋ̥↓]		***
b. [s]	*!	

Following Tesar and Smolensky's (2000) view, Christina could demote *Cor, which would create the ranking:

(46) Fill >> *Cor

The ranking in (46) is certainly plausible, but *Cor is most likely violated. Therefore, *Cor cannot be the highest ranked constraint. Ranking *Cor high, even solely for coda positions, would seem odd, since such a constraint would rule out the unmarked segments of [t], [d], and [n] in coda position. This seems highly unlikely, especially when a marked segment such as [fŋ̊↓] is allowed in coda position. Therefore, if [t] and [fŋ̊↓] are allowed in coda position, the following tableau can be presented.

Tableau 29. Nonfatal violation of *Cor

/s/	*Cor	Fill
a.? [fŋ̊↓]		***
b. [s]	*	
/t/		
a. ? [t]	*	

Tableau 29 shows that if the constraint *Cor is violated elsewhere in the grammar, it is not the highest ranking constraint regarding codas. As pointed out earlier, it is odd that fricatives are not stopped (e.g. substituted with [t] or [d]), which are [+cor] segments. Typically, as shown with Val's data in chapter three, children do not have a problem with the place of articulation (IDENT-IO(Place)) of fricatives, but rather have trouble with the manner of articulation (IDENT-[cont]). In this sense, Christina's ranking of the two faithfulness constrains IDENT-IO(Place) and IDENT-[cont] is the opposite of Val's ranking. Christina's ranking is IDENT-IO(Place) >> IDENT-[cont], whereas Val's ranking is IDENT-[cont] >> IDENT-IO(Place). (The constraint IDENT-IO(Place) will be added to the next Tableau (30).) Simply put, Christina has already acquired the more difficult aspect of fricatives: the [+cont] feature.

Since Christina uses [fŋ̥↓], which is a fricative, she violates all the markedness constraints concerning the fricative [s]. That is, the markedness constraint *Fricative, which is typically ranked high in developing grammars, is ranked low in Christina's. Also, other markedness constraints, such as *Dor, No-Coda, and *Cor (considering *Cor to be violated with other data such /t/ in coda positon), are already violated, leaving no markedness constraints to demote. The following Tableau expresses this idea.

Tableau 30. All Markedness Constraints are violated

any [+ cor] affricate or fricative	*Cor	*Fricative	*Dor	Fill	Ident-IO(Place)
a.? [fŋ̥↓]		*	*	***	*
b. any [+cor] affricate or fricative	*!				
/t/					
a. ? [t]	*				

Since all markedness constraints are already violated, Christina must promote the faithfulness constraints IDENT-IO(Place) and Fill. These constraints cannot be violated if she produces a faithful output.

Tableau 31. Promotion of Fill

/s/	Fill	*Cor	*Fricative	*Dor	Fill	Ident-IO(Place)
a. [fŋ̥↓]	***!		*	*	***	*
b. [s]		*!	*			
c. ? [h]			*	*		

Promoting Fill is not enough to force a faithful output. [s] is still disallowed, as candidate (31b) shows. Also, as (31c) shows, [h] would be a possible optimal candidate. Therefore, the faithfulness constraint IDENT-IO(Place) needs to be promoted, too. Tableau 32 shows the promotion of IDENT-IO(Place) after the promotion of Fill has already occurred.

Tableau 32. Promotion of IDENT-IO(Place)

/s/	Fill	Ident-IO(Place)	*Cor	*Fricative	*Dor	Fill Promoted	Ident-IO(Place)
a. [fŋ̥↓]	***!			*	*	***	*
b. ? [s]			*	*			
c. [h]		*!		*	*		

The faithful output of [s] surfaces once the constraint IDENT-IO(Place) is promoted. The constraints *Cor and *Dor have been crossed out because once the faithfulness constraint IDENT-IO(Place) is ranked high in the grammar, all the place markedness constraints such as *Cor, *Lab, and *Dor will be violated. These constraints, are in a sense, a constraint pair. Consider the following visual:

(47) <u>IDENT-IO(Place)</u> constraint pair
*Cor, *Lab, *Dor

(47) shows that constraints possibly suggest redundancy. If the constraint IDENT-IO(Place) is not violated, then we know that the markedness place constraints, such as *Cor, *Lab, and *Dor, are violated. This is similar to distinctive feature values. For example, if a vowel is [+high], it is not necessary to say that is [-low].

A similar pair can be made for the constraints *Fricative and IDENT-[cont].

(48) <u>IDENT-[cont]</u> constraint pair
*Fricative

If the constraint IDENT-[cont] is not violated, then we know that the markedness constraint *Fricative is violated. Thus, the constraint *Fricative in Tableau 31 could be crossed out as well. Therefore, after the two promotions of Fill and IDENT-IO(Place), a final non-redundant ranking for Christina's grammar would only include the constraints Fill, IDENT-[cont], and IDENT-IO(Place). Furthermore, these constraints would be ranked high on the constraint hierarchy. From this, if /s/ is the input, the optimal output is [s].

Ultimately, constraint promotions are consistent with a grammar that has marked outputs dominating unmarked outputs ($M^{o} >> U^{o}$). If markedness constraints are already being violated, the only constraints left to re-rank are faithfulness constraints; the only direction they can go are up (i.e. promotion).

5.9 Summary of rare phonological disorders

Comparing Val's and Christina's rule processes within a derivational approach shows that each child's process is relatively the same, since both children substitute affricates and fricatives with another segment. This is, of course, not the full solution since one process is common and the other is rare.

Since Optimality Theory is based on markedness and faithfulness constraints, it has helped to show differences between Val and Christina's processes, which a derivational approach does not show. In fact, it is not necessarily the specific constraints themselves that allows a difference to be distinguished, but simply the framework of markedness and faithfulness which the constraints obey.

Without markedness and faithfulness the necessary rankings in (49) and (50) cannot be adopted.

(49) Neither (M >> F) or (F >> M)

(50) M^o >> U^o

These rankings consequently differentiate common and rare phonological disorders. When marked outputs dominate unmarked outputs, constraints need to be promoted, not demoted. This possibility in rare phonological disorders shows that there is something intrinsically different between common and uncommon disorders versus rare disorders. This seems to follow, because if constraints were re-ranked the same way with rare disorders as they are with common and uncommon disorders (e.g. demotion), the rare classification presented here would be invalid.

CHAPTER 6. CONCLUSION

This thesis has presented phonologically disordered data and compared the data with derivational phonology and Optimality Theory. McCarthy (2002) states "…while a rule-based analysis is, quite literally, an analysis of some phenomenon, an OT analysis brings with it typological commitments that go well beyond that phenomenon" (p. 240). This is, of course, why OT has been the preferred theory throughout this thesis. OT allows for a typology of phonological disorders to be created.

As presented in this paper, phonological disorders can be classified into three types: common, uncommon, and rare. The distinction between each classification is clear because the constraint ranking or pattern that composes a particular disorder is unique to that disorder.

The following table compares common, uncommon, and rare disorders along with adult grammar and normal phonological acquisition.

(33) Relative Markedness of Outputs Compared to Input

	Neither M >>F, or F >> M	F >> M	M >> F	
	More marked than input	Faithful to input	Output Markedness	Output Unmarkedness
Normal				?
Common Dis.				?
Uncommon Dis.			?	
Adult		?		
Rare Dis.	?			

From Table (33) the following can be deduced:

1) Normal acquisition, common disorders, and uncommon disorders have the constraint ranking M >> F.

2) The outputs in normal acquisition and in common disorders are unmarked in relation to inputs.

3. Outputs in uncommon disorders are more marked than the outputs of normal and common disordered phonologies

4. An adult grammar is faithful to the input. (The output in an adult grammar may be marked, but at this stage, faithfulness constraints dominate markedness constraints, allowing marked segments to appear).

5. The outputs in rare phonological disorders are more marked than all the other grammars. In a sense, this shows that rare phonological disorders are outside the set of typical ranking patterns. Thus, a ranking of M >> F, or F >> M cannot be formulated with rare disorders.

As discussed in the introduction of this thesis, phonological processes have been classified elsewhere as "delayed" and "deviant." This general classification is one of the most common classifications in the field of speech pathology. Common phonological disorders were labeled "delayed" because the child's phonology seemed to be a slower version of a normal phonology. Uncommon phonological disorders were labeled "deviant" because such processes were not seen in normal acquisition.

However, a two-part classification such as this can be ambiguous. Recall that Yavas stated that "the …distinction between delayed and deviant … is not clearly established" in the field of speech pathology (Yavas 1998:155). Yavas' statement could be paraphrased more generally by saying that there is no clear distinction among phonological disorders, not just delayed and deviant ones. This is made clear by pointing out that Ingram (1989) considered the phonological processes of Val, Joe, and Christina to all be "deviant". However, this paper has pointed out that each child's phonological behavior is, in fact, different.

Common, uncommon, and rare phonological disorders can be defined in the following way.

1. All structures/segments in common disorders are unmarked.

2. Structures/segments in uncommon disorders have the characteristics of being both marked and unmarked. (The marked segment shows faithfulness in someway).

3. Structures/segments in rare disorders are marked. (The marked /structure

segment is due to an addition in the output that was not present in the input).

This paper has shown that OT clears up the ambiguity of other classifications of phonological disorders. OT assigns the basic constraint ranking of M >> F for common and uncommon disorders, but also shows that the outputs differ slightly in markedness value. Furthermore, OT shows that rare disorders are in fact rare because constraints cannot be properly ordered as M >> F and the outputs have a higher markedness value than the input (M^{o} >> UM^{o}).

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