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Syllable Weight Asymmetries in Distinctive and Coercive Environments

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0. Introduction

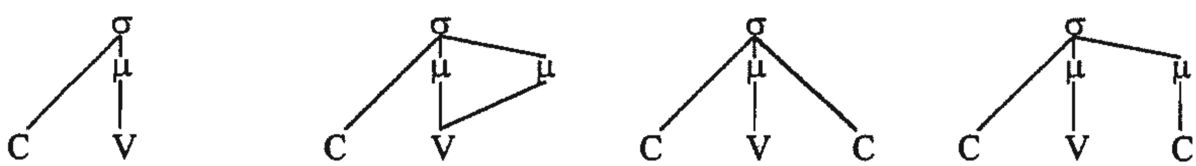
Syllable weight arises from two sources: distinctive weight, which is the result of underlying moraic specifications reflected in a surface contrast (e.g. geminate vs. non-geminate intervocalic consonants); and coerced weight, which is the result of a restriction on surface moraicity (e.g. weight by position, foot binarity, etc.). While the distribution of moraic segments in coerced weight environments is subject to a near-universal restriction based on sonority, the distribution of distinctive weight is subject to phonetically-driven tendencies at odds with a sonority-based approach to weight.

In this paper, I explore the descriptive generalizations regarding these two aspects of syllable weight, and propose an optimality theoretic analysis to account for them.

1. Syllable Representations

Following McCarthy & Prince (1986), the surface representations for syllables of different weights assumed in this paper are given in (1). Syllable weight, as used here, refers to relative moraic content, where light syllables contain a single mora, and heavy syllables contain two moras.

(1) a. Light Open   b. Heavy Open   c. Light Closed[1]   d. Heavy Closed



[1] Leaving aside the possibility of the coda consonant sharing the mora with the vowel (Broselow et al. 1997).

Pius Tamanji, Masako Hirotani, and Nancy Hall (eds.), NELS 29:113-127

2. Description of Two Types of Weight

2.1. Coerced Weight

Restrictions on surface moraicity can be due to a number of factors: the need for prosodic feet to be minimally bimoraic (Foot Binarity), the need for coda consonants to be moraic (Weight by Position), the need for stressed syllables to be bimoraic (Stress to Weight), etc. There are many languages which manifest coerced weight in a variety of environments for consonants, vowels, or both.

1. Languages with coerced consonant weight:

   - Icelandic, Kashmiri - all stressed closed syllables must be heavy (Kristján Árnason 1980, Bhatt 1989, Morén 1997a, 1998a).
   - Italian[2], Japanese, Latin - all closed syllables must be heavy (Zec 1995).
   - Lithuanian, Tiv - all syllables closed by sonorants must be heavy (Zec 1995).
   - Gumbaynggir - all stressed syllables closed by a glide must be heavy (Sherer 1994).

2. Languages with coerced vowel length:

   - Icelandic - all stressed open syllables must have long vowels (Kristján Árnason 1980, Morén & Miglio 1998).
   - Italian - all stressed open penultimate syllables must have long vowels.
   - Hawaiian - all stressed open monosyllables must have long vowels (Senturia 1998).
   - Hungarian - all stressed open monosyllables containing non-low vowels must have long vowels (Nádasdy 1985, Morén 1998b, section 4)

2.1.1. Near-Universal Restriction on Coerced Weight

In her seminal work on the relationship between syllabicity, moraicity and sonority, Zec (1988) argued that segment weight is dependent on the sonority scale (2). Subsequent research has supported this assertion using examples from a variety of languages (Zec 1995, Morén 1996, et seq.).

[2] In Modern Standard Italian, the claim that stressed closed penultimate syllables are heavy is supported by the predictable nature of the main stress system. However, as pointed out by Irene Vogel (p.c.), the weight of pre-penultimate syllables closed by non-geminates is indeterminate due to the lack of diagnostics such as weight dependent secondary stress, etc.

(2) <u>Sonority Scale</u> - (simplified) (Zec 1995:86)
Vowels
Sonorants
Obstruents

However, it must be noted that this relationship does not generalize beyond coerced weight environments (see section 2.2), nor is it absolute (see section 4). The most that can be said about this relationship is that, barring other influences, if a consonant of one sonority is forced to be moraic in some environment, then consonants of equal or higher sonority will also be moraic in that environment. More formally,

(3) if α is moraic under coercion, then β is moraic under coercion if β is more sonorous than α.

As (4) shows, there is a subset relationship between moraicity and sonority, for example, some languages restrict moraic segments to the class of vowels (e.g. Khalkha Mongolian), others allow all sonorants (including vowels) to be moraic (e.g. Tiv), and still others allow all segments to be moraic (e.g. Aklan).

(4)

Sets of Moraic Segments	Languages
Vowels	Khalkha Mongolian, Yidiɲ (Zec 1988)
Vowels + Glides	Gumbaynggir (Sherer 1994)
Vowels + Non-glottal Sonorants	Kwakwala (Zec 1988)
Vowels + Sonorants	Lithuanian, Tiv (Zec 1988, 1995)
All Segments	English[3], Latin, Arabic dialects, Aklan, Koya (Zec 1988, 1995)

Although Zec claims that only stricture features can play a role in determining moraic class behavior within the sonorant and obstruent classes, there is evidence that aspiration and voicing play a role in the moraic hierarchies of some languages. In Icelandic, all segments except the least sonorous (aspirated stops) can be moraic (Morén & Miglio 1998), and in Metropolitan New York English, all segments except the least sonorous (voiceless stops) can be moraic following the low front vowel (Morén 1996, 1997b).

2.2. Distinctive Weight

Distinctive weight is an underlying moraic specification reflected in a surface contrast (e.g. underived geminates). Many languages have distinctive weight for consonants, vowels, or both.

[3] Morén 1996, 1997b claims that in some environments, some consonants are not able to be moraic in English.

1. Languages with distinctive consonant weight:

   - Finnish, Hindi, Ilocano, Italian, Japanese, Kashmiri - intervocalic geminates in contrast with intervocalic onsets.
   - Hungarian, Icelandic - intervocalic and post-vocalic final geminates in contrast with intervocalic onsets and non-moraic single final codas, respectively.

2. Languages with distinctive vowel length:

   - English dialects, Finnish, Hawaiian, Hungarian, Kashmiri - long and short opposition in various environments.

2.2.1. Restrictions on Distinctive Weight

Given the claims of Zec (1988, 1995) regarding segment moraicity in coercive environments, one could hypothesize that distinctive weight would also follow the sonority scale. Predictions of this hypothesis would be:

1. A synchronic tendency in geminate inventories toward higher-sonority geminates, not lower-sonority geminates.

   - According the Jaeger (1978), of the 72 languages with geminates that she surveyed, 9 had only sonorant geminates.

2. A diachronic loss of less-sonorous geminates prior to a loss of more-sonorous geminates.

   - Holt (1997, 1998) claims that there was a progressive loss of geminates in Late Spoken Latin and Proto-Romance that "...mirrors the sonority hierarchy" (Holt 1998:2). First obstruent geminates were lost (proto-Romance), then sonorant geminates were lost (10th-11th c).

However, although there are cases where more-sonorous geminates are preferred to less-sonorous geminates, the overall tendency of geminate patterns is the reverse of that predicted by a sonority-based approach to weight – especially within the obstruent and sonorant classes:

1. There are languages with geminate obstruents, but not geminate sonorants:

   - Japanese, Iraqw, Tarasan, Totonac, Lak, Nez Perce, Ojibwa (Jaeger 1978, Taylor 1985).

2. There are languages with nasal, but not liquid geminates:

    - Educated Colloquial Hungarian (Vago 1992, Morén 1998b), and 16 out of 72 languages with geminates surveyed by Jaeger (1978).

3. There are many languages which prefer less-sonorous obstruent geminates to more-sonorous obstruent geminates:

    - Japanese, Lak, Nez Perce, Ojibwa, Yakut, Totonac, Ocaina have voiceless geminates but no voiced geminates (Jaeger 1978, Taylor 1985).
    - Wolof, Songhai, Finnish, Telugu, Totonac, Ocaina have stop geminates, but not fricative geminates (Jaeger 1978, Taylor 1985).

It should be clear from the above discussion that distinctive weight is subject to non-absolute generalizations not dependent on sonority. Lower-sonority obstruent geminates are preferred to higher-sonority obstruent geminates, lower-sonority sonorant geminates are preferred to higher-sonority sonorant geminates, and these preferences can be violated. The explanation for this preference for certain long consonants over others, as many studies have shown, has to do with the aerodynamic properties of the vocal apparatus (Jaeger 1978, Kirchner 1998, Ohala 1983).

> "...a stop closure of long duration will allow air pressure in the oral cavity enough time to equalize with sub-glottal pressure and cause voicing to stop; this is also true of the narrow constriction for fricatives..." Jaeger 1978; 320.[4]

However, this preference is only a tendency, as it is violated in some languages (see above).

It is clear that the sonority scale (translated into sonority classes) by itself is not adequate to explain geminate inventories. In fact, sonority by itself makes exactly the wrong prediction in a number of cases.

3. Analysis

The following Optimality Theoretic (Prince & Smolensky 1993) analysis not only accounts for the descriptive generalizations regarding vowel and consonant weight in both coercive and distinctive environments, thus unifying weight behavior across segment types, but it also lays the groundwork for analyzing exceptions to Zec's generalization.

[4] See Jaeger (1978), Ohala (1980), or Kirchner (1998) for more details regarding this phonetic motivation toward less-sonorous obstruent geminates.

3.1. Constraints

Three major constraint types will be used in the following analysis: 1) general moraic markedness constraints which are structural markedness constraints against moraic segments, 2) moraic faithfulness constraints which require input and output segments to be associated with the same number of moras, and 3) coercive markedness constraints which require minimal moraicity within a given context.

3.1.1. General Moraic Markedness

The general moraic markedness constraints are simply cooccurrence constraints against moraic segments.

(5) ***MORA[seg]** - Do not associate a mora with a particular type of segment. (Zec 1995, Morén 1996, et seq.)

This family of constraints is universally ranked with respect to some version of the sonority hierarchy, thus capturing Zec's generalization (Zec 1995, Morén 1996, et seq.).

(6) *MORA[stop]>>*MORA[cont]>>*MORA[son]>>*MORA[high]>> ... (simplified)

3.1.2. Moraic Faithfulness

The moraic faithfulness constraints are of the McCarthy and Prince (1995) identity type, however, they differ in two important respects. First, they specify a relationship between segments and moras, not segments and features. Second, they allow for the specification of segment type, whereas the McCarthy and Prince constraints do not[5].

(7) **IDENTITYMORA[seg]**[6] – Let α be a segment in S_1 and β be any correspondent of α in S_2. If α is associated with n moras, then β is associated with n moras, and vice versa. "Correspondent segments are associated with the identical number of moras." (Morén 1996, et seq.)

This family of constraints is not in a fixed ranking.

(8) IDMORA[stop], IDMORA[cont], IDMORA[son], IDMORA[high], etc.

3.1.3 Coercive Markedness

A variety of constraints force segments to have a minimal moraic content in some environment, for example:

[5] See Pater (1996) for an example of featural identity constraints that refer to different segment types.
[6] Morén (1997a) and Morén & Miglio (1998) show evidence from Icelandic that the Identity family must be divided into two families - IDENTITY_{IO}[seg] (Max-like) which penalizes the deletion of underlying moraic associations, and IDENTITY_{OI}[seg] (Dep-like) which penalizes the addition of moraic associations.

(9) **FOOTBINARITY** – Prosodic feet must be binary under syllabic or moraic analysis (McCarthy & Prince 1993)

(10) **WEIGHTBYPOSITION** – Coda consonants must surface as moraic (based on Hayes 1989).

(11) **STRESSTOWEIGHT** – Prominent syllables must be heavy – i.e. "stressed syllables must be heavy" (based on Prince 1990).

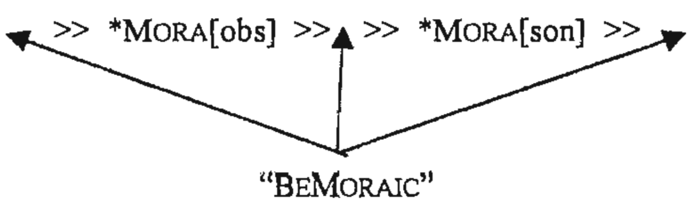
For ease of exposition, the following constraint will be used in the tableaux below to represent a generic coercive markedness constraints.

(12) **"BEMORAIC"** - shorthand for any constraint which forces moraicity.

3.2. Weight in Coercive Environments

Ranking the "BeMoraic" type of constraint relative to the universal markedness hierarchy yields Zec's generalization. This generalization is near-universal[7].

(13)



The factorial ranking of these constraints, respecting the universal markedness hierarchy, is[8]:

(14)
a. *MORA[obs] >> *MORA[son] >> "BEMORAIC"
b. *MORA[obs] >> "BEMORAIC" >> *MORA[son]
c. "BEMORAIC" >> *MORA[obs] >> *MORA[son]

With "BEMORAIC" ranked below all general consonant moraic markedness constraints, there are no coerced weight consonants (e.g. Khalkha Mongolian).

[7] Without interactions with moraic faithfulness constraints, this pattern would be universal (see section 4).

[8] This is obviously a much simplified typology, but sufficient to demonstrate the common obstruent/sonorant dichotomy. A more fine-grained hierarchy would include all aspects of sonority.

(15) *MORA[obs] >> *MORA[son] >> "BEMORAIC"

/CV$^{\mu}$O/	*MORA[obs]	*MORA[son]	"BEMORAIC"
a. ☞ CV$^{\mu}$O			*
b. CV$^{\mu}$O$^{\mu}$	*!		

/CV$^{\mu}$S/			
a. ☞ CV$^{\mu}$S			*
b. CV$^{\mu}$S$^{\mu}$		*!	

With "BEMORAIC" ranked above the constraint against moraic sonorants, but below the constraint against moraic obstruents, only sonorants have coerced weight (e.g. Lithuanian, Tiv).

(16) *MORA[obs] >> "BEMORAIC" >>*MORA[son]

/CV$^{\mu}$O/	*MORA[obs]	"BeMoraic"	*MORA[son]
a. ☞ CV$^{\mu}$O		*	
b. CV$^{\mu}$O$^{\mu}$	*!		

/CV$^{\mu}$S/			
a. CV$^{\mu}$S		*!	
b. ☞ CV$^{\mu}$S$^{\mu}$			*

With "BEMORAIC" ranked above all the general consonant moraic markedness constraints, all consonants have coerced weight (e.g. Icelandic, Italian, Kashmiri).

(17) " BEMORAIC" >> *MORA[obs] >> *MORA[son]

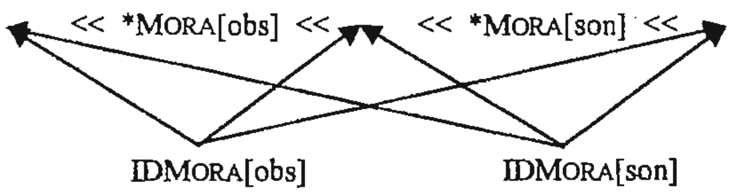
/CV$^{\mu}$O/	" BEMORAIC"	*MORA[obs]	*MORA[son]
a. CV$^{\mu}$O	*!		
b. ☞ CV$^{\mu}$O$^{\mu}$		*	

/CV$^{\mu}$S/			
a. CV$^{\mu}$S	*!		
b. ☞ CV$^{\mu}$S$^{\mu}$			*

3.3. Distinctive Weight

Distinctive weight is the result of ranking the faithfulness constraint on underlying moraic content of a particular segment type above the markedness constraint against the association of a mora with that segment type. Factorial reranking of the faithfulness constraints with respect to each other and the universal markedness hierarchy (simplified) is given in (19) through (22). The hierarchies shown in bold will be evaluated in the following tableaux.

(18)



(19) a. ***MORA[obs] >> *MORA[son] >> IDMORA[son] >> IDMORA[obs]**
b. *MORA[obs] >> *MORA[son] >> IDMORA[obs] >> IDMORA[son]
c. *MORA[obs] >> IDMORA[obs] >> *MORA[son] >> IDMORA[son]

(20) a. ***MORA[obs] >> IDMORA[son] >> *MORA[son] >> IDMORA[obs]**
b. *MORA[obs] >> IDMORA[son] >> IDMORA[obs] >> *MORA[son]
c. *MORA[obs] >> IDMORA[obs] >> IDMORA[son] >> *MORA[son]
d. IDMORA[son] >> *MORA[obs] >> *MORA[son] >> IDMORA[obs]
e. IDMORA[son] >> *MORA[obs] >> IDMORA[obs] >> *MORA[son]

(21) a. **IDMORA[obs] >> *MORA[obs] >> *MORA[son] >> IDMORA[son]**[9]

(22) a. **IDMORA[son] >> IDMORA[obs] >> *MORA[obs] >> *MORA[son]**
b. IDMORA[obs] >> IDMORA[son] >> *MORA[obs] >> *MORA[son]
c. IDMORA[obs] >> *MORA[obs] >> IDMORA[son] >> *MORA[son]

With the rankings in (19), no consonants have a weight distinction. Underlyingly moraic consonants neutralize to nonmoraic.

(23) *MORA[obs] >> * MORA[son] >> IDMORA[obs] >> IDMORA [son]
(19a)

/$CV^{\mu}O^{\mu}$/	*MORA[obs]	*MORA[son]	IDMORA[obs]	IDMORA[son]
a. ☞ $CV^{\mu}O$			*	
b. $CV^{\mu}O^{\mu}$	*!			

/$CV^{\mu}S^{\mu}$/				
a. ☞ $CV^{\mu}S$				*
b. $CV^{\mu}S^{\mu}$		*!		

With the rankings in (20), only sonorants have a weight distinction.

[9] It may be that languages of this type are so rare because there is only one out of the twelve constraint rankings that will result in such a language.

(24) *MORA[obs] >> IDMORA[son] >> * MORA[son] >> IDMORA[obs] (20a)

	$/CV^{\mu}O^{\mu}/$	*MORA[obs]	IDMORA[son]	*MORA[son]	IDMORA[obs]
a. ☞	$CV^{\mu}O$				*
b.	$CV^{\mu}O^{\mu}$	*!			

	$/CV^{\mu}S^{\mu}/$				
a.	$CV^{\mu}S$		*!		
b. ☞	$CV^{\mu}S^{\mu}$			*	

With the ranking in (21), only obstruents have distinctive weight. Note that this system violates the prediction that a moraic segment of one sonority implies a moraic segment of higher sonority in the same environment.

(25) IDMORA[obs] >> *MORA[obs] >> * MORA [son] >> IDMORA[son] (21a)

	$/CV^{\mu}O^{\mu}/$	IDMORA[obs]	*MORA[obs]	*MORA[son]	IDMORA[son]
a.	$CV^{\mu}O$	*!			
b. ☞	$CV^{\mu}O^{\mu}$		*		

	$/CV^{\mu}S^{\mu}/$				
a. ☞	$CV^{\mu}S$				*
b.	$CV^{\mu}S^{\mu}$			*!	

With the rankings in (22), both obstruents and sonorants have distinctive weight.

(26) IDMORA[son] >> IDMORA[obs] >> *MORA[obs] >> * MORA[son] (22a)

	$/CV^{\mu}O^{\mu}/$	IDMORA[son]	IDMORA[obs]	*MORA[obs]	*MORA[son]
a.	$CV^{\mu}O$		*!		
b. ☞	$CV^{\mu}O^{\mu}$			*	

	$/CV^{\mu}S^{\mu}/$				
a.	$CV^{\mu}S$	*!			
b. ☞	$CV^{\mu}S^{\mu}$				*

4. Interactions: Coerced and Distinctive Weight

In the absence of a direct competition between moraic faithfulness and coercive moraic markedness ("BeMoraic"-type constraint), Zec's generalization holds and there is an absolute correlation between sonority classes and moraicity. However, since faithfulness constraints are unrestricted in their ranking, it is conceivable to have faithfulness to the moraicity of a lower-sonority segment outranking the "BeMoraic"-type constraint to yield a violation of Zec's generalization. An example of this interaction is seen in Hungarian.

4.1. Hungarian Distinctive Length

In Hungarian, all vowels have distinctive length, as seen in (27).[10] However, there are several environments in which vowels of different qualities neutralize to either long or short depending on both the vowel and the environment (Nádasdy 1985, Morén 1998b). One such neutralization is discussed and analyzed below, and demonstrates a violation of Zec's generalization.

(27) Phonological Length Grouping of Hungarian Vowels

	Front		Back
High	i:/i	ü:/ ü	u:/u
Mid		ö:/œ	o:/ɔ
Low	e:/ɛ		a:/ɑ

Distinctive length results from ranking the vowel length faithfulness constraints above the moraic markedness constraints for the different vowel types. The rankings needed for Hungarian are given in (28), and (29) shows how these rankings are evaluated for high and low vowels.

(28) a. IDMORA[high] >> *MORA[high]
b. IDMORA[mid] >> *MORA[mid]
c. IDMORA[low] >> *MORA[low]

(29)

	/Ci$^{\mu\mu}$C/	IDMORA[high]	*MORA[high]
a.	Ci$^{\mu}$C	*!	*
b. ☞	Ci$^{\mu\mu}$C		**

	/Ca$^{\mu\mu}$C/	IDMORA[low]	*MORA[low]
a.	Cɑ$^{\mu}$C	*!	*
b. ☞	Ca$^{\mu\mu}$C		**

4.2. Hungarian Length Neutralization (Coerced Length)

In open monosyllables, low vowels display distinctive length (30a), but high vowels lengthen (30b).

[10] The pairing of long and short vowels is supported by morphologically conditioned alternations. The somewhat unconventional classification of [e:] and [ɛ] as low vowels is well-supported by the phonological patterns of the language. However, given the proper combination of features and constraints, this classification may not be necessary.

(30)	a.	[fa:]	'FA in music'	[fɑ]	'tree'
		[le:]	'juice'	[lɛ]	'down'
	b.	[bu:]	'melancholy'	*[bu]	
		[fü:]	'grass'	*[fü]	
		[fi:]	'phi'	*[fi]	

This high vowel neutralization results from the constraint requiring that phonological feet be minimally bimoraic (FOOTBINARITY) ranked above the high vowel length faithfulness constraint.

(31)

/bu$^{\mu}$/	FTBIN	IDMORA[high]
a. bu$^{\mu}$	*!	
b. ☞ bu$^{\mu\mu}$		*

Distinctive length for low vowels in this environment results from the low vowel length faithfulness constraint ranked above the constraint requiring foot binarity.

(32)

/fɑ$^{\mu}$/	IDMORA[low]	FTBIN
a. ☞ fɑ$^{\mu}$		*
b. fa$^{\mu\mu}$	*!	

Keeping in mind the universal markedness hierarchy, the resulting constraint ranking is:

(33) IDMORA[low] >> FTBIN >> IDMORA[high] >> *MORA[high] >> *MORA[low]

Since low vowels are more sonorous than high vowels (Selkirk 1984), markedness against moraic low vowels must be lower than markedness against moraic high vowels. Without re-rankable faithfulness constraints, all vowels would neutralize to long in open monosyllables because of this universal ranking and the fact that FTBIN forces high vowels to lengthen, as seen in (34). This yields the wrong result.

(34)

/bu$^{\mu}$/	FTBIN	*MORA[high]	*MORA[low]
a. bu$^{\mu}$	*!	*	
b. ☞ bu$^{\mu\mu}$		**	

/fɑ$^{\mu}$/			
a. ← fɑ$^{\mu}$	*!		*
b. ☛ fa$^{\mu\mu}$			**

However, as (35) shows, with re-rankable faithfulness constraints, a system like that of Hungarian can emerge.

(35)

	/bu$^\mu$/	IDMORA[low]	FTBIN	IDMORA[high]	*MORA [high]	*MORA [low]
a.	bu$^\mu$		*!		*	
b. ☞	bu$^{\mu\mu}$			*	**	

	/fa$^\mu$/					
a. ☞	fa$^\mu$		*			*
b.	fa$^{\mu\mu}$	*!				**

To summarize, the universal markedness hierarchy predicts that low vowels are more susceptible to lengthening processes than high vowels[11]. However, freely re-rankable faithfulness constraints can cause a violation of this prediction.

5. Conclusion

This paper shows that there are two types of weight – coerced and distinctive. Further, these two types of weight have quite different distributions by virtue of the nature of the constraints relevant to them and the interaction of these constraints with respect to each other.

Coerced weight by itself is strictly dependent on the sonority of the segment. This is due to the interaction of constraints forcing minimal moraicity with a universally ranked moraic markedness hierarchy.

Distinctive weight by itself has a fairly free distribution. This is due to the faithfulness constraints on underlying moraicity being freely re-rankable with respect to each other and the universal markedness hierarchy.

Evidence was given that an interaction of constraints on coerced weight and distinctive weight can conspire to violate the prediction made by Zec that if a segment of one sonority is forced to be moraic in some environment, then a more sonorous segment is necessarily moraic in that environment.

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[11] As is the case for low back vowel lengthening in American English dialects (Morén 1996, 1997b).

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