Metaphony as Morpheme Realization, Not Vowel Harmony*

Caitlin M. Dillon
Department of Linguistics
Indiana University
November 25, 2003

* I would like express my gratitude to Stuart Davis, Ken de Jong, Jaye Padgett, Brian José, Vicki Anderson, Noah Silbert, Dan Dinnsen, Laura McGarrity, Rich File, Jill Beckman, and Kathleen Bardovi-Harlig for their invaluable input during various stages in the development of this paper. I am also grateful to all of the IU Linguistics Department members and McWOP 10 attendees who heard draft versions of this paper.

Abstract

The present paper is an analysis of metaphony phenomena that occur in the Lena dialect of Spanish (Hualde, 1989) and the Treia dialect of Italian (Papa, 1981). Metaphony is a change in the height of a stem vowel triggered by a suffix vowel. Previous accounts of metaphony phenomena have treated metaphony as an example of vowel harmony. However, metaphony phenomena often differ from harmony phenomena in several ways. Vowel harmony phenomena are either "stem-controlled" or "dominant-recessive" (Baković, 2000). Stem-controlled harmony involves a phonological characteristic of a stem inducing a phonological change in an affix. However, metaphony is the occurrence of an affix inducing a change in a stem. Thus, metaphony is not stem-controlled. In dominant-recessive harmony, a dominant-feature-valued vowel triggers a change in the 'recessive' vowels in the morpheme, and sometimes across morphemes. In Lena, however, the vowel change occurs only across a morpheme boundary and only one vowel in each stem is targeted. Furthermore, the targeted vowel is the stressed stem vowel; thus, a paradox arises in that the stressed vowel would have to be considered 'recessive'. Therefore, metaphony phenomena as witnessed in Lena are not cases of dominant-recessive harmony. In the present analysis, metaphony is discussed as a case of 'double morphemic exponence' (similar to German umlaut), in which the input suffix morpheme is phonologically realized both as a suffix and as a change in the stem. Double morphemic exponence is accounted for by Kurisu (2001), using Realizational Morphology Theory (RMT), which is framed within Optimality Theory (Prince and Smolensky, 1993/2002). An important constraint in RMT is Realize Morpheme, which requires the phonological realization of a morpheme. In the present analysis, Realize Morpheme is highly-ranked. Within RMT, double morphemic exponence is accounted for using Sympathy Theory (McCarthy, 1999a). The selector constraint is a low-ranking constraint which requires that the output phonological word

include only the stem, and not the affix. Satisfaction of this selector constraint causes the suffix to be ‘invisible’. Thus, in order to satisfy high-ranking Realize Morpheme, a change in the stem vowel occurs. Faithfulness to the change in stem vowel is enforced by Faith ❀O constraints. The change in the stem vowel surfaces because the winning candidate satisfies these Faith ❀O constraints. The suffix vowel also surfaces because the winning candidate satisfies Max IO, a constraint that requires every input segment to have a correspondent segment in the output. In summary, the present analysis accounts for metaphony not as a case of vowel harmony but as a case morphological opacity in the form of double morphemic exponence.

Metaphony as Morpheme Realization, Not Vowel Harmony

§1 Introduction

Metaphony is a phonological change in the height of a stem vowel triggered by a suffix vowel. Various metaphonic phenomena occur in dialects of Romance languages (e.g., Chitoran, 2002 for Romanian; Miranda, 2002 for Brazilian Portuguese; Zetterstrand, 1998 for Italian). In the present paper, I discuss metaphonic phenomena in two languages: (1) the Lena dialect of Spanish, which is spoken in the Asturias area of northwestern Spain (Hualde, 1989), and (2) the Treia dialect of Italian, spoken in Marche, in southern Italy (Papa, 1981: 8-9). In both Lena and Treia, suffix morphemes that consist of a high vowel trigger metaphony[1]; the target of metaphony is the stressed vowel in the stem; unstressed vowels do not undergo metaphony; and input high vowels always surface faithfully as high. More specifically, in Lena, stressed input low vowels surface as mid, and stressed input mid vowels surface as high. In Treia, stressed input low vowels surface faithfully (i.e., they do not undergo metaphony); stressed input mid lax vowels surface as tense; and stressed input mid tense vowels surface as high. (Papa, 1981: 280-282). A summary of the metaphony phenomena in Lena and Treia is shown in Table 1.

Table 1. The input-output correspondence between vowels in metaphonic contexts in Lena (Spanish) and Treia (Italian). Parentheses and brackets indicate that the surface form is faithful to the input form.

Dialect	**Stressed input vowel**				**Unstressed input vowel**
	low	mid lax	mid tense	high	
Lena output vowels	mid		high	(high)	[faithful to the input]
Treia output vowels	(low)	tense	high	(high)	[faithful to the input]

[1] Hualde (1989) differs from the present account in that the suffix vowel is considered to be underlyingly mid. In Hualde's account of metaphony in Lena, it is necessary to posit an underlying mid suffix vowel that raises to high (rather than an underlying high suffix vowel).

Early accounts of metaphony examined its diachronic development (Hall, 1950; Blaylock, 1965; Manczak, 1974; Leonard, 1978; Papa, 1981; see also Kaze, 1989). In the early 1980s, researchers began to examine metaphony as a synchronic process (e.g., Saunders, 1984; McCarthy, 1984; Calabrese, 1987; Vago, 1988; Hualde, 1989). The synchronic accounts have employed both derivational rule-based phonology (e.g., underspecification, Vago, 1988; autosegmental phonology, Hualde, 1989) and a non-derivational approach (Optimality Theory; Walker, 2003). Although accounts vary in the mechanisms they use to motivate metaphony, previous accounts treat metaphony as a form of vowel harmony. In treating metaphony as vowel harmony, the primary impetus for a change in the stem vowel is assimilation to the final vowel. In contrast, in the present account, a different conception of metaphony is proposed: the primary impetus for a change in the stem vowel is realization of a morpheme. That is, morpheme realization is the motivation for metaphony, and assimilation of the stem vowel to the final vowel happens to be to the means of morpheme realization. In the present paper, this approach to metaphony is exemplified with a optimality-theoretic account of metaphony phenomena Lena and Treia.

A discussion of metaphony as vowel harmony is provided in §2. An overview of Optimality Theory (OT) is provided in §3, followed by a summary of Realizational Morpheme Theory (RMT) in §4, both of which are employed in the present analysis. §5 contains the definitions of the constraints that are relevant for the present optimality theoretic account. The following sections, §6 and §7, provide an optimality theoretic (OT) account of metaphony in Lena and Treia, respectively. Finally, discussion and conclusions are presented in §8.

§2 Metaphony as Vowel Harmony

Although previous theoretical accounts of metaphony phenomena have treated it as an example of vowel harmony, metaphony phenomena differ from harmony phenomena in several ways. Vowel harmony phenomena are either 'stem-controlled' or 'dominant-recessive' (Baković, 2000). Stem-controlled harmony involves a phonological characteristic of a stem inducing a phonological change in an affix. However, metaphony is the occurrence of an affix inducing a change in a stem. Thus, metaphony is not stem-controlled. In dominant-recessive harmony, a dominant-feature-valued vowel triggers a change in the 'recessive' vowels in the morpheme (and sometimes across morphemes). In the dialects discussed in the present paper, however, the vowel change occurs only across a morpheme boundary and only one vowel in the stem is targeted. Furthermore, the targeted vowel is the stressed stem vowel; thus, a paradox arises in that the stressed vowel would have to be considered 'recessive'. Therefore, the metaphony phenomena examined in this paper are not cases of dominant-recessive harmony. The treatment of metaphony as vowel harmony is in direct opposition to Baković's (2003: 29) claim that "the core empirical generalization about vowel harmony [is] that stem vowels never alternate to agree with affix vowels even if disharmony is the inevitable result (the *stem precedence* generalization)." On the other hand, Van Coetsem and Buccini (1990: 173) state that, "with the term *metaphony* we refer specifically to a distance assimilation of accented vowel to nonaccented vowel." Thus, the conceptualization of vowel harmony is in direct opposition to the conceptualization of metaphony.

The fact that the stem vowels in metaphony sometimes undergo change but still do not agree with the affix vowel (e.g., low vowel raises to mid but not high in the context of a final high vowel) is not consistent with the featural assimilation characteristic of vowel harmony systems (in which, for example, a high trigger causes all targets to also surface as high). In addition, the ‘skipping’ of vowels between the target and trigger, i.e., the ‘transparency’ of the intervening vowel(s), is characteristic of metaphonic processes, while it is arguably considered non-existent in vowel harmony systems (Walker, 1999).

The Lena phenomena discussed in this paper are also interesting when viewed in terms of ‘prominence faithfulness’. Beckman (1997, 1998), in an examination of faithfulness, found that segments in certain prominent positions (such as onsets or stressed syllables) are faithful to their underlying representations more often than those in non-prominent positions. That is, segments in prominent positions are less likely to undergo phonological change. Furthermore, segments in prominent positions often trigger harmony, but rarely undergo it. Lena metaphony is therefore unusual in two ways. First, the trigger of metaphony is an affix vowel, which is not a prominent position (Beckman, 1998: 3). Second, the target of the metaphony is a stressed vowel, which means that a segment in a prominent position (i.e., the stressed syllable) is forced to be unfaithful to its underlying representation.

Most previous accounts of metaphony have utilized derivational theories (e.g., Hualde, 1989, autosegmental phonology). The present paper provides an account of metaphony using Optimality Theory. However, a unified account of metaphony in Romance dialects using the optimality-theoretic approaches that have been used to account for vowel harmony seems to require an appeal to otherwise-unattested constraints that do not reflect generally-held phonological observations. For instance, an account using Anchor constraints (e.g., in Optimal Domains Theory, Cole and Kisseberth, 1994) would involve an unusual appeal to a constraint requiring that non-sponsoring anchors (i.e., segments affiliated with the harmony feature in the output but not in the input) be stressed, so that only stressed vowels would undergo metaphony.

Optimality-theoretic accounts of metaphony have not been published to the author's knowledge. However, an unpublished manuscript by Walker (2003), available on her website (see References), provides an optimality-theoretic account of metaphony in Veneto, a dialect of Italian. Walker's account appeals to a License constraint and positional markedness to account for metaphony. This approach does not seem to be appropriate for the present cases of metaphony, because the stressed vowel alternations that occur do not reflect avoidance of marked structures (e.g., vowels) in the output. In addition, Walker's account requires an appeal to very specific constraints. For example, an otherwise-unattested constraint proposed for Walker's account of Veneto metaphony is "License([+high]post-tonic, σ́): [+high] in a post-tonic syllable must be associated with a stressed syllable." (Walker 2003: 15). The method of accounting for metaphony presented below differs from Walker (2003) because it primarily appeals to general constraints that are motivated elsewhere for different (but related) phenomena (e.g., in Kurisu, 2001).

The present analysis offers a different conception of metaphony. Metaphony is not viewed as a case of vowel harmony, but as a case of 'double morphemic exponence' (similar to German umlaut), in which the input affix morpheme is phonologically realized both as a suffix and as a change in the stem. Double morphemic exponence is accounted for by Kurisu (2001), using Realizational Morphology Theory (RMT), which is framed within Optimality Theory (Prince and Smolensky, 1993/2002).

§3 Optimality Theory

The non-derivational approach implemented in the present paper is Optimality Theory (Prince and Smolensky, 1993/2002; Kager, 1999). Optimality Theory is a framework that utilizes constraints on phonology to select the best, or 'optimal,' output given an input sequence of phonological segments. The possible outputs, or ‘candidates’ for any given input are a theoretically infinite number of segment sequences. All of the candidates are evaluated in terms of a set of phonological constraints. The correct, or ‘winning’ output for a given input is the candidate that best satisfies the phonological constraints.

The phonological constraints fall into two categories: faithfulness constraints and markedness constraints. Faithfulness constraints promote similarity (or ‘identity’ or ‘faithfulness’) between the input and the output. For example, one faithfulness constraint requires all input segments to correspond with an output segment that has the same value for the feature [high]. Markedness constraints promote a tendency toward ‘universal’ properties of language. For example, one markedness constraint states that syllables do not have codas, which is often true in language. However, it is not true that syllables *never* have codas. Thus, the constraints in OT (both faithfulness and markedness) can be violated. The faithfulness and markedness constraints themselves are ‘universal’ in that they are posited to be the same for every language. However, the priority given to the constraints in relation to each other varies from language to language. That is, the constraints are ranked on hierarchical tiers within each language. I assume that a single tier can contain more than one constraint (i.e., constraints can be given equal priority or ranking), though this point is controversial (see Kager 1999: 21).

In OT, a phonological analysis consists of the ranked constraints with a comparison of possible output candidates for a given input (underlying) form. A candidate that violates a higher-ranked constraint is never chosen as the winning output over a candidate that violates only a lower-ranked constraint (or violates no constraints). Within a tier of constraints, a candidate that violates fewer (or no) constraints is always chosen as the winning candidate over a candidate that violates more constraints. The candidate that best satisfies the constraints, or is the ‘most harmonic’, is the winning candidate and thus surfaces as the output.

In an optimality-theoretic framework, the differences between phonological systems arise from differences between constraint rankings. It has been proposed that children begin with all markedness constraints ranked above all faithfulness constraints, and gradually rerank the constraints until their phonology is similar to that of an adult speaker of their language (Tesar and Smolensky, 1998; but see also Hale and Reiss, 1997). Similarly, historical change within a language can occur due to constraint rerankings (e.g., Anttila and Cho, 1998; Padgett, 2003).

OT has been used to account for various phonological phenomena in a range of languages. However, cases of phonological opacity are difficult to account for in OT. In phonological theories that employ serial-ordered rules, 'opacity' is what occurs when a phonological rule appears to have 'overapplied' (i.e., the rule applied although its conditions are not apparent on the surface) or 'underapplied' (i.e., the rule does not appear to have applied even though its conditions are met on the surface). Opacity arises as 'overapplication' when rules are ordered such that the necessary conditions for one rule are present at one point in the derivation but are made opaque via the application of a later rule (i.e., counterbleeding). Opacity arises as 'underapplication' when rules are ordered such that the conditions for a rule were not met at the point in the derivation when the rule applied, but the application of a later rule causes the conditions to be met in the surface form (i.e., counterfeeding). McCarthy (1999a) proposed Sympathy Theory as a means of accounting for 'opaque' phonological phenomena within OT.

McCarthy's (1999a) proposal, Sympathy Theory, extended the idea of faithfulness in OT from existing between an input and an output form, to existing between two output candidates. In Sympathy Theory, one 'selector' constraint is used to select a 'sympathetic' candidate, which is the most harmonic candidate among the subset of candidates that satisfy the selector constraint. The winning candidate is forced to be faithful to the sympathetic candidate by a high-ranking ‘sympathy constraint,’ which requires faithfulness between the sympathy candidate and the output candidate.

Sympathy Theory, while controversial, has been used to account for various cases of phonological opacity (e.g., Itô and Mester, 1997; Orgun, 2001). Recently, Kurisu (2001) has extended the use of Sympathy, employing it to account for cases of morphological opacity, including ‘double morphemic exponence’ (DME). In analyzing cases of DME such as German umlaut, Kurisu (2001) uses Sympathy Theory and Realizational Morpheme Theory (RMT).

§4 Realizational Morpheme Theory

Realizational Morpheme Theory was developed by Kurisu (2001) for the purpose of providing a unified method of accounting for both concatenative and nonconcatenative morpho-phonological phenomena. An important constraint in RMT is Realize Morpheme (RM), which requires that all morphemes in the input be realized on the surface. The formal definition of RM is the following (Kurisu, 2001: 39):

> Realize Morpheme (RM):
> *Let α be a morphological form, β be a morphosyntactic category, and $F(\alpha)$ be the phonological form from which $F(\alpha+\beta)$ is derived to express a morphosyntactic category β. Then RM is satisfied with respect to β iff $F(\alpha+\beta)\neq F(\alpha)$ phonologically.*

RM requires that each morphological form (e.g., a stem) have a phonological output form. Furthermore, it requires that any multimorphemic form that includes both a ‘morphological form’ (stem) and a derivational ‘morphosyntactic category’ (e.g., PLURAL), have a phonological form that differs from that of the bare stem from which the multimorphemic form was derived.

When an input contains a stem and an affix, then Realize Morpheme is satisfied by any candidate that is not simply a faithful stem. Thus, any candidate that includes the affix (regardless of its faithfulness to the input affix) satisfies Realize Morpheme; in addition, any candidate that includes only the stem (and not the affix) satisfies Realize Morpheme iff the output stem is unfaithful to the input stem in some way. In such a case, the unfaithful characteristic of the output stem is the means of 'realizing' the affix, and thus satisfying Realize Morpheme. For example, given the input /dɔg+PLURAL/, several outputs that could satisfy RM are [dɔgs], [dɔgz], and [dug]. Kurisu (2001) conceives of RM as a faithfulness constraint, and specifically, a morphological faithfulness constraint (Kurisu 2000: 4). In requiring that each morpheme be realized on the surface, RM drives contrast between morphological forms. RM is crucial in accounting for both concatenative and nonconcatenative morphophonological phenomena without appealing to process-specific constraints such as Trunc (Truncate), Red (Reduplicate), or Reverse-Onset-and-Rime (i.e., exhibit metathesis). For example, Kurisu uses RM to account for a plural morpheme in Hessian German. The plural morpheme for some forms in Hessian German is the subtraction of the final consonant (from a homorganic consonant cluster). Kurisu's analysis involves the ranking of Realize Morpheme above Max (which prohibits the deletion of input segments). Thus, for an input /hond/$_{\text{Plural}}$ (*'dogs'*), the output [hon] wins over [hond] because [hond] is identical to the singular form [hond] (*'dog'*), thereby violating higher-ranked Realize Morpheme (Kurisu 2001: 119). (For more detail, see Kurisu 2001: 117-122.)

Another important constraint utilized by Kurisu (2001) in accounting for DME is Stem≡Prosodic Word (Stem≡PrWd), which requires that the output be coextensive with the stem, i.e., that the output include the whole stem and only the stem, not any affixes. Conceptually, Stem≡PrWd is a constraint formed from the conjunction of three other constraints commonly discussed in OT literature: Anchor-L (Stem, PrWd), Anchor-R (Stem, PrWd), and Contiguity. Anchor-L (Stem, PrWd) requires that the left edge of a stem be the left edge of the prosodic word in an output. Similarly, Anchor-R (Stem, PrWd) requires that the right edge of a stem be the right edge of the prosodic word in the output. The third constraint that is conjoined to form Stem≡PrWd, Contiguity, requires that a contiguous string of segments in the input correspond with a contiguous string of segments in the output. A candidate that fails to satisfy any of the three constraints that are conjoined in Stem≡PrWd also fails to satisfy Stem≡PrWd. In other words, this is a case of "positive constraint conjunction" (Kurisu, 2001: 199 cites, e.g., Crowhurst and Hewitt, 1997). Anchor-L (Stem, PrWd), Anchor-R (Stem, PrWd) and Contiguity militate against prefixation, suffixation, and infixation (respectively). In effect, the conjunction of these three constraints requires that the output (prosodic word) contain only segments that correspond with segments in the input *stem*. Importantly, Stem≡PrWd does not speak to the faithfulness of the features or the order in which the segments must occur. Thus, Stem≡PrWd can be satisfied even if the output contains a stem in which metathesis has occurred or a stem with an unfaithful vowel. Stem≡PrWd is violated, however, when the output does not contain a correspondent segment for every input *stem* segment or when the output contains additional segments that do not correspond with an input *stem* segment.[2] Kurisu (2001) demonstrates that Stem≡PrWd is needed for an optimality theoretic account of cases of double morphemic exponence (such as German umlaut and Japanese dominant affix effects). Specifically, Stem≡PrWd serves as the selector constraint in these cases of morphological opacity. In the

[2] McCarthy (1997: 31-2) seems to provide indirect evidence for the existence of a constraint such as Stem≡PrWd in an account of a reduplication phenomenon: "The canonical realization of *stem*, accomplished via Generalized Alignment (McCarthy & Prince 1993…), is as Prosodic Word (PrWd). This much we take to be uncontroversial; the challenge is to make the transition from the coarse-grained characterization of *stem* as a Prosodic Word to the exact details of the … reduplicant structure that is observed in the language. This, we claim, is emergent as the most harmonic possible prosodic word (PrWd), as defined by independently motivated constraints...". Thus, McCarthy seems to assume the existence of a constraint such as Stem≡PrWd, which would be violated by reduplicated forms.

present paper, metaphony is treated as a case of double morphemic exponence. Stem≡PrWd serves as the selector constraint in the following OT account of metaphony in Lena Spanish.

§5 The relevant constraints

As stated in §4 on Realizational Morpheme Theory, Realize Morpheme and Stem≡PrWd are relevant constraints in the present analysis. Kurisu's (2001) definition of Realize Morpheme was provided above. Again, RM requires that every morphological form in a language (e.g., a stem) have a phonological output form. Furthermore, it requires that any multimorphemic form that includes both a 'morphological form' (stem) and a derivational 'morphosyntactic category' (e.g., PLURAL), have a phonological form that differs from that of the bare stem from which the multimorphemic form was derived. The definition of RM is reworded below, and an example of a violation of Realize Morpheme is shown in Tableau 1.

Realize Morpheme (RM)
A morphosyntactic category in an input must be realized in the output, such that the output form corresponding to the input "stem$_\alpha$ + morphosyntactic category" contrasts with the output form of "stem$_\alpha$".

Tableau 1. A violation of Realize Morpheme

Gast + [plural]	Realize Morpheme
a. Gast	*
b. Gäst	
c. Gaste	

I propose a more specific version of RM for the present analysis of Lena. This constraint, Head Realize Morpheme (Head RM), specifically requires that the *prosodic head* manifest the input morphosyntactic category. Head RM is an extension of the family of head-specific phonological constraints such as those proposed in Alderete (1995; see also Kager 1999: 283).

Head RM could also be thought of in terms of prominence faithfulness as discussed by Beckman (1997, 1998): however, Head RM differs from previously-discussed head-specific constraints because it does not require faithfulness between an output head and its input correspondent. Instead, Head RM requires faithfulness to a morphosyntactic category, motivating the realization of the morphosyntactic category on the prosodic head, possibly at the expense of faithfulness between the output head vowel and its input correspondent.

Head Realize Morpheme (Head RM)
A morphosyntactic category in an input must be realized in the output, such that the prosodic head *of the output form corresponding to the input "stem*$_{\alpha}$ *+ morphosyntactic category" contrasts with the* prosodic head *of the output form of "stem*$_{\alpha}$*".*

Kurisu (2001) does not provide an explicit definition of Stem≡PrWd. However, he states that this constraint is satisfied if and only if "the stem domain is coextensive with the prosodic word domain." (p. 194-5) The following statement serves as the definition of Stem≡PrWd in the present analysis. An example of a violation of Stem≡PrWd is provided in Tableau 2.

Stem≡ProsodicWord (Stem≡PrWd)
The stem domain is coextensive with the prosodic word domain, i.e.,
All segments in an output form correspond to input stem *segments, and all input stem segments have output correspondents.*

Tableau 2. A violation of Stem≡PrWd

Gast + [plural]	Stem≡PrWd
a. Gast	
b. Gäst	
c. Gaste	*

In all forms in which metaphony occurs (by definition), the input form contains both a stem and a suffix morpheme. In the present analysis, each output candidate is a prosodic word. Thus, in order to satisfy Stem≡PrWd, an output candidate must only contain segments that correspond with input *stem* segments. In order to satisfy RM, a candidate must contain some realization of the suffix morpheme. Thus, any candidate that both excludes the suffix (thereby satisfying Stem≡PrWd) *and* contains only completely faithful stem segments violates RM. However, RM is *satisfied* by candidates that, despite satisfying Stem≡PrWd by excluding the input suffix, incur at least one faithfulness violation in the stem. The change in the stem that incurs the faithfulness violation is precisely what satisfies RM. The specific input-output faithfulness violation that surfaces is determined by the relative ranking of both input-output faithfulness constraints and a sympathetic (faithfulness) constraint that drives faithfulness between the sympathy candidate and the winning output candidate. The faithfulness constraints that are relevant in the present analysis are the following:

For any input that contains both a stem and an affix, any candidate that satisfies Stem≡PrWd will violate a constraint that militates against the deletion of input segments from the output. This constraint, Max IO, is defined as follows:

Max IO[3]
Input segments must have output correspondents. ('No deletion') (Kager 1999: 67)

Furthermore, more specific versions of Max IO (see Lombardi, 1998; Walker, 1999), and related Dep IO constraints, are relevant for the analysis of Lena and Treia. These faithfulness constraints are the following:

Max IO-[hi]
Input [hi] feature specifications have [hi] output correspondents. ('No deletion of input [hi]')

Dep IO-[hi]
Output [hi] feature specifications have [hi] input correspondents. ('No insertion of input [hi]')

[3] The constraint Max IO will not appear in the tableaux since segmental deletion is not at issue

Max IO-[lo]
Input [lo] feature specifications have [lo] output correspondents. ('No deletion of input [lo]')

Dep IO-[lo]
Output [lo] feature specifications have [lo] input correspondents. ('No insertion of input [lo]')

Max IO-[ATR]
Input [ATR] feature specifications have [ATR] output correspondents. ('No deletion of input [ATR]')

Dep IO-[ATR]
Output [ATR] feature specifications have [ATR] input correspondents. ('No insertion of input [ATR]'

Max IO and Dep IO constraints that references features assume privative (one-valued) rather than binary features. These constraints do not necessarily require that the input feature be realized on the corresponding output segment. The constraint that prevents an input feature from being realized on a non-correspondent output segment in the present analysis is the constraint Uniformity, as defined below. Uniformity is undominated in Lena; candidates that violate Uniformity will not be considered in the tableaux in §6.

Uniformity
No output segment has multiple correspondents in the input. ('No Coalescence')
(see McCarthy and Prince, 1995: 123)

Lastly, the constraint that drives output faithfulness to the sympathy candidate is Dep ❀O-[F], as defined below.

Dep ❀O-[F]
Output feature specifications must have correspondents in the sympathy candidate.

In the analysis presented below, mid vowels are assumed to be unspecified for height, being neither [lo] nor [hi] (as consistent with Archangeli's discussion of Spanish, 1988). High vowels are assumed to be specified for the feature [ATR] for ease of exposition. These assumptions are not crucial to the analysis. In addition, candidates with segments that are not part of the Lena inventory are not considered. Constraints that require faithfulness to consonants and faithfulness in terms of vowel 'backness' (such as 'Max IO-[back]') are assumed to be undominated (i.e., in the highest tier of constraints). Thus, candidates that would violate these constraints are not considered in the analysis below. In addition, the assignment of stress is not discussed in the present paper; thus, input forms in the present paper include stress.

§6 An OT account of Lena metaphony

Lena is a dialect of Spanish spoken in the Asturias area of northern Spain (Hualde, 1989). The vowel inventory of Lena includes five vowels (/i, u, e, o, a/). In Lena, metaphonic alternations occur in stressed vowels, triggered by a high suffix vowel. Specifically, stressed input mid vowels (/e, o/) surface as high ([i, u], respectively), and stressed input low vowels (/a/) surface as mid ([e]) in the context of a suffix high vowel. Several examples taken from Hualde (1989) are provided in Table 2. As shown, for forms with input low or mid vowel in the stressed position, the masculine plural morpheme is expressed both as a change in the stressed vowel and as the affix itself. This presence of two phonological expressions of a single morpheme in a word is an example of double morphemic exponence.

Table 2. Examples of Lena stems with suffixes that create a metaphonic context (masculine singular) or a non-metaphonic context (masculine plural and feminine singular). In the metaphonic context, vowel alternations occur for low and mid stressed vowels; high stressed vowels and unstressed vowels are faithful. It is assumed that the underlying form of the stem vowel is reflected in the masculine plural and feminine plural forms.

In a metaphonic context:	Gloss	Masc. Sing. (metaphonic context)	Masc. Plur.	Fem. Sing.
stressed low → [mid]	*'cat'*	gétu	gátos	gáta
	'diligent worker'	sénu	sános	sána
stressed mid → [high]	*'child'*	nínu	nénos	néna
	'wolf'	tsúbu	tsóbos	tsóba
stressed high → [high]	*'son/daughter'*	fíu	fíos	fía
unstressed → (faithful)	*'week'*	sébanu	sábanos	sábana
	'window'	benténu	bentános	bentána
	'head'	kabíθu	kabéθos	kabéθa
	'window'	benténu	bentános	bentána

As stated in §4, Kurisu (2001) uses Realizational Morpheme Theory, with a high-ranking constraint Realize Morpheme, to account for double morphemic exponence. According to Kurisu (2001), DME occurs because the constraint Stem≡PrWd serves as a selector constraint in an account that utilizes Sympathy. Just as in Kurisu's accounts of double morphemic exponence, the selector constraint in the present account is low-ranked Stem≡PrWd. The sympathetic candidate is selected from among those candidates that satisfy Stem≡PrWd due to the fact that they do not include the masculine plural affix. As a result, the affix is "invisible" during the selection of the sympathy candidate. The selected sympathetic candidate is a candidate that satisfies both the selector constraint Stem≡PrWd, and high-ranking Realize Morpheme. In Lena, the sympathy candidate satisfies Realize Morpheme by means of a vowel alternation. As shown in the examples below, for some forms, the candidate that ultimately surfaces contains both the affix segment (due to high-ranking Max IO constraints), and a stressed stem vowel that agrees with the sympathy candidate (due to high-ranking Dep ❀O-[F]). Thus, the masculine plural morpheme is doubly expressed in these forms in Lena.

Tableau 3 shows the selection of the sympathy candidate for an input with a [lo] (stressed) stem vowel. (It does not show the actual winning candidate.) The possible sympathy candidates are those that do not violate the selector constraint ❀Stem≡PrWd: candidates (a), (b), and (c). Among these three possible sympathy candidates, the one that is selected as the actual sympathy candidate is the one that best satisfies the rest of the constraint hierarchy. Candidate (a) incurs a violation of Realize Morpheme because it is identical to the stem. The crucial ranking Realize Morpheme >> Max IO-[lo] prevents candidate (a) from being the sympathy candidate. Candidates (b) and (c) satisfy Realize Morpheme because they differ from the stem. Candidate (c) violates both Dep IO-[hi][4] and Max IO-[lo], while candidate (b) violates only Max IO-[lo]. Thus, candidate (b) is selected as the sympathetic candidate because, among the candidates that satisfy the selector constraint, it is the most harmonic.

Tableau 3. Lena stressed input low vowel: Sympathy candidate

gát + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Realize Morpheme	Dep IO-[hi]	Max IO-[lo]	❀Stem ≡PrWd
a. gát	*			*			
b. ❀ gét	*					*	
c. gít	*				*	*	
d. gátu							*
e. gétu						*	*
f. gítu					*	*	*
g. géto	*					*	*

[4] The vowel in candidate (c) is assumed to be affiliated with a [hi] feature specification that is not the input [hi] affliated with the suffix vowel. A candidate that is similar to candidate (c) but does not violate Dep IO-[hi] because its [hi] feature corresponds with the input [hi] from the suffix vowel is not shown. Such a candidate would be affiliated with the backness feature from its corresponding input stem vowel, *and* the height feature ([hi]) from the input suffix vowel. Thus, this candidate would be incur a fatal violation of undominated Uniformity (see §5), which requires that, “No output segment has multiple correspondents in the input” (see McCarthy and Prince, 1995: 123).

Tableau 4 shows the selection of the winning candidate for an input with a low vowel, for which the selection of the sympathy candidate was shown in Tableau 3. Candidates (a), (b), and (c) are eliminated because they violate undominated Max IO-[hi], due to the deletion of the suffix /u/. Candidates (d) and (f) are eliminated because their stem vowels do not agree with that of the sympathy candidate. (Violations of the constraint Dep ❀O-[F] are shown as ‘lo’ or ‘hi’ according to which feature incurred the violation.) Candidate (e) is chosen as the winning output because its stem vowel is faithful to the stem vowel in the sympathy candidate *and* it includes the suffix vowel.

Tableau 4. Lena stressed input low vowel: Winning output

gát + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Realize Morpheme	Dep IO-[hi]	Max IO-[lo]	❀Stem ≡PrWd
a. gát	*!		*(lo)	*			
b.❀ gét	*!					*	
c. gít	*!		*(hi)		*	*	
d. gátu			*!(lo)	*			*
e.☞ gétu						*	*
f. gítu			*!(hi)		*	*	*
g. géto	*!					*	*

Tableau 5 shows a hypothetical input stem that has two syllables and a portion of the constraint hierarchy. In the selection of the sympathy candidate, candidates (b) and (c) tie because they both realize the suffix morpheme on <u>one</u> stem vowel (while the other stem vowel remains faithful), thereby satisfying realize morpheme. In candidate (b), the morpheme is realized on the unstressed vowel. In candidate (c), the morpheme is realized on the stressed vowel, which is what is actually selected as the sympathy candidate in Lena (as indicated by the

✿). Thus, an additional constraint is necessary. This constraint is a more specific version of the constraint Realize Morpheme, Head Realize Morpheme, as introduced in §5.

Tableau 5. Sympathy candidate is not selected for a multi-syllabic stem

sában + u	Realize Morpheme	Max IO-[lo]	❀Stem ≡PrWd
a. sában	*		
b. ? sáben		*	
c.✿? séban		*	
d. sében		**	
e. sában			*
f. sáben		*	*
g. séban		*	*
h. sében		**	*

In Tableau 6, the more specific version of Realize Morpheme, <u>Head Realize Morpheme</u>, appears in the ranking where Realize Morpheme appeared above.[5] As stated in §5 above, the constraint Head Realize Morpheme in essence requires that Realize Morpheme be satisfied on the prosodic head, which is the stressed syllable. Head Realize Morpheme requires that the head (or stressed vowel) of a stem plus affix form not be identical to the head of the plain stem. Because Head Realize Morpheme and Realize Morpheme are in a specific-general relationship, the more general constraint Realize Morpheme is assumed to be lower-ranked due to a universal default ranking of specific over general constraints (Beckman 1998: 34-35; Lombardi, 1999).

Candidates (a), (b), (c) and (d) in Tableau 6 all satisfy the selector constraint, ❀Stem≡PrWd. In the selection of the sympathy candidate from among candidates (a) through (d), candidate (b) is now eliminated because it realizes the morpheme on the unstressed vowel and not on the stressed vowel, thereby violating Head RM. Candidate (c) is selected as the

[5] Because any candidate that violates Head Realize Morpheme will necessarily also violate Realize Morpheme, the correct sympathy candidate is still chosen in Tableau 3 if Head Realize Morpheme replaces Realize Morpheme.

sympathy candidate because it is the most harmonic candidate among those that satisfy the selector constraint. In Tableau 7, it is shown that candidate (g) is selected as the winning output candidate because its stem vowels are faithful to those of the sympathy candidate, <u>and</u> it includes the suffix morpheme.

Tableau 6. Lena stressed input low vowel, unstressed input low vowel: Sympathy candidate

sabán + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. sában	*			*			*	
b. sáben	*			*		*		
c. ❀ séban	*					*		
d. sében	*					**		
e. sábanu				*				*
f. sábenu				*		*		*
g. sébanu						*		*
h. sébenu						**		*

Tableau 7. Lena stressed input low vowel, unstressed input low vowel: Winning output

sában + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. sában	*!		*(lo)	*			*	
b. sáben	*!		*(lo)	*		*		
c. ❀ séban	*!					*		
d. sében	*!					**		
e. sábanu			*!(lo)	*				*
f. sábenu			*!(lo)	*		*		*
g. ☞ sébanu						*		*
h. sébenu						**!		*

Tableau 8 shows an input with a mid stem vowel. In the selection of the sympathy candidate (where only those candidates that satisfy the selector constraint are considered), candidate (a) is eliminated because it violates undominated Dep IO-[lo], and candidate (b) is eliminated because it is identical to the stem, in violation of Head RM. Thus, candidate (c) is selected as the sympathy candidate. In Lena, mid vowels undergo metaphony because Head Realize Morpheme crucially outranks Dep IO-[hi]; and mid vowels <u>raise</u> rather than <u>lower</u> in order to realize the suffix morpheme because Dep IO-[lo] is ranked above Dep IO-[hi].

Tableau 8. Lena stressed input mid vowel: Sympathy candidate

nén + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. nán	*	*						
b. nén	*			*			*	
c. ❀ nín	*				*			
d. nánu		*						*
e. nénu				*				*
f. nínu					*			*

As shown in Tableau 9, in the selection of the winning candidate based on the sympathy candidate selected in Tableau 8, all candidates that violate undominated Max IO-[hi] or Dep ❀O-[F] are eliminated. Although the stem vowel in candidate (e) does not agree with the stem vowel in the sympathy candidate, (c), candidate (e) does not violate Dep ❀O-[F] because mid vowels are not affiliated with a height feature, and thus no features have been inserted.[6] Candidate (f) surfaces because its stem vowel is faithful to the stem vowel of the sympathy candidate (which satisfies Head Realize Morpheme) <u>and</u> it includes the suffix vowel.

[6] Candidate (e) in Tableau 9 violates a constraint not shown, Max ❀O (or Max ❀O[F]), because candidate (e) involves the deletion of the feature [hi] that is present in the sympathy candidate. The constraint Max ❀O is not shown in the tableau because candidate (e) is eliminated anyway due to its violation of Head Realize Morpheme. Max ❀O does not lead to the incorrect selection of any other winning outputs because all winning outputs agree with the sympathy candidate. Alternatively, the present analysis could employ ❀Cumulativity, which requires that the output candidate incur the same violations of constraints as the sympathy candidate (McCarthy, 1999b).

Tableau 9. Lena stressed input mid vowel: Winning output candidate

nén + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. nán	*!	*	*(lo)					
b. nén	*!			*			*	
c. ❀ nín	*!				*			
d. nánu		*!	*(lo)					*
e. nénu				*!				*
f. ☞ nínu					*			*

Tableau 10 demonstrates that high vowels always surface faithfully. Candidate (a) is selected as the sympathy candidate because, among the constraints that satisfy the selector constraint, it is the most harmonic: the crucial ranking of Max IO-[hi] over Head Realize Morpheme leads to the selection of candidate (a) as the sympathy candidate over candidate (b), capturing the fact that faithfulness to input high features takes precedence over double realization of the suffix morpheme in Lena.

Tableau 10. Lena stressed input high vowel: Sympathy candidate

fí + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ fí	*			*				
b. fé	**						*	
c. fá	**	*						
d. fíu				*				*
e. féu	*							*
f. fáu	*	*						*

In Tableau 11, the fully faithful candidate, candidate (d), surfaces as the winner because it incurs no violations of the high-ranking constraints, being faithful to the sympathy candidate and including the final suffix vowel.

Tableau 11. Lena stressed input high vowel: Winning output

fí + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ fí	*!			*			*	
b. fé	**!							
c. fá	**!	*	*(lo)					
d.☞ fíu				*				*
e. féu	*!							*
f. fáu	*!	*	*(lo)					*

Finally, in the selection of the sympathy candidate for an input with a multisyllabic stem and a stressed high vowel, the possibility that an unstressed vowel would undergo metaphony in order to realize the suffix morpheme must be ruled out. As shown in the schematic examples in Tableaux 12 and 13, the crucial ranking of Dep IO-[hi] and Max IO-[lo] over Realize Morpheme successfully prevents unstressed vowels from exhibiting vowel alternations in order to satisfy Realize Morpheme.

Tableau 12. Lena stressed input high vowel, unstressed input mid vowel: Sympathy candidate

CeCíC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CeCíC	*			*			*	
b. CiCíC	*			*	*			

Tableau 13. Lena stressed input high vowel, unstressed input low vowel: Sympathy candidate

CaCíC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CaCíC	*			*			*	
b. CeCíC	*			*		*		

The present set of constraints and ranking correctly predict the output candidates for all inputs in Lena. Additional tableaux with input forms not shown in Tableaux 3-11 above are included in Appendix I. The crucial rankings (and tableaux in which the ranking is relevant) and complete ranking schema for the present account of Lena metaphony are listed below:

Lena crucial rankings:
Max IO >> ❀Stem≡PrWd (motivates DME)
Head Realize Morpheme >> Max IO-[lo] (Tableau 3 and footnote 4)
Head Realize Morpheme >> Dep IO-[hi] (Tableau 8)
Dep IO-[lo] >> Dep IO-[hi] (Tableau 8)
Max IO-[hi] >> Head Realize Morpheme (Tableau 10)
Dep IO-[hi] >> Realize Morpheme (Tableau 12)
Max IO-[lo] >> Realize Morpheme (Tableau 13)

Complete Lena ranking schema:
Max IO-[hi], Dep IO-[lo], Dep ❀O-[F] >>
Head Realize Morpheme >>
Dep IO-[hi], Max IO-[lo] >>
Realize Morpheme, ❀Stem≡PrWd

In summary, double morphemic exponence occurs in Lena because Max IO >> ❀Stem≡PrWd induces a stressed stem vowel alternation in the sympathy candidate for some forms, in order to satisfy Head Realize Morpheme. The undominated ranking of Dep ❀O-[F] leads to the selection of winning output candidates that are faithful to the sympathy candidate. The ranking of Head Realize Morpheme over faithfulness constraints Max IO-[lo] and Dep IO-[hi] motivates the realization of the suffix morpheme on the stressed stem vowel at the expense of faithfulness. Specifically, stressed mid vowels raise instead of lower because Dep IO-[lo] is ranked above Dep IO-[hi]. Stressed high vowels always surface faithfully because Max IO-[hi] is ranked over Head Realize Morpheme; in Lena, it is more important to be faithful to input [hi] features than to exhibit double morphemic exponence. Finally, the ranking of the faithfulness constraints Dep IO-[lo] and Max IO-[hi] over Realize Morpheme causes unstressed stem vowels to remain faithful.

§7 An OT account of Treia metaphony

Metaphony is a well-known feature of many Italian dialects (see Maiden, 1991). The Treia dialect, spoken in Marche, Italy (Papa, 1981) exemplifies a case of metaphony in Italian. An account of metaphony in which the metaphonic alternations are treated as double morphemic exponence, as in the account of Lena in §6, is provided below. Treia's vowel inventory, /i, e, ɛ, a, o, ɔ, u/, contains both tense and lax mid vowels. Following Archangeli and Pulleyblank (1994: 172-176), it is assumed for the present analysis that the feature [ATR] ('advanced tongue root') is associated with the tense vowels (/i, e, o, u/), but no tongue root feature is associated with the lax vowels (/ɛ, ɔ, a/).

The metaphonic alternations in Treia differ from Lena in that stressed low vowels in Treia do not undergo metaphony. Therefore, forms with stressed low vowels do not exhibit double morphemic exponence as they do in Lena. As in Lena, though, stressed mid vowels in Treia do exhibit double morphemic exponence. Stressed tense mid vowels in Treia surface as high in metaphonic contexts, as do stressed mid vowels in Lena. As stated above, however, in comparison to Lena, the Treia vowel inventory contains two additional mid vowels, lax /ɛ, ɔ/. These lax mid vowels surface as tense in metaphonic contexts, thereby exhibiting double morphemic exponence. Stressed high vowels in Treia do not exhibit double morphemic exponence, as in Lena, surfacing faithfully even in metaphonic contexts.

Examples of metaphonic vowel alternations in Treia are shown in Table 3 (taken from Papa, 1981: 282). Papa (1981) does not provide examples of forms in which metaphony does not occur in Treia. Therefore, for input forms with a low or high vowel in stressed position, and for input forms with unstressed stem vowels, schematic examples are used in the tableaux below to demonstrate the faithful surfacing of these vowels.

Table 3. Examples of Treia stems with suffixes that create a metaphonic context (masculine plural) or a non-metaphonic context (masculine or feminine singular). Vowel alternations occur for stressed lax and tense mid vowels.

In a metaphonic context:	Gloss	Masc. Plur. (metaphonic context)	Masc./Fem. Sing.
stressed lax mid → [tense]	*'tooth'*	dénti	dɛ́nde
	'foot'	pjédi	pjɛ́de
	'new	nou	nɔ́a
stressed tense mid → [high]	*'black'*	níru	néra
	'flower'	fjúri	fjóre
	'flea'	púlǧi	pólǧe
	'nephew'	nipúti	nipóte

As in Lena, the interactions among the constraints Max IO, Realize Morpheme, the selector constraint ❀Stem≡PrWd motivate the occurrence of double morphemic exponence in some Treia forms. The specific constraint Head RM plays the same role in Treia as in Lena (as demonstrated in Tableau 16). As in Lena, faithfulness constraints and their ranking in relation to Head RM and RM determine the alternations (or lack thereof) that occur in Treia. The fact that the feature [ATR] serves a contrastive role in Treia necessitates the use of two constraints introduced in §5, Max IO-[ATR] and Dep IO-[ATR], which were not active in Lena.

Tableau 14 shows the selection of the sympathy candidate for an input with a lax mid vowel in the stem. Candidate (c) is selected as the sympathy candidate because, among the candidates that satisfy the selector constraint, it is the most harmonic. The crucial ranking of Dep IO-[lo] over Dep IO-[ATR] leads to the elimination of candidate (a), causing the stem vowel to become tense rather than low. The crucial ranking of Head RM over Dep IO-[ATR] causes the stem vowel to change (by becoming tense) rather than remaining faithful to the input stem. Candidate (d) violates a superset of the constraints violated by candidate (c), and so candidate (c) will always be selected over candidate (d). That is, in candidate (d), both the [ATR] feature and the [hi] feature are inserted, so that the input /ɛ/ changes to /i/. In candidate (c), however, only the feature [ATR] is inserted.[7]

Tableau 14. Treia stressed input lax mid vowel: Sympathy candidate

dɛ́nt + i	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. dánt	*		*	*						
b. dɛ́nt	*		*			*			*	
c. ❀ dént	*		*					*		
d. dínt	*		*				*	*		
e. dánti				*						*
f. dɛ́nti						*				*
g. dénti								*		*
h. dínti							*	*		*

In Tableau 15, the selection of the winning output for an input with a lax mid vowel is shown. Among the candidates that satisfy Max IO-[hi] (or Max IO-[ATR]; candidates (e) - (h)), candidates that violate undominated Dep ❀O-[F] are eliminated. Candidate (g), with a tense mid vowel in the stem, is selected over the faithful candidate (f) because Head RM is ranked above Dep IO-[ATR]. (Candidate (f) is not eliminated by Dep ❀O-[F] because, although its stem vowel is not faithful to the sympathy candidate, it does not involve the insertion of any features.)

[7] A candidate in which [hi] is inserted but in which [ATR] is not inserted is not considered because such this would result in a segment, [ɪ], that is not included in the inventory of Treia.

Tableau 15. Treia stressed input lax mid vowel: Winning output

dɛ́nt + i	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. dánt	*!		*	*	*(lo)					
b. dɛ́nt	*!		*			*			*	
c. ❀ dént	*!		*					*		
d. dínt	*!		*		*(hi)		*			
e. dánti				*!	*(lo)					*
f. dɛ́nti						*!				*
g. ☞dénti								*		*
h. dínti					*!(hi)		*			*

Tableau 16 demonstrates that, as in Lena, the specific version of Realize Morpheme, Head Realize Morpheme, is necessary in Treia for input forms with multisyllabic stems in which the plural morpheme could potentially be realized on either the stressed vowel (as in candidate (c)) or an unstressed vowel (as in candidate (b)). The presence of Head RM in the constraint heirarchy leads to the selection of the correct sympathy candidate, candidate (c), in which the stressed stem vowel has undergone metaphony while the unstressed vowel remains faithful to the input.

Tableau 16. Treia stressed input lax mid vowel, unstressed input lax mid vowel: Sympathy candidate

CɛCɛ́C + u	Max IO-[hi]	Max IO- [lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem≡PrWd
a. CɛCɛ́C	*		*			*			*	
b. CeCɛ́C	*		*			*		*		
c.❀ CɛCéC	*		*					*		
d. CeCéC	*		*					**		

An input with a tense mid stem vowel is shown in Tableau 17. Candidates (a) - (d) are possible sympathy candidates because they satisfy the selector constraint. Candidate (b), with a lax mid vowel, is eliminated in favor of candidate (d), with a high vowel, because Max IO-[ATR] is crucially ranked above Dep IO-[hi]. In Treia, the insertion of the feature [hi] is preferred over the deletion of the feature [ATR]. The crucial ranking of Head RM over Dep IO-[hi] leads to the elimination of candidate (c), and the selection of candidate (d) as the sympathy candidate. In the selection of the winning candidate, shown in Tableau 18, candidate (h), whose stem vowel exhibits metaphony and agrees with the sympathy candidate, is selected as the winning candidate.

Tableau 17. Treia stressed input tense mid vowel: Sympathy candidate

nér + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. nár	*		**	*						
b. nɛ́r	*		**							
c. nér	*		*			*			*	
d. ❀ nír	*		*				*			
e. náru			*	*						*
f. nɛ́ru			*							*
g. néru						*				*
h. níru							*			*

Tableau 18. Treia stressed input tense mid vowel: Winning output

nér + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. nár	*!		**	*	*$_{(lo)}$					
b. nɛ́r	*!		**							
c. nér	*!		*			*			*	
d. ❀ nír	*!		*				*			
e. náru			*	*!	*$_{(lo)}$					*
f. nɛ́ru			*!							*
g. néru						*!				*
h. ☞níru							*			*

In Treia, input forms with stressed high vowels surface faithfully even in metaphonic contexts. The ranking of the faithfulness constraint Max IO-[hi] over Head RM prevents the deletion of the feature [hi] from the stem vowel, even though this ranking leads to the selection of a sympathy candidate, and ultimately a winning output candidate, that violates Head RM because its stressed vowel is identical to that of the stem (unlike the Treia forms presented above). This is demonstrated in Tableau 19, which shows the selection of the sympathy candidate for an input with a high stem vowel. Among the candidates that satisfy the selector constraint (candidates (a) - (d)), the crucial ranking of Max IO-[hi] over Head RM leads to the elimination of candidates (a), (b), and (c), in favor of candidate (d), with a faithful stem vowel. Tableau 20 illustrates that the correct winning candidate, with a faithful high stem vowel, is also selected for this input.

Tableau 19. Treia stressed input high vowel: Sympathy candidate

CíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CáC	**		**	*						
b. Cɛ́C	**		**							
c. CéC	**		*							
d.❀ CíC	*		*			*			*	
e. CáCu	*		*	*						*
f. Cɛ́Cu	*		*							*
g. CéCu	*									*
h. CíCu						*				*

Tableau 20. Treia stressed input high vowel: Winning output

CíC + u	Max IO-[hi]	Max IO- [lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem≡PrWd
a. CáC	*!*		**	*	*(lo)					
b. Cɛ́C	*!*		**							
c. CéC	*!*		*							
d.❀ CíC	*!		*			*			*	
e. CáCu	*!		*	*	*(lo)					*
f. Cɛ́Cu	*!		*							*
g. CéCu	*!									*
h. ☞CíCu						*				*

Tableaux 21 and 22 demonstrate the selection of sympathetic candidates for inputs with multisyllabic stems with a high vowel in stressed position. Dep IO-[hi] and Dep IO-[ATR] (respectively) are crucially ranked above Realize Morpheme. These crucial rankings prevent unstressed vowels from undergoing metaphony when the stressed vowel remains faithful.

Tableau 21. Treia stressed input high vowel, unstressed input tense mid vowel: Sympathy candidate

CeCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CeCíC	*		*			*			*	
b. CiCíC	*		*			*	*			
c. CeCéC	**		*							
d. CiCéC	**		*				*			

Tableau 22. Treia stressed input high vowel, unstressed input lax mid vowel: Sympathy candidate

CɛCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CɛCíC	*		*			*			*	
b. CeCíC	*		*			*		*		
c. CɛCéC	**		*							
d. CeCéC	**		*					*		

Tableau 23 illustrates the selection of the sympathetic candidate for a monosyllabic stem with an input low vowel, which is similar to the selection of the sympathetic candidate for a form with a stressed high vowel, because both high and low vowels surface faithfully. As shown, candidates (a) - (d) are possible sympathy candidates because they satisfy the selector constraint, Stem≡PrWd. The crucial ranking of Max IO-[lo] over Head RM leads to the elimination of candidates (b), (c), and (d), and the selection of candidate (a), with the faithful stem vowel, as the sympathy candidate. Tableau 24 demonstrates the selection of the winning output. Candidates (g) and (h) are eliminated because they violate Max IO-[lo] (and Dep ❀O-[F]). Candidate (f) does not violate Dep ❀O-[F], because it involves only *deletion* of a feature ([lo]), not insertion of any features; nevertheless, the ranking of Max IO-[lo] over Head RM leads to the surfacing of the faithful candidate (e) over candidate (f). In summary, the undominated ranking of Max IO-[lo] in Treia causes all input low features to surface, even if this leads to the selection of a candidate that violates Head RM. This differs from Lena, in which stressed low vowels undergo metaphony because Max IO-[lo] is ranked below Head RM.

Tableau 23. Treia stressed input low vowel: Sympathy candidate

CáC + u	Max IO-[hi]	Max IO- [lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CáC	*		*			*			*	
b. Cɛ́C	*	*	*							
c. CéC	*	*	*							
d. CíC	*	*	*				*			
e. CáCu						*				*
f. Cɛ́Cu		*								*
g. CéCu		*								*
h. CíCu		*					*			*

Tableau 24. Treia stressed input low vowel: Winning output

CáC + u	Max IO-[hi]	Max IO- [lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CáC	*!		*			*			*	
b. Cɛ́C	*!	*	*							
c. CéC	*!	*	*		*(ATR)					
d. CíC	*!	*	*		**(ATR, hi)		*			
e.☞ CáCu						*				*
f. Cɛ́Cu		*!								*
g. CéCu		*!			* (ATR)					*
h. CíCu		*!			**(ATR, hi)		*			*

The constraints and ranking presented above correctly predict the output candidates for all inputs in Treia. Additional tableaux with input forms not shown in Tableaux 14-23 above are included in Appendix II. The crucial rankings (and tableaux in which the ranking is relevant) and complete ranking schema for the present account of Treia metaphony are listed below:

Treia crucial rankings:
Max IO >> ❀Stem≡PrWd (motivates DME)
Head Realize Morpheme >> Dep IO-[ATR] (Tableau 15)
Head Realize Morpheme >> Dep IO-[hi] (Tableau 17)
Dep IO-[lo] >> Dep IO-[ATR] (Tableau 14)
Max IO-[ATR] >> Dep IO-[hi] (Tableau 17)
Max IO-[hi] >> Head Realize Morpheme (Tableau 19)
Max IO-[lo] >> Head Realize Morpheme (Tableau 23)
Dep IO-[hi] >> Realize Morpheme (Tableau 21)
Dep IO-[ATR] >> Realize Morpheme (Tableau 22)

Complete Treia ranking schema:
Max IO-[hi], Max IO-[lo], Max IO-[ATR], Dep IO-[lo], Dep ❀O-[F] >>
Head Realize Morpheme >>
Dep IO-[hi], Dep IO-[ATR] >>
Realize Morpheme, ❀Stem≡PrWd

In summary, double morphemic exponence occurs in Treia because Max IO >> ❀Stem≡PrWd induces a stressed stem vowel alternation in the sympathy candidate for some forms, in order to satisfy Head Realize Morpheme. The ranking of Head Realize Morpheme over the faithfulness constraints Dep IO-[hi] and Dep IO-[ATR] motivates the realization of the suffix morpheme on the stressed stem vowel at the expense of faithfulness. Specifically, stressed lax mid vowels surface as tense instead of lowering because Dep IO-[lo] is ranked above Dep IO-[ATR]. Stressed tense mid vowels raise instead of becoming lax because Max IO-[ATR] outranks Dep IO-[hi]. Stressed high and low vowels always surface faithfully because Max IO-[hi] and Max IO-[lo] (respectively) are ranked over Head Realize Morpheme; in Treia, it is more important to be faithful to input [hi] and [lo] features than to exhibit double morphemic exponence. Finally, the ranking of the faithfulness constraints Dep IO-[hi] and Dep IO-[ATR] over Realize Morpheme causes unstressed stem vowels to remain faithful.

§8 Discussion and Conclusions

The analyses of Romance metaphony provided in the present paper demonstrate that metaphony is morphologically-driven (at least synchronically). The metaphonic vowel alternations in Lena and Treia occur because ❀Stem≡PrWd's role as a selector constraint causes the suffix vowel to be "opaque" or "invisible", so that the sympathy candidate undergoes a stem change in order to satisfy Head Realize Morpheme. The specific vowel alternations that occur *emerge* from the interaction of Head Realize Morpheme and faithfulness constraints, in that "RM itself does not require any particular phonological realization of a morpheme" (Kurisu 2001: 42). Double morphemic exponence ultimately occurs because high-ranking Max constraints prevent deletion of the suffix morpheme in the winning output candidate.

Close inspection of the tableaux provided in the Appendix reveals that phonological neutralization occurs as a result of the occurrence of DME in Lena. That is, multiple inputs converge on the same output forms, surfacing identically. Any two forms that differ only in that one form has a stressed input *mid* vowel and the other has a stressed input *high* vowel will have identical output forms. In these forms, the output stressed vowel will be high, as shown below:

Schematic Lena or Treia input and corresponding output forms:		
/CéC + u/	☞	[CíCu]
/CíC + u/	☞	[CíCu]

In these forms, morphosyntactic 'exponence', or double-marking of the (suffix) morpheme, takes precedence over phonological stem contrast. Hence, expression of the morpheme surfaces on the stressed vowel, in some cases at the expense of stem faithfulness. In these case (e.g., [CíCu] from /CéC + u/), double morphemic exponence occurs. This double-marking of a morpheme emphasizes the constrast between the double-marked form and its morphosyntactically-contrasting counterparts, such as the feminine form, e.g., [CéCa] from /CéC + a/ contrasts with its masculine counterpart [CíCu] in both the stem and final vowel. This contrast between the morphosyntactically distinct pairs (masculine and feminine) is emphasized at the expense of the neutralization of lexically-contrasting stems (shown above, in which two lexically distinct forms /CéC + u/ and /CíC + u/ both surface as [CíCu]).

Furthermore, the neutralization of input vowels incurs faithfulness violations. In OT, faithfulness violations must be motivated. Kager (1999: 190) summarizes "input vowels are never given up for free: there must be some pressure (due to a well-formedness constraint) to syncopate, and when vowels are deleted, their number always (precisely) suffices to restore the balance [between faithfulness and well-formedness]. This is the economy principle *'do-only-when-necessary'*, a true hallmark of OT." The economy principle in OT is considered relevant to the "battle between *faithfulness* and *well-formedness*" (Kager, 1999: 190). The metaphony phenomena presented above demonstrate an extension of this concept: DME occurs as a result of a tension between stem faithfulness and morpheme expression. It is conceivable that DME is one stage in a diachronic process in which the suffix vowel will be lost (as in umlaut plural in Middle English), because the morphosyntactic role of the suffix is exhibited as a stem vowel alternation.

A weakness of the present account stems from the fact that McCarthy (1999: 365-366) proposed Sympathy on the grounds that Local Constraint Conjunction cannot account for all cases of opacity in OT (in particular, for a specific type of counterfeeding, in which (in derivational terms) the conditioning environment of one rule is stripped by the application of an earlier rule). On the other hand, Itô and Mester (1999: 12-16) argued for the use of Local Constraint Conjunction, on the grounds that Sympathy Theory cannot account for all cases of opacity in OT. Thus, both LCC and Sympathy were proposed in order to account for cases of phonological opacity using OT. Because Stem≡PrWd is a conjoined constraint, the present account requires the use of both Local Constraint Conjunction (due to Stem≡PrWd) and Sympathy. Fukazawa (2001) proposed that some phonological phenomena appear to require the use of both LCC and Sympathy, which is supported by the present analysis. In the present analysis, Sympathy mediates between morphological levels: an appeal to Sympathy as a means of maintaining faithfulness (or contrast) between stem forms and stem+affix forms is reminiscent of Lexical Phonology. Further research should investigate whether the role of Sympathy could be restricted to mediating between morphological levels.

In conclusion, the analysis presented above demonstrates that at least two cases of Romance metaphony can be accounted for using well-established OT faithfulness constraints, previously-attested morphological constraints introduced by Kurisu (2001), and one head-specific version of Kurisu's constraint Realize Morpheme. The present analysis supports the conceptualization of metaphony as a morphologically-driven phenomenon, specifically, as a case of double morphemic exponence, rather than as a case of vowel harmony. Such an analysis coincides with the fact that metaphonic vowel alternations do not resemble vowel harmony alternations, in that metaphony involves an affixal trigger and a single (stressed) target, inducing stressed vowels to surface unfaithfully while unstressed vowels remain faithful. Ultimately, the analysis of metaphony as double morphemic exponence precludes the need to explain why metaphony would constitute such an unusual case of vowel harmony.

References

Alderete, J. (1995). Faithfulness to prosodic heads. Ms, University of Massachusetts, Amherst. ROA-94-0000, Rutgers Optimality Archive, http://roa.rutgers.edu/

Anttila, A., and Cho, Y.Y. (1998). Variation and change in optimality theory. *Lingua, 104,* 31-56.

Archangeli, D. (1988). Aspects of underspecification theory. *Phonology, 5,* 183-207.

Baković, E. (2000) *Harmony, dominance and control*. New Brunswick, NJ: Rutgers University Dissertation. ROA-360-1199, Rutgers Optimality Archive, http://roa.rutgers.edu/

Baković, E. (2003). Vowel harmony and stem identity. ROA-540-0902, Rutgers Optimality Archive, http://roa.rutgers.edu

Beckman, J. (1997). Positional faithfulness, positional neutralization, and Shona vowel harmony. *Phonology, 14,* 1-46.

Beckman, J. (1998). *Positional Faithfulness*. Amherst, MA: University of Massachusetts Dissertation. ROA-234-1297, Rutgers Optimality Archive, http://roa.rutgers.edu

Blaylock, C. (1965). Hispanic metaphony. *Romance Philology, 18,* 253-271.

Calabrese, A. (1987). The interaction of phonological rules and filters in Salentino. *North Eastern Linguistic Society, 17,* 79-98.

Chitoran, I. (2002). The phonology and morphology of Romanian diphthongization. *Probus, 14,* 205-246.

Cole, J., and Kisseberth, C. (1994). An optimal domains theory of harmony. *Studies in the Linguistic Sciences, 24,* 1-13. ROA-22-0894, Rutgers Optimality Archive, http://roa.rutgers.edu

Crowhurst, M., and Hewitt, M. (1997). Boolean operations and constraint interactions in optimality theory. ROA-229-1197, Rutgers Optimality Archive, http://roa.rutgers.edu

Fukazawa, H. (2001). Local conjunction and extending sympathy theory: OCP effects in Yucatec Maya. In Lombardi, L. (Ed.), *Segmental Phonology in Optimality Theory: Constraints and Representations*. Cambridge, UK: Cambridge U Press, pp. 231-260.

Hale, M. and Reiss, C. (1997). Evidence in phonological acquisition: Implications for the initial ranking of faithfulness constraints. In Clark, E. (Ed.), *The proceedings of the Twenty-eighth Annual Child Language Research Forum.* Stanford, CA: Center Study Language & Information, pp. 143-152. ROA-132-0496, Rutgers Optimality Archive, http://roa.rutgers.edu

Hall, R.A. (1950). The reconstruction of Proto-Romance. *Language, 26*, 6-27. Rpt in Joos, M. (Ed.), *Readings in Linguistics I* (4th ed). Chicago: University of Chicago Press, 1966, 303-314.

Hualde, J.I. (1989). Autosegmental and metrical spreading in vowel-harmony systems of northwestern Spain. *Linguistics, 27*, 773-805.

Itô, J., and Mester, A. (1997). Sympathy Theory and German truncations. In Miglio, V., and Morén, B. (Eds.), *Proceedings of the Hopkins Optimality Workshop/Maryland Mayfest 1997. University of Maryland Working Papers in Linguistics, 5*. ROA-211-0897, Rutgers Optimality Archive, http://roa.rutgers.edu

Itô, J., and Mester, A. (1999). On the sources of opacity in OT: Coda processes in German. Ms., University of California, Santa Cruz. ROA-347-0999, Rutgers Optimality Archive, http://roa.rutgers.edu

Itô, J., Mester, A., and Padgett, J. (1995). Licensing and underspecification in Optimality Theory, *Linguistic Inquiry, 26*, 571-613.

Kager, R. (1999). *Optimality theory*. Cambridge: Cambridge University Press.

Kaze, J. (1989). *Metaphony in Italian and Spanish dialects revisited.* Urbana, IL: University of Illinois at Urbana-Champaign Dissertation.

Kurisu, K. (2001). *The phonology of morpheme realization*. Santa Cruz, CA: University of California at Santa Cruz Dissertation. ROA-490-0102, Rutgers Optimality Archive, http://roa.rutgers.edu/

Leonard, C.S. (1978). Umlaut in Romance. An essay in Linguistic Archeaology. *Giessener Beiträge zur Sprachwissenschaft 12*. Gossen-Linden: Hoffman.

Lombardi, L. (1998). Evidence for MaxFeature constraints from Japanese. *University of Maryland Working Papers in Linguistics, 7,* pp. 20-40. Available on ROA-247-0298, Rutgers Optimality Archive, http://roa.rutgers.edu.

Lombardi, L. (1999). Positional faithfulness and voicing assimilation in Optimality Theory. *Natural Language and Linguistic Theory, 17*, 267-302.

Maiden, M. (1991). *Interactive morphophonology: Metaphony in Italy*. New York: Routledge.

Manczak, W. (1974). Metaphony before u in the Romance languages. *Kwartalnik neofilogiczny, 21*, 343-353.

McCarthy, J. (1984). Theoretical consequences of Montañes vowel harmony. *Linguistic Inquiry, 15*, 291-318.

McCarthy, J., and Prince, A. (1995). Faithfulness and reduplicative identity. In Beckman, J., Urbanczyk, S., and Dickey, L.W. (Eds), *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory* (pp. 249-384). Available on ROA-60-0000, Rutgers Optimality Archive, http://www.roa.rutgers.edu.

McCarthy, J. (1997). Faithfulness and identity in prosodic morphology. ROA-216-0997, Rutgers Optimality Archive, http://roa.rutgers.edu.

McCarthy, J. (1999a). Sympathy and phonological opacity. *Phonology, 16*, 331-399.

McCarthy, J. (1999b). Sympathy, cumulativity, and the Duke-of-York gambit. *Indiana Working Papers in Linguistics, 1*, 57-91. Available on ROA-315-0499, Rutgers Optimality Archive, http://roa.rutgers.edu.

Miranda, A.R.M. (2002). Nominal metaphony. *Letras de Hoje, 37*, 69-98.

Orgun, C.E. (2001). English r-insertion in Optimality Theory. *Natural Language and Linguistic Theory, 19*, 737-749.

Padgett, J. (2003). The emergence of contrastive palatalization in Russian. In Holt, E. (Ed.), *Optimality Theory and language change*. Boston, MA: Kluwer Academic Press, pp. 307-335.

Papa, E. (1981). *Two studies on the history of Southern Italian vocalism*. Bloomington, IN: Indiana University Dissertation.

Prince, A., and Smolensky, P. (1993/2002). Optimality theory: constraint interaction in generative grammar. ROA-537-0802, Rutgers Optimality Archive, http://roa.rutgers.edu.

Saunders, G.E. (1984). The expression of number in Bolognese nouns and adjectives: a morphological analysis. In Pulgram, E. (Ed.), *Romanitas: Studies in Romance Languages*. Ann Arbor, MI: University of Michigan, pp. 213-244.

Tesar, B., and Smolensky, P. (1998). Learnability in Optimality Theory. *Linguistic Inquiry, 29*, 229-268.

Vago, R. (1988). Underspecification in the dual harmony system of Pasiego. *Phonology, 5*, 343-362.

Van Coetsem, F., and Buccini, A. (1990). Variation and the reconditioning of phonological rules. *Lingua, 81*, 169-220.

Walker, R. (1999). Esimbi vowel height shift: implications for faith and markedness. ROA-336-0899, Rutgers Optimality Archive, http://roa.rutgers.edu/

Walker, R. (2003). Weak triggers in vowel harmony. Ms. University of Southern California. Available July 2003 at http://www-rcf.usc.edu/~rwalker/pubs.html

Zetterstrand, S. (1998). Scalar effects in Italian metaphony. In Lema, J., and Trevino, E. (Eds), *Theoretical analyses on Romance languages: Selected papers from the 26th Linguistic Symposium on Romance Languages, Mexico City, 28-30 March 1996.* Amsterdam: John Benjamins, pp. 351-366.

Appendix I: Lena

(1) Lena stressed input low vowel, unstressed input mid vowel

CeCáC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. CeCáC	*!		*(lo)	*			*	
b. CiCáC	*!		**(hi, lo)	*	*			
c. ❀ CeCéC	*!					*		
d. CiCéC	*!		*(hi)		*	*		
e. CeCáCu			*!(lo)	*				*
f. CiCáCu			*!*(hi, lo)	*	*			*
g. ☞ CeCéCu						*		*
h. CiCéCu			*!(hi)		*	*		*

(2) Lena stressed input low vowel, unstressed input high vowel

CiCáC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. CiCáC	*!		*(lo)	*			*	
b. CeCáC	*!*		*(lo)	*				
c. ❀ CiCéC	*!					*		
d. CeCéC	*!*					*		
e. CiCáCu			*!(lo)	*				*
f. CeCáCu	*!		*(lo)	*				*
g. ☞ CiCéCu						*		*
h. CeCéCu	*!					*		*

(3) Lena stressed input mid vowel, unstressed input low vowel

kabéθ + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. kabéθ	*!			*			*	
b. kebéθ	*!			*		*		
c. kabáθ	*!	*	*(lo)					
d. ❀ kabíθ	*!				*			
e. kebíθ	*!				*	*		
f. kabéθu				*!				*
g. kebéθu				*!		*		*
h. kabáθu		*!	*(lo)					*
i. ☞ kabíθu					*			*
j. kebíθu					*	*!		*

(4) Lena stressed input mid vowel, unstressed input mid vowel

CeCéC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. CeCéC	*!			*			*	
b. CiCéC	*!		*(hi)	*	*			
c. ❀ CeCíC	*!				*			
d. CiCíC	*!		*(hi)		**			
e. CeCéCu				*!				*
f. CiCéCu			*!(hi)	*	*			*
g. ☞ CeCíCu					*			*
h. CiCíCu			*!(hi)		**			*

(5) Lena stressed input mid vowel, unstressed input high vowel

CiCéC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. CiCéC	*!			*			*	
b. CeCéC	*!*			*				
c. CiCáC	*!	*	*(lo)					
d. ❀ CiCíC	*!				*			
e. CeCíC	*!*				*			
f. CiCéCu				*!				*
g. CeCéCu	*!			*				*
h. CiCáCu		*!	*(lo)					*
i. ☞ CiCíCu					*			*
j. CeCíCu	*!				*			*

(6) Lena stressed input high vowel, unstressed input low vowel

CaCíC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a. ❀ CaCíC	*!			*			*	
b. CeCíC	*!			*		*		
c. CaCéC	*!*							
d. CeCéC	*!*					*		
e. ☞ CaCíCu				*				*
f. CeCíCu				*		*!		*
g. CaCéCu	*!							*
h. CeCéCu	*!					*		*

(7) Lena stressed input high vowel, unstressed input mid vowel

CeCíC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CeCíC	*!			*			*	
b. CiCíC	*!		*(hi)	*	*			
c. CeCéC	**!							
d. CiCéC	**!		*(hi)		*			
e.☞ CeCíCu				*				*
f. CiCíCu			*!(hi)	*	*			*
g. CeCéCu	*!							*
h. CiCéCu	*!		*(hi)		*			*

(8) Lena stressed input high vowel, unstressed input high vowel

CiCíC + u	Max IO-[hi]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Max IO-[lo]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CiCíC	*!			*			*	
b. CeCíC	*!*			*				
c. CiCéC	*!*							
d. CeCéC	*!**							
e.☞ CiCíCu				*				*
f. CeCíCu	*!			*				*
g. CiCéCu	*!							*
h. CeCéCu	*!*							*

Appendix II: Treia

(1) Treia stressed input low vowel, unstressed input low vowel

CaCáC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ✿O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	✿Stem ≡PrWd
a. ✿ CaCáC	*!		*			*			*	
b. CɛCáC	*!	*	*			*				
c. CaCɛ́C	*!	*	*							
d. CɛCɛ́C	*!	**	*							
e.☞ CaCáCu						*				*
f. CɛCáCu		*!				*				*
g. CaCɛ́Cu		*!								*
h. CɛCɛ́Cu		*!*								*

(2) Treia stressed input low vowel, unstressed input lax mid vowel

CɛCáC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ✿O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	✿Stem ≡PrWd
a.✿ CɛCáC	*!		*			*			*	
b. CeCáC	*!		*		*(ATR)	*		*		
c. CɛCɛ́C	*!	*	*							
d. CeCɛ́C	*!	*	*		*(ATR)			*		
e.☞ CɛCáCu						*				*
f. CeCáCu					*!(ATR)	*		*		*
g. CɛCɛ́Cu		*!								*
h. CeCɛ́Cu		*!			*(ATR)			*		*

(3) Treia stressed input low vowel, unstressed input tense mid vowel

CeCáC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CeCáC	*!		*			*			*	
b. CiCáC	*!		*		*(hi)	*	*			
c. CeCɛ́C	*!	*	*							
d. CiCɛ́C	*!	*	*		*(hi)		*			
e.☞ CeCáCu						*				*
f. CiCáCu					*!(hi)	*	*			*
g. CeCɛ́Cu		*!								*
h. CiCɛ́Cu		*!			*(hi)		*			*

(4) Treia stressed input low vowel, unstressed input high vowel

CiCáC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CiCáC	*!		*			*			*	
b. CeCáC	*!*		*			*				
c. CiCɛ́C	*!	*	*							
d. CeCɛ́C	*!*	*	*							
e. ☞ CiCáCu						*				*
f. CeCáCu	*!					*				*
g. CiCɛ́Cu		*!								*
h. CeCɛ́Cu	*!	*								*

(5) Treia stressed input lax mid vowel, unstressed input low vowel

CaCɛ́C + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CaCɛ́C	*!		*			*			*	
b. CɛCɛ́C	*!	*	*			*				
c.❀ CaCéC	*!		*					*		
d. CɛCéC	*!	*	*					*		
e. CaCɛ́Cu						*!				*
f. CɛCɛ́Cu		*!				*				*
g.☞ CaCéCu								*		*
h. CɛCéCu		*!						*		*

(6) Treia stressed input lax mid vowel, unstressed input lax mid vowel

CεCέC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CεCέC	*!		*			*			*	
b. CeCέC	*!		*		*(ATR)	*		*		
c.❀ CεCéC	*!		*					*		
d. CeCéC	*!		*		*(ATR)			**		
e. CεCέCu						*!				*
f. CeCέCu					*!(ATR)	*		*		*
g.☞ CεCéCu								*		*
h. CeCéCu					*!(ATR)			**		*

(7) Treia stressed input lax mid vowel, unstressed input tense mid vowel

CeCέC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CeCέC	*!		*			*			*	
b. CiCέC	*!		*		*(hi)	*	*			
c. ❀ CeCéC	*!		*					*		
d. CiCéC	*!		*		*(hi)		*	*		
e. CeCέCu						*!				*
f. CiCέCu					*!(hi)	*	*			*
g. ☞ CeCéCu								*		*
h. CiCéCu					*!(hi)		*	*		*

(8) Treia stressed input lax mid vowel, unstressed input high vowel

CiCέC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CiCέC	*!		*			*			*	
b. CeCέC	*!*		*			*				
c. ❀ CiCéC	*!		*					*		
d. CeCéC	*!*		*					*		
e. CiCέCu						*!				*
f. CeCέCu	*!					*				*
g.☞ CiCéCu								*		*
h. CeCéCu	*!							*		*

(9) Treia stressed input tense mid vowel, unstressed input low vowel

CaCéC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CaCéC	*!		*			*			*	
b. CɛCéC	*!	*	*			*				
c.❀ CaCíC	*!		*				*			
d. CɛCíC	*!	*	*				*			
e. CaCéCu						*!				*
f. CɛCéCu		*!				*				*
g.☞ CaCíCu							*			*
h. CɛCíCu		*!					*			*

(10) Treia stressed input tense mid vowel, unstressed input lax mid vowel

CɛCéC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CɛCéC	*!		*			*			*	
b. CeCéC	*!		*		*(ATR)	*		*		
c.❀ CɛCíC	*!		*				*			
d. CeCíC	*!		*		*(ATR)		*	*		
e. CɛCéCu						*!				*
f. CeCéCu					*!(ATR)	*		*		*
g.☞ CɛCíCu							*			*
h. CeCíCu					*!(ATR)		*	*		*

(11) Treia stressed input tense mid vowel, unstressed input tense mid vowel

CeCéC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CeCéC	*!		*			*			*	
b. CiCéC	*!		*		*(hi)	*	*			
c.❀ CeCíC	*!		*				*			
d. CiCíC	*!		*		*(hi)		**			
e. CeCéCu						*!				*
f. CiCéCu					*!(hi)	*	*			*
g. ☞ CeCíCu							*			*
h. CiCíCu					*!(hi)		**			*

(12) Treia stressed input tense mid vowel, unstressed input high vowel

CiCéC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. CiCéC	*!		*			*			*	
b. CeCéC	*!*		*			*				
c. ❀ CiCíC	*!		*				*			
d. CeCíC	*!*		*				*			
e. CiCéCu						*!				*
f. CeCéCu	*!					*				*
g.☞ CiCíCu							*			*
h. CeCíCu	*!						*			*

(13) Treia stressed input high vowel, unstressed input low vowel

CaCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CaCíC	*!		*			*			*	
b. CɛCíC	*!	*	*			*				
c. CaCéC	*!*		*							
d CɛCéC	*!*	*	*							
e.☞ CaCíCu						*				*
f. CɛCíCu		*!				*				*
g. CaCéCu	*!									*
h. CɛCéCu	*!	*								*

(14) Treia stressed input high vowel, unstressed input lax mid vowel

CɛCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a.❀ CɛCíC	*!		*			*			*	
b. CeCíC	*!		*		*(ATR)	*		*		
c. CɛCéC	*!*		*							
d. CeCéC	*!*		*		*(ATR)			*		
e.☞ CɛCíCu						*				*
f. CeCíCu					*!(ATR)	*		*		*
g. CɛCéCu	*!									*
h. CeCéCu	*!				*(ATR)			*		*

(15) Treia stressed input high vowel, unstressed input tense mid vowel

CeCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. ❀ CeCíC	*!		*			*			*	
b. CiCíC	*!		*		*$_{\text{(hi)}}$	*	*			
c. CeCéC	*!*		*							
d. CiCéC	*!*		*		*$_{\text{(hi)}}$		*			
e. ☞ CeCíCu						*				*
f. CiCíCu					*!$_{\text{(hi)}}$	*	*			*
g. CeCéCu	*!									*
h. CiCéCu	*!				*$_{\text{(hi)}}$		*			*

(16) Treia stressed input high vowel, unstressed input high vowel

CiCíC + u	Max IO-[hi]	Max IO-[lo]	Max IO-[ATR]	Dep IO-[lo]	Dep ❀O-[F]	Head RM	Dep IO-[hi]	Dep IO-[ATR]	Realize Morpheme	❀Stem ≡PrWd
a. ❀ CiCíC	*!		*			*			*	
b. CeCíC	*!*		*			*				
c. CiCéC	*!*		*							
d. CeCéC	*!**		*							
e. ☞ CiCíCu						*				*
f. CeCíCu	*!					*				*
g. CiCéCu	*!									*
h. CeCéCu	*!*									*