

Faith in Moras: A Revised Approach to Prosodic Faithfulness¹

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1. Introduction

Correspondence Theory (McCarthy and Prince 1995, 1999) opens the possibility for correspondence relations that hold between phonological elements of different related structures. Thus, a wide range of faithfulness constraints arises with this theory. In this paper we focus on one of these constraints, namely the prosodic faithfulness constraint DEP- μ , which bans insertion of a mora. We show that as traditionally formulated this constraint is problematic since it predicts that coda consonants may contrast in moraic status within a language and it gives rise to unattested syllabification contrasts.

These facts suggest that DEP- μ should distinguish between regular syllabification of vowels and coda consonants and lengthening phenomena. Consequently, a revision of this constraint is needed. We propose that this moraic faithfulness constraint should not penalize the insertion of a mora when this element is inserted as part of the syllabification process of vowels and of weight-contributing coda consonants.

Although this paper is developed with the Optimality Theory framework, it should be noted that the behavior of coda consonants must be analyzed in any phonological theory. Thus, the approach pursued here sheds light on the character of these consonants and, moreover, on the nature of mora epenthesis. It provides an explanation to the dual status of moras as being part of the underlying representation but also as structure inserted by structural demands.

The paper is organized as follows. In section 2, Correspondence Theory and the prosodic faithfulness constraint under study are introduced. Next, in section 3, we present the different problems that DEP- μ faces. These facts call for a revision, which is explained in section 4. Section 5 shows how the revised version of DEP- μ solves the

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problems previously presented. Finally, section 6 gives an overview of the conclusions reached in the paper and further issues that might be considered for future research.

2. Correspondence Theory and Prosodic Faithfulness

Correspondence Theory as such is developed in McCarthy and Prince (1995, 1999). They define correspondence as follows in (1):

- (1) Correspondence
Given two strings S_1 and S_2 , correspondence is a relation R from the elements of S_1 to those of S_2 . Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as correspondents of one another when $\alpha R \beta$.

Correspondence is a relation between two structures, such as base and reduplicant or input and output. McCarthy & Prince note that a range of phonological units may stand in correspondence relation, for instance segments, moras, syllables, feet, tones, distinctive features. Thus, McCarthy (1997) elaborates on the prosodic faithfulness. He formulates the constraints MAX- μ and DEP- μ . His proposal is that moras are subject to faithfulness requirements independently of the segment to which they are linked. Thus, MAX- μ bans deletion of a mora and DEP- μ penalizes insertion of a mora²:

- (2) DEP- $\mu_{S_1-S_2}$
Every mora in S_2 has a correspondent in S_1
- (3) MAX- $\mu_{S_1-S_2}$
Every mora in S_1 has a correspondent in S_2

In our study, we consider the predictions made by DEP- μ . It should be noted that as formulated in (2), DEP- μ does not distinguish between insertion of a mora to syllabify a segment as nucleus or as a moraic coda, and insertion of a mora that leads to lengthening. In section 3, it becomes clear that this lack of distinction is problematic.

3. Problems for DEP- μ

3.1 First Problem: Weight-contributing coda consonants.

DEP- μ is violated whenever there is a mora in the output that is not present in the input. The output elements that can bear a mora are vowels and coda consonants³ depending on the language, i.e., whether codas consonants are moraic or not is language specific. This means that the grammar of the particular language specifies whether the coda consonants are weight-contributing or weightless. More precisely, the ranking of the constraint

² For our purposes, S_1 and S_2 refer to the input and output respectively.

³ Syllabic consonants are presumably moraic. These consonants are not taken into consideration but our proposal treats a mora linked to such a consonant in the same fashion as a mora linked to a vowel.

demanding coda consonants to be moraic, i.e., Weight-by-Position (Hyman 1985, Hayes 1989) determines the moraic status of these segments.

- (4) Weight-by-Position (WBP) (Hayes 1989)
Coda consonants are moraic.

In a system where surface structures are determined by the interaction of different constraints, the relative ranking of WBP with respect to some other conflicting constraint indicates the distribution of moraic coda consonants. Furthermore, assuming Richness of the Base (Prince and Smolensky 1993), we cannot predict the moraic specification of the input⁴. The ranking of the constraints is responsible for the output distribution of moras. The same results should be predicted regardless of the moraic specification of the input.

WBP stands clearly in conflict with DEP- μ . Therefore, it is relevant to consider the conflict between WBP and DEP- μ , crossed with the possibilities made available given Richness of the Base. The following results are predicted:

- | | | | |
|-----|---|-----|--|
| (5) | For a non-moraic input | (6) | For a moraic input |
| | a. WBP >> DEP- μ : /CVC/ → [CVC μ] | | a. WBP >> DEP- μ : /CVC μ / → [CVC μ] |
| | b. DEP- μ >> WBP: /CVC/ → [CVC] | | b. DEP- μ >> WBP: /CVC μ / → [CVC μ] |

For ranking (a), when WBP dominates DEP- μ , the same results are obtained regardless of the input specification since the high position of WBP in the ranking forces the insertion of a mora, even at the expense of a DEP- μ violation. So, no contrast emerges in this case. However, for ranking (b), when DEP- μ dominates WBP, we get different results depending on the moraic status of the input. If the input is non-moraic, DEP- μ blocks insertion of a mora to satisfy WBP, thus a weightless output coda surfaces. On the other hand, if the input is moraic, DEP- μ is vacuously satisfied since the consonant mora is already present in the input. Consequently, ranking (b) yields a language in which coda consonants contrast in their moraic status. This prediction appears to be problematic. We are not aware of any such language.

WBP is also in conflict with the constraint against moraic consonants. This markedness constraint reflects the fact that in general consonants are not moraic. (7) shows the definition of * μ /C, which bans moraic consonants:

- (7) * μ /C (Broselow, Chen and Huffman 1997)
A mora must not be headed by a consonant.

So, whether codas are weight-contributing or weightless depends on the ranking between WBP and * μ /C. Consider the interaction of these constraints with respect to two inputs varying in their moraic status:

⁴ We focus on non-geminate consonants. Presumably, geminate consonants have their length represented in the input.

- (8) For a non-moraic input. (9) For a moraic input.
 a. $WBP \gg *_{\mu}/C: /CVC/ \rightarrow [CVC^{\mu}]$ a. $WBP \gg *_{\mu}/C: /CVC^{\mu}/ \rightarrow [CVC^{\mu}]$
 b. $*_{\mu}/C \gg WBP: /CVC/ \rightarrow [CVC]$ b. $*_{\mu}/C \gg WBP: /CVC^{\mu}/ \rightarrow [CVC]$

(8) and (9) show that when WBP is high ranked coda consonants will be moraic. However, when WBP is low ranked, more precisely, lower than $*_{\mu}/C$, coda consonants will be non-moraic. There is no contrast depending on the input specification of moras. Therefore, we conclude that DEP- μ is not necessary for deciding the moraicity of coda consonants. However, DEP- μ is able to block the insertion of a mora to satisfy WBP (see (5b)).

3.2 Second Problem: Unattested syllabification contrasts

3.2.1 Background factorial typology

Assuming the three constraints introduced so far, namely DEP- μ , WBP and $*_{\mu}/C$, it is relevant to look into the factorial typology predicted from their interaction. A particular interaction between these constraints will be the basis for the emergence of the unattested syllabification contrasts. The rankings in (10) and (11) show all the typological possibilities with respect to two different inputs with different moraic status.

- (10) For non-moraic inputs:
 a- (DEP- $\mu \gg$), $*_{\mu}/C \gg WBP$, (\gg DEP- μ) \rightarrow non-moraic coda.
 b- $WBP \gg *_{\mu}/C (\gg)$, DEP- $\mu \rightarrow$ moraic coda.
c- DEP- $\mu \gg WBP \gg *_{\mu}/C \rightarrow$ non-moraic coda.
- (11) For moraic inputs:
 a- (DEP- $\mu \gg$), $*_{\mu}/C \gg WBP$, (\gg DEP- μ) \rightarrow non-moraic coda.
 b- $WBP \gg *_{\mu}/C (\gg)$, DEP- $\mu \rightarrow$ moraic coda.
c- DEP- $\mu \gg WBP \gg *_{\mu}/C \rightarrow$ moraic coda.

The outcome of these rankings is exemplified in tableaux (10') and (11').

- (10') For a non-moraic input
 a. $/CVC/ \rightarrow [CVC]$.

$/CVC/$	DEP- μ	$*_{\mu}/C$	WBP
a. CVC^{μ}	*(!)	*(!)	
b. CVC			*

- b. $/CVC/ \rightarrow [CVC^{\mu}]$.

$/CVC/$	WBP	$*_{\mu}/C$	DEP- μ
a. CVC^{μ}		*	*
b. CVC	*!		

- (11') For a moraic input.
 a. $/CVC^{\mu}/ \rightarrow [CVC]$.

$/CVC^{\mu}/$	DEP- μ	$*_{\mu}/C$	WBP
a. CVC^{μ}		*!	
b. CVC			*

- b. $/CVC^{\mu}/ \rightarrow [CVC^{\mu}]$.

$/CVC^{\mu}/$	WBP	$*_{\mu}/C$	DEP- μ
a. CVC^{μ}		*	
b. CVC	*!		

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c. /CVC/→[CVC].				c. /CVC ^μ /→[CVC ^μ].			
/CVC/	DEP-μ	WBP	*μ/C	/CVC ^μ /	DEP-μ	WBP	*μ/C
a. CVC ^μ	*!		*	☞ a. CVC ^μ			*
☞ b. CVC		*		b. CVC		*!	

When *μ/C dominates WBP (10a & 11a), coda consonants are non-moraic regardless of the position of DEP-μ. On the other hand, when WBP dominates *μ/C, we get different results depending on the position of DEP-μ. If the latter is low ranked (10b & 11b), the output bears a moraic coda. If DEP-μ is high ranked, the results are contrastive. In (10c), DEP-μ penalizes insertion of mora to satisfy WBP so it results in a weightless coda consonant. In (11c), the same ranking chooses a weight-contributing coda since the relevant mora is in the input and DEP-μ is vacuously satisfied. The block of WBP mora epenthesis by the moraic faithfulness constraint is problematic because it gives rise to unattested syllabification contrasts that we discussed in section 3.2.2.

A possible solution to this problem raised by the factorial typology could be to assume a fixed hierarchy: whenever coda consonants are moraic, i.e., WBP dominates *μ/C, DEP-μ is low ranked, crucially lower than WBP. However, stipulating a fixed hierarchy is not a satisfactory solution. Although some OT practitioners have proposed fixed hierarchies, they typically involve constraints of the same type, for instance, the universal ranking for markedness constraints governing place of articulation or the fixed ranking of faithfulness to the root over faithfulness to the affix (McCarthy & Prince 1995, Prince and Smolensky 1993, Padgett 2002). Clearly, DEP-μ and WBP do not belong to the same family of constraints and they do not form any universal implicational scale. A further reason against posing a fixed ranking between these two constraints is the fact that DEP-μ may be relevant for lengthening phenomena. WBP is not the only constraint that triggers insertion of a mora; lengthening processes also cause mora epenthesis. These processes violate DEP-μ but this constraint fails to distinguish between lengthening and consonant moraicification through WBP. However, these two processes are different and as we will show, DEP-μ should be able to differentiate them.

3.2.2 Unattested syllabification contrasts: [ak.la] vs. [a.kla]

The interaction of the ranking (10c & 11c) DEP-μ >> WBP >> *μ/C with other markedness constraints gives rise to unattested syllabification patterns (see Bermúdez-Otero (2001) for a similar observation). To exemplify this problem, consider a language in which coda consonants are moraic. This means that WBP dominates *μ/C. Suppose this language syllabifies biconsonantal clusters as heterosyllabic regardless of their sonority contour. The ranking of the two following markedness constraints predicts this behavior.

- (12) *ComplexOnset (Prince and Smolensky 1993)
The onset comprises no more than one segment.
- (13) CONTACT (Davis & Shin 1999, Venneman 1988)
Given a syllable contact α.β, α must be more sonorous than β

If *ComplexOnset dominates CONTACT, two consonants in an intervocalic cluster will be syllabified as belonging to different syllables, i.e., they will not form a complex onset. So, in our language, the constraint against complex onsets dominates CONTACT. Finally, consider that DEP- μ and WBP dominate *ComplexOnset. Thus, the final constraint ranking for this language is that in (14):

- (14) DEP- μ , WBP >> *ComplexOnset >> CONTACT, * μ /C

Once the relevant ranking has been established, it is important to take into consideration the predictions that this ranking makes for two inputs differing only in the moraic specification of the consonants. Tableau (15) shows the result for a moraic input and tableau (16) the optimal output for a non-moraic input.

- (15)⁵ Interaction of ranking (14) for an input with consonantal moraic specification.

/a^μk^μla^μ/ → [a^μk^μ.la^μ]

/a ^μ k ^μ la ^μ /	DEP- μ	WBP	*ComplexOnset	CONTACT	* μ /C
<p>a. a k.l a</p>		*!		*	
<p>b. a k.l a</p>		*!	*		
<p>c. a k . l a</p>				*	*
<p>d. a k . l a</p>			*!		*
<p>e. a . k l a</p>			*!		

⁵ I follow Hayes (1989) representation of weightless coda consonants as being linked to the mora headed by the vowel in the syllable nucleus.

(16) Interaction of ranking (14) for an input without consonantal moraic specification.

/a^μkla^μ/ → [a^μ.kla^μ]

/a ^μ kla ^μ /	DEP-μ	WBP	*CompleOnset	CONTACT	*μ/C
<p>a. a . k . l a</p>		*!		*	
<p>b. a . k . l a</p>		*!	*		
<p>c. a . k . l a</p>	*!			*	*
<p>d. a . k . l a</p>	*!		*		*
<p>e. a . k l a</p>			*		

The output in tableau (15) is candidate (c). This candidate satisfies all the high ranked constraints unlike other competing candidates that are ruled out by their violation of WBP (a, b) and *ComplexOnset (d, e). On the other hand, in tableau (16) the optimal output is candidate (e). Consequently, the syllabification contrast [ak.la] and [a.kla] is obtained. According to Hayes (1989) this pattern is not attested, i.e., syllabification is not contrastive. Notice that candidate (c) in tableau (16) is ruled out by its violation of DEP-μ due to the insertion of a mora to satisfy WBP. DEP-μ blocks WBP from applying in (16e), so the consonant has to be syllabified as part of the complex onset. If candidate (c) did not violate DEP-μ, it would be the output of this tableau. Consequently, we would not face the problem of the unattested syllabification contrast that the relevant ranking gives rise to.

4. Revised moraic faithfulness constraint

The problems presented above call for a revision of the prosodic faithfulness constraint DEP-μ. The facts suggest that this constraint should not penalize insertion of a mora in

the processes of syllabification of vowels and coda consonants by WBP. On the other hand, DEP- μ should penalize insertion of a mora that leads to lengthening. To bring this idea into the formulation of the prosodic constraint, we make use of the notion of positional μ -licensing (cf. Bermúdez-Otero 2001).

- (17) Positional μ -licensing.
A segment α is positionally μ -licensed by a mora μ iff μ is the only prosodic unit directly dominating α .

Vowels and consonants get linked to a mora due to their position in the syllable, i.e., either the nucleus or the coda. These segments in the nucleus or coda are positionally μ -licensed by a mora. The mora links the segment into the prosodic structure. Note that only one mora is needed to positionally μ -license a segment. If another mora is linked to the segment, lengthening is obtained. This is the case of lengthened vowels, assuming the representation according to which these vowels are linked to two moras. If another prosodic unit is directly linked to the segment, lengthening takes place. Geminate consonants are an example of the latter case, since these consonants are linked to a mora and a syllable node. Therefore, a mora is a positional μ -licenser if it is the only prosodic unit dominating a given segment. This is captured in definitions (18) and (19).

- (18) Positional μ -licenser
Let μ be a mora and α be a segment, μ is a positional μ -licenser of α , iff μ is the only prosodic unit immediately dominating α .
- (19) Non-positional μ -licenser
Let μ be a mora and α be a segment, μ is a non-positional μ -licenser of α , iff μ is not the only prosodic unit immediately dominating α .

This notion is incorporated into the definition of a revised moraic faithfulness constraint (20). The result is that this constraint only penalizes inserted moras that lead to lengthening.

- (20) **P(ositional)-DEP- μ**
A non-positional μ -licenser mora in S_2 has a correspondent in S_1 .

It is worth considering what kind of output representations violate this constraint. Table (21) presents the potential inputs and outputs relevant for our purpose. It illustrates how these outputs are evaluated with respect to DEP- μ . Also the status of the moras as positional μ -licensors is included in the table.

(21) Evaluation of P-DEP- μ .

Input	Output	Positional μ -licenser	P-DEP- μ	
μ_1 a. V C	μ_1 \ / V C.	Yes	✓	(a) non-moraic coda
μ_1 b. V C	$\mu_1 \mu_2$ V C.	Yes	✓	(b) moraic coda
μ_1 c. V	$\mu_1 \mu_2$ / V	No	*	(c) lengthened vowel
d. C	$\mu_1 \sigma$ / C.	No	*	(d) geminated consonant

Output (a) is a non-moraic consonant so no mora is inserted. This means that P-DEP- μ is vacuously satisfied. The output in (b) represents a weight-contributing coda consonant, i.e., a mora is inserted to satisfy WBP. This mora is a positional mora licenser. Therefore P-DEP- μ is satisfied. On the other hand, the mora inserted in output (c), which represents a lengthened vowel, is not a positional μ -licenser since it is not the only prosodic unit dominating the vowel. A second mora is linked to the relevant segment. Consequently, P-DEP- μ is violated by (c). Finally, output (d) shows a geminated consonant linked both to the syllable node and to the inserted mora. Clearly, the latter is not a positional μ -licenser and a violation of P-DEP- μ is obtained.

5. Revised constraint solves previous problems

5.1 Revised constraint and codas contrasting in moraic status

In section 3.1, we saw that traditional DEP- μ predicts that coda consonants may contrast in moraicity within the same language. Remember that this prediction emerges when DEP- μ dominates WBP, so that DEP- μ prevents insertion of mora to satisfy the latter markedness constraint. The following tableaux (22) and (23) consider the interaction of P-DEP- μ and WBP, and also include the behavior of DEP- μ for comparison purposes.

(22) Non-moraic input
/CVC/ → [CVC^μ]

/CVC/	DEP- μ	P-DEP- μ	WBP
a. CVC			*!
☞ b. CVC ^μ	*		

(23) Moraic input
/CVC^μ/ → [CVC^μ]

/CVC ^μ /	DEP- μ	P-DEP- μ	WBP
a. CVC			*!
☞ b. CVC ^μ			

Let's compare how DEP- μ and P-DEP- μ work. For a moraic input, they behave similarly since the mora is already present in the input, i.e., there is no insertion. For a

non-moraic input, they behave differently. Unlike DEP- μ , the revised P-DEP- μ does not penalize insertion of a mora to satisfy WBP. This constraint gets rid of the wrong prediction made by the traditional faithfulness constraint.

5.2 Revised constraint and unattested syllabification patterns

DEP- μ gives rise to unattested syllabification patterns (section 3.2). The problematic ranking from (14) is repeated in (24).

(24) DEP- μ , WBP >> *ComplexOnset >> CONTACT, * μ /C

Tableaux (25) and (26) (comparable with tableaux (15) and (16)) show the interaction of P-DEP- μ with the relevant markedness constraints. A column with traditional DEP- μ is included in order to compare both faithfulness constraints.

(25) Moraic specification for consonant in the input.

/a^μk^μla^μ/ → [a^μk^μ.la^μ]

/a ^μ k ^μ la ^μ /	Traditional DEP- μ	P-DEP- μ	WBP	*Complex Onset	CONTACT	* μ /C
<p>a. a k.l a</p>			*!		*	
<p>b. a k l a</p>			*!	*		
<p>c. a k.l a</p>					*	*
<p>d. a k.l a</p>				*!		*
<p>e. a.k l a</p>				*!		

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(26) Non-moraic specification for coda consonant in the input.

/a^μkla^μ/ → [a^μk^μ.la^μ]

/a ^μ kla ^μ /	Traditional DEP-μ	P-DEP-μ	WBP	*Complex Onset	CONTACT	*μ/C
<p>a. a k.l a</p>			*!		*	
<p>b. a k.l a</p>			*!	*		
<p>c. a k.l a</p>	*				*	*
<p>d. a k.l a</p>	*			*!		*
<p>e. a .k l a</p>				*!		

The output of tableaux (25) and (26) is candidate (c) [ak^μ.la]. The difference between DEP-μ and P-DEP-μ is that the latter does not block insertion of a mora by WBP. Thus, in (26) candidate (c) is the most harmonic and wins over all the other candidates. Consequently, the unattested syllabification contrast is lost.

6. Conclusion

Traditional DEP-μ proves to be problematic in two different aspects. First, it predicts that moraic and non-moraic coda consonants can be contrastive in a language. Second, this faithfulness constraint gives rise to unattested syllabification patterns. The main problem posed by DEP-μ is that it does not distinguish between syllabification of vowels and coda consonants and lengthening processes. In view of this, we propose the revised prosodic faithfulness constraint P-DEP-μ. Its definition is based on the positional μ-licensing character of moras: moras link mora-bearing segments into the prosodic structure. The relevant observation is that only one mora is necessary to achieve this linkage. The

intervention of more prosodic elements leads to lengthening. In these cases, the moras are subject to P-DEP- μ since they are not positional μ -licensors.

This revised approach to moraic faithfulness solves the problems raised by previous accounts. Furthermore, it offers an insight into the dual status of moras, which can be inserted to satisfy structural demands such as WBP or to lengthen a segment. In this spirit, it is relevant to further explore the behavior of moras and its implications for moraic theory. For instance, the possibility of extending the notion of positional μ -licenser to MAX- μ , which bans deletion of moras, should be considered. Moreover, it may prove fruitful to examine the consequences of this approach for Correspondence Theory. Another further development could be the generalization of positional μ -licensing to the idea of prosodic licensing, i.e., a segment must be directly dominated only by one unit of the prosodic hierarchy. Clearly, all these issues deserve further research. Our proposal is just a first excursus in the revision of moraic faithfulness.

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