The Prosodic Conspiracy of English CiV Tensing*

Jae-Young Lee

I claim that conditions on syllable and foot structure conspire to induce a complex chain reaction between the three vowels in the VCiV environment. I propose a principled analysis of CiV Tensing, adopting the constraint-based model of Optimality Theory framework (Prince and Smolensky 1993), in which tensing results from the interaction between the Onset constraint and the Foot-Form constraint.

The underlying representation VCiV presents vowel hiatus, which is prohibited in the surface representation of English level 1 phonology. The Onset constraint is satisfied in surface form by the insertion of a consonantal position, which is filled by spreading of the /i/ melodeme, yielding V.Ci. $\boxed{\text{y}}$ V. This structure incurs fewer violations of Dep than a competing candidate with full C epenthesis; V.Ci. $\boxed{\text{C}}$ V.

Glide formation, which recruits /i/ into Onset position, confers the feature [Tense] to the melodeme /i/, and that the [Tense] feature is realized in both the nucleus and onset positions which /i/ occupies.

The realization of tense nuclear /i/ has immediate consequences for foot structure. The optimal parse of $\cdots \sigma_\mu \sigma_\mu \sigma_\mu \#$ in English is $(\sigma_\mu \sigma_\mu)\sigma_\mu \#$, as in *(cá.me.)ra.* But in the CiV tensing examples, that parse would yield the unbalanced trochee, (…V. Ci), in which the strong syllable contains a lax vowel nucleus and the weak syllable contains a tense vowel nucleus. The unbalanced foot is resolved by increasing the prominence of the foot head in (V. Ci). Thus, CiV Tensing involves the insertion of [Tense] on the stressed syllable, and the consequent lengthening of that vowel, in order to maintain the prominence profile of the optimal trochee, HL.

The implications of the proposed account are (i) that an apparently English-specific phenomenon turns out to be explainable in terms of universal well-formedness constraints, (ii) that the feature [Tense] affects syllable prominence, and (iii) that OT is suitable for the account of a complex chain reaction initiated by phonological conspiracy.

* I am grateful to Jennifer Cole, José Hualde, Charles Kisseberth, and two anonymous Language Research readers for their comments and suggestions on earlier drafts of this paper. I alone am responsible for any errors found herein.

1. Introduction

This paper examines vowel alternations in such pairs as *Cănada ~ Canādian, rĕmedy ~ remēdial, and hărmony ~ harmōnious.* Lax vowels occur in unstressed position followed by a CV syllable while tense vowels appear in stressed position followed by a CiV sequence. This alternation between tense and lax vowels is governed by a rule of CiV Tensing, according to SPE, Rubach (1984) and Halle and Mohanan (1985).

I argue that conditions on syllable and foot structure conspire to induce a complex chain reaction between the three vowels in the VCiV environment. I propose a principled analysis of CiV Tensing within the framework of Optimality Theory put forth by Prince and Smolensky (1993) and McCarthy and Prince (1993a, b).

Previous rule-based analyses of CiV Tensing in SPE, Rubach (1984) and Halle and Mohanan (1985) do not capture the interaction of syllable and metrical structures in the effects of CiV Tensing and do not explain why the CiV sequence conditions the tensing of the preceding vowel. Burzio's (1994) metrical analysis, discussed in section 5.2, is drastically different from the account proposed here.

This paper is organized into six sections including section 1. Section 2 reviews the framework of Optimality Theory (OT) adopted here and discusses several preliminary assumptions made in this paper. In section 3, I examine the conditions of the trigger and target of CiV Tensing. Section 4 contains the proposed account of CiV Tensing. I propose that CiV Tensing is explained in terms of universal well-formedness constraints concerning prosodic structure. In section 5, I address problems in previous analyses of CiV Tensing. Section 6 contains a summary and conclusion of this paper.

2. Theoretical Assumptions

I shall assume the theory of OT in which the input-output relation is governed by well-formedness constraints. In OT an input is matched with its corresponding output via two functions, Gen(erator) and Eval(uation). The function Gen constructs a set of potential surface forms (called output candidates) for a given input. Among the set of output candidates, the surface form (an optimal output) is determined by the function Eval, which imposes a language-specific ranking on a set of well-formedness constraints. The function Eval sifts through the set of output candidates, discarding all but one, which is an optimal output for its corresponding input. By definition, an optimal output best satisfies the constraint system with respect to other potential surface forms. In OT, Gen, the evaluation procedure, and the set of constraints are a fixed part of Universal Grammar.

OT shifts the focus of phonological theory from derivational operations to well-formedness constraints. The constraints are assumed to have two characteristics: ranking and violability. Conflicting constraints are resolved by ranking constraints in a strict dominance hierarchy. A highly ranked constraint has absolute priority over a constraint ranked lower in the dominance hierarchy. The lowly ranked constraint can be violated as far as an optimal candidate satisfies the highly ranked constraint and other candidates violate it. OT assumes two more important principles: inclusiveness and parallelism. The principle of inclusiveness requires that Gen construct a set of potential surface forms that includes results of all possible repairs. Parallelism forces all candidates to be simultaneously evaluated with respect to the complete hierarchy of ranked constraints.

There are two versions of OT. One is the "Containment" version of OT (Prince and Smolensky 1993, McCarthy and Prince 1993a, b), and the other one is the "Correspondence" version of OT (McCarthy and Prince 1995). One of the major difference between them centers around the view on the concept of faithfulness. In Containment Theory, no element can be literally removed from the input, and thus the input must be contained in every output candidate. In Correspondence Theory, underlying elements do not have to be contained in output candidates. For example, deleted elements are literally removed from output candidates. The concept of correspondence, which applies to the relation in reduplication between the base and the reduplicant, extends to the input-output relation. The analysis of English CiV Tensing proposed here adopts without explicit discussion faithfulness constraints advanced in Correspondence Theory. I refer the reader to McCarthy and Prince (1995), which presents arguments for Correspondence Theory over Containment Theory.

I shall also assume that the feature [Tense] is distinctive and privative in English phonology. In English tenseness carries greater contrastive weight in identifying vowel opposition than length does. For example, let us consider the minimal pair *beat* and *bead.* Both vowels in the pair are tense and high, so they can be phonologically treated as identical. The words *beat* and *bead* form a minimal pair because of a contrast of final consonant voicing, not because of the vowel contrast. On the other hand, if we rely on the feature [long], we will have difficulty treating the vowels in *beat* and *bead* as constituting a natural class because the high vowel in *beat* is only half as long as the vowel in *bead* (Gimson 1980). The vowel length of *beat* is approximately equal to that of *bid* (Gimson 1980). The criterion of length would incorrectly predict that the vowels in *beat* and *bead* are contrastive while the vowels in *beat* and *bid* are non-contrastive. The criterion of tenseness, however, correctly predicts that both vowels in *beat* and *bead* are non-contrastive, while the vowels in *beat* and *bid* are contrastive.

I make two more assumptions concerning the feature [Tense]. I assume, following Halle (1977), Wood (1975), Jakobson and Halle (1956) and Bell (1867), that [Tense] has an inherent property of tongue body raising. This assumption is made based on the claim that [Tense] is a realization of narrow constriction of the vocal tract. I also assume, following Lass (1976), that post-nucleus glides are a realization of [Tense] sponsored by the nucleus. It thus follows that diphthongization is a natural consequence of the realization of tense vowels.

Let us now consider conditions on English CiV Tensing.

3. Conditions on the Trigger and Target of CiV Tensing

CiV Tensing refers to the phenomenon in which underlying lax vowels are realized as tense vowels before the CiV sequence, as seen in (1) below. The suffixed forms show the effects of CiV Tensing. For example, the underlying lax vowel /æ/ in *Cana̱da* surfaces as [ey] in *Caná̱dian,* /e/ in *reme̱dy* as [iy] in *remḗdial,* and /ɒ/ in *harmo̱ny* as [ow] in *harmó̱nious.*[1] The target vowels are taken to be underlyingly lax since they do not attract stress to the penult position of unsuffixed nouns, i.e., *Caná̱da, *remḗ̱dy,

[1] The penultimate vowels of unsuffixed forms surface as schwa in unstressed positions. When tensing occurs in suffixed forms, underlying low vowels shift to mid vowels and underlying mid vowels to high vowels. The height alternation between tense and lax vowels is covered by Modern English Vowel Shift. An analysis of English Vowel Shift is beyond the scope of this paper.

and *harmóny. If the target vowels were underlyingly tense, they would be predicted to bear stress in unsuffixed forms, since the stress pattern of nouns places stress on a penult containing a tense vowel.

(1)	/æ/	/e/	/ɒ/
	Canada~Canadian	remedy~remedial	harmony~harmonious
	Jordan~Jordanian	comedy~comedian	colony~colonial
	Arab~Arabian	college~collegian	Baylon~Babylonia
	regal~regalia	funeral~funereal	Mongol~Mongolian
	courage~courageous	manager~managerial	custody~custodial

Based on the observation of the data in (1), we can find three major conditions on the target and trigger of CiV Tensing. First, stress affects CiV Tensing, as shown in (2), where target vowels are in boldface. The examples in the left column show that the target vowel is stressed and thus tensed. However, the examples in the right column show that the target vowel of CiV Tensing is not stressed and remains lax.

(2)	a. simultán/i + ous/	vs.	simultan/í + ity/
	b. contemporán/i + ous/	vs.	contemporan/í + ity/
	c. notór/i + ous/	vs.	notor/í + Vty/

Second, the conditioning environment of CiV Tensing excludes CCiV, as seen in (3). The period marks a syllable boundary. The left column of (3) shows the environment of CiV, with forms that undergo CiV Tensing. However, the right column of (3) shows the environment of CCiV, with forms that does not undergo CiV Tensing.

(3)	a. re.g[éy].li.a; Mong[ów].li.a	vs.	Fin.l[ǽ]n.di.a
	b. co.m[íy].di.an	vs.	com.p[é]n.di.ous

In metrical terms, the structure V′ Ci of V′ CiV forms a single binary, trochaic foot, with the left member of the foot showing the effects of Tensing. However, the structure V′ CCiV forms a single foot with left member as a closed heavy syllable. The CC clusters of VCCiV in (3) do not define legitimate onset clusters and thus the VC_1C_2 iV structure is syllabified as VC_1. C_2 i.V. Thus, the closed heavy VC_1 syllable has no need to have a tense vowel: *Fin(léyn. di)a and *com(píyn. di)ous. A formal analysis is proposed in section 4, by appealing to constraints like WSP, Ft-Bin, and TTW (Tense-to-Weight).

Third, the vowel sequence i. V in V. C i. V plays an important role in the occurrence of CiV Tensing, as seen in (4). CiV Tensing occurs in the left column where the triggering environment has the vowel sequence. However, in the right column with no vowel sequence, CiV Tensing does not occur. The examples in (4) suggest that CiV Tensing is related to Prevocalic Tensing. If there is Prevocalic Tensing, CiV Tensing occurs; if there is no Prevocalic Tensing, then CiV Tensing does not occur.

(4)	Caná.di.an	vs.	Amé.ri.can
	rá.di.al	vs.	rá.di.cal
	ingrá.ti.ation	vs.	ingrá.ti.tude
	á.mi.able	vs.	á.mi.cable

I propose that CiV Tensing is a consequence of Prevocalic Tensing as it applies to the iV vowel sequence that forms the context for CiV Tensing. Prevocalic Tensing is an independently motivated phenomenon in English phonology. This phenomenon is covered by the Prevocalic Tensing rule (5), which tenses the first vowel in a VV sequence.

(5) Prevocalic Tensing (SPE:52)

$$V \longrightarrow [+\text{tense}] \,/\, \underline{\quad\quad} \; V$$

The examples of Prevocalic Tensing are given in (6). Examples in (6a) show Prevocalic Tensing in stressed position, and examples in (6b) show Prevocalic Tensing in unstressed position. As also pointed out by Hayes (1995), if the preceding vowel of the VV sequence were lax, then it would be pronounced as schwa in unstressed position.

(6) a. VV in stressed position

i. algebráic, altáic, archáic, choleráic, gáiety, mosáic

ii. contemporanéity, simultanéity

iii. muséum, bóa, pháeton, Danáides

b. VV in unstressed position

Whíttier, Grópius (taken from Hayes 1995:14)

simultáneous, contemporáneous

As discussed below, I derive the effects of Prevocalic Tensing from the Onset constraint, which prohibits VV hiatus. In the case of an iV sequence, hiatus is resolved by recruiting /i/ as the onset of the following syllable, while maintaining its position as nucleus of the preceding syllable as well. The surface representation is …i. yV. The tensing of /i/ derives from the tense, raised properties it must have to function as an onset.

High vowels are systematic exceptions to CiV Tensing, as illustrated in *trivial* (see also Burzio 1994, where high vowels are put aside as exceptions). The underlying high lax vowel /i/ does not surface as a tense vowel in the VCiV environment, even though [+high] and [Tense] go well together or the underlying lax high vowel /i/ can surface as [ɑy] through CiV Tensing and English Vowel Shift.

Words like *companion, Spaniard, spaniel,* and *battalion* also seem to be exceptions to CiV Tensing. However, as pointed out by Jespersen (1909), they are not exceptions to CiV Tensing. They do not undergo CiV Tensing because they do not meet the conditions of CiV Tensing. The suffixes of such words contain the underlying form /yVC/, not /iVC/. The suffixes do not consist of two heterosyllabic vowels. Historically speaking, the orthographic forms *-ni-* and *-li-* in *companion, Spaniard, spaniel,* and *battalion* represent Old French palatal *n* and *l*, i.e., [ɲ] and [ʎ], respectively; they do not represent a CV structure. On the other hand, Rubach (1984) restricts the context vowel of CiV Tensing to low vowels in order to exclude the suffix *-ion* from the context of CiV Tensing (Rubach does not discuss cases like *Spaniard,* and *spaniel*). Rubach takes /yon/ as the underlying form of *-ion*. However, there is no evidence that the suffix *-ion* has an underlying mid vowel. The vowel of the suffix always surfaces as schwa without showing alternation.

There are several words which satisfy the conditions of CiV Tensing and yet do not undergo CiV Tensing, as seen in (7). The antepenult of the words in (7) is not tense even though it is a nonhigh vowel in stressed position followed by a CiV sequence.

(7) Italian, Maxwellian, rebellious

There are three possible ways to deal with those words. The first option is to regard such words as exceptions to CiV Tensing. This option is taken by Rubach (1984) and Halle and Mohanan (1985). I go with this exception analysis since the number of exceptions are limited and two other alternatives to be discussed have problems.

One of the alternatives is to posit that they have a geminate consonant /l/ and thus do not meet the conditions of CiV Tensing. Under this geminate analysis, words like *Italian, Maxwellian,* and *rebellious* are not exceptional. This analysis is proposed by SPE. However, the geminate analysis faces a problem regarding the status of geminate consonants in English phonology. It is widely observed that geminate consonants are not allowed in English monomorphemic surface forms (Borowsky 1986 and Myers 1987). If geminates are posited in underlying representation, they must be deleted by a rule of absolute neutralization. Kiparsky (1973) argues that neutralization rules should be blocked from applying in non-derived environments. Thus, the proposed underlying geminate /l/ in *Italy,* and *Maxwell,* and *rebel* can not be deleted in non-derived contexts and thus should surface as a geminate [l].

The other alternative would be to postulate that the suffixes like *-ian* and *-ion* have the underlying representation of /yVC/. The glide /y/ becomes the syllabic [i] after CiV Tensing. Under this analysis, the suffixes *-ian* and *-ion* have allomorphs like /-ian/ vs. /yan/, and /iVn/ vs. /yVn/. This allomorph analysis has the burden of justifying why a lot of allomorphs are needed just to account for a few exceptional words. Note that the change from /y/ to [i] would be lexically restricted, and so this analysis also marks the exceptionality through lexical information.

To summarize this section, CiV Tensing is related to foot structure, as seen in examples (2 and 3), and is also related to Prevocalic Tensing, as evidenced in (4). I claim that the effects of CiV result from conditions on syllable and foot structure.

4. The Proposed Prosodic Account of CiV Tensing

As discussed above, a vowel undergoes CiV Tensing when it occurs in foot-head position and the non-head vowel immediately precedes an onsetless syllable. CiV Tensing, thus, can be accounted for in terms of syllable structure and foot structure. Specifically, the effects of CiV Tensing derive from the interaction between the Onset constraint and the Foot-Form constraint.

This analysis relies on the following, minimal assumptions regarding syllable and foot structure: Syllable weight is determined on the basis of rhyme structure alone. In English, a coda consonant is moraic, as is the nucleus of the syllable; Following Prince and Smolensky (1993), McCarthy and Prince (1993a, b) and Hayes (1995), feet are binary, counting moras or syllables.

I want to begin by considering the role of the Onset condition in CiV Tensing. As an example, I take the word *harmón[iyə]s* with the underlying form /harmoni + Vs/.[2] The underlying CiV sequence presents vowel hiatus, yielding an onsetless syllable. Vowel hiatus and onsetless syllables are prohibited in the surface structure in English level 1 phonology:

(8) * har. mo. ni. Vs (CV. VC)

There are two possible ways to rule out the VV sequence. One possibility is to insert a consonantal position between the VV sequence, as in (9) where an onsetless syllable and vowel hiatus are avoided.

(9) har. mo. ni. yVs (CV. GVC)

The other possibility is to delete one of the VV sequence, as in (10a, b).[3] Both (10a) and (10b) avoid an onsetless syllable and vowel hiatus. However, (10a, b) show the change from two syllables to one syllable.

(10) a. har. mo. n<i>Vs (CVC)
b. har. mo. ni<V>s (CVC)

Both possibilities in (9) and (10) violate faithfulness to the underlying representation. The first possibility in (9) violates the ban on epenthesis. The second possibility in (10a, b) violates the ban on deletion. So, the relevant constraints concerning these two options are Onset, Max, and Dep. The Max constraint family has a general schema stating that "every segment of S1 has a correspondent in S2" (McCarthy and Prince 1995). This constraint family corresponds to the Parse constraint family in the "Contain-

[2] I assume that the underlying form of the suffix initial vowel is just a lax vowel without being specified for features, since it is always pronounced as schwa in surface and it shows no alternation. Thus, there is no basis for postulating that the underlying form of the suffix is specified for the quality of the vowel, say, the mid back lax vowel /o/.

[3] I use the angled bracket "< >" to represent deletion and the square symbol "□" for insertion in this paper, for the convenience of presentation, even though I adopt faithfulness constraints advanced in Correspondence Theory.

ment" version of OT. The Dep constraint family states that "every segment of S2 has a correspondent in S1" (McCarthy and Prince 1995). The Dep constraint family bans epenthesis, which is expressed as the Fill constraint family in the Containment version. The relevant constraints are summarized in (11).

(11) a. Onset: Syllables have onsets.
b. Max: Underlying elements must be preserved.
c. Dep: No elements are inserted.

In order to select one of the two possible ways to rule out the VV sequence, there must be a ranking among the three constraints. If we assume that Onset and Max(V) dominate Dep, then we can select candidate (12a) as the winner. The symbol "☞" in tableau (12) indicates an optimal output. The mark "*" indicates a violation of the constraint under consideration. The solid line signifies the ranking between constraints. The dotted line is used between columns when two constraints are not ranked with respect to each other. The shaded cells mean that they do not play a role in the decision. The winner (12a) is the anticipated surface form. Other candidates in tableau (12) violate either Onset or Max(V). Thus, the dominance of Onset and Max(V) over Dep is motivated. The winner (12a) corresponds to the insertion option. The losers (12b, c) correspond to the deletion option. Candidate (12d) is the most faithful to underlying material, violating the Onset constraint.

(12) Onset, Max(V) > > Dep

Candidates harmoni+ous	Onset	Max(V)	Dep
☞ a. har. mo. ni. $\boxed{y}$ ous			*
b. har. mo. n<i>. ous		*!	
c. har. mo. ni. <ou>s		*!	
d. har. mo. ni. ous	*!		

As shown in (12a), the Onset constraint is satisfied in surface form by the insertion of a consonantal position. This position is filled in by the glide [y]. I claim that this type of glide formation yields a minimal Dep violation. Since the melodeme /i/ in the <u>iV</u> sequence has features that can appear in onset position, it is recruited as an onset, while simultaneously maintaining its nucleus status of the preceding syllable. In other words, the inserted consonantal position is filled by spreading the melodeme /i/, yielding the glide [y] in onset position. Thus, the nucleus and glide share all features with one another. This structure with the glide [y] incurs fewer violations of Dep than a competing candidate with full C epenthesis, as seen in (13). Recruiting /i/ into onset position provides an efficient means of satisfying Onset.

(13) Minimal Violation of Dep

Candidates	Onset	Max(V)	Dep(F)
☞ a. har. mo. ni. $\boxed{y}$ ous			
b. har. mo. ni. $\boxed{C}$ ous			*!

Similar patterns of glide formation are widely observed across languages. An example of this pattern is attested in the Malay/Indonesian language, as in (14) below. The palatality of the glide is determined by the preceding vowel in the VV sequence. If the preceding vowel is front, then the glide is [y]. If the preceding vowel is back, then the glide is [w].

(14) Malay/Indonesian (data from McCarthy and Prince 1993b:48)

/diam/	di.yam	'quiet'
/buah/	bu.wah	'fruit'
/uji-an/	uji.yan	'test'
/bantu-an/	bantu.wan	'aid, relief'

Glide formation has additional consequences in English. Glide formation can be viewed as the ultimate source of tensing in the VCiV input environment. As represented in (15), I claim that glide formation confers the feature [Tense] to the melodeme /i/, and thus the [Tense] feature is realized in both the nucleus and onset positions. This claim follows from the assumption that post-nucleus glides are a realization of [Tense] sponsored by a nucleus.

(15)

$\boxed{\text{Tense}}$

har. mo. ni. $\boxed{y}$ ous

The realization of the [Tense] feature in the nucleus /i/ has immediate consequences for foot structure, as seen in (16). This foot structure is unbalanced. The trochee (V. Ci) shows that the strong syllable contains a lax vowel nucleus and the weak syllable contains a tense vowel nucleus. According to the basic assumption for the Foot-Form constraint, the strong syllable of a trochaic foot should have prominence greater than or equal to that of the weak syllable (Prince and Smolensky 1993).[4]

(16) Metrical Structure of <u>harmónious</u>:

$\boxed{\text{Tense}}$

har. (mó. ni.) $\boxed{\text{y}}$ ous

The unbalanced foot is resolved in English by increasing the prominence of the foot-head in the (V. Ci) foot. Thus, CiV Tensing involves the insertion of [Tense], as represented in (17). Here, relevant constraints are the Foot-Form constraint and the Dep(Tense) constraint.

(17) The Balanced Foot

$\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$

har.(mó. ni.) $\boxed{\text{y}}$ ous

If Foot-Form dominates Dep(Tense), candidate (18a) is predicted to be the winner.

(18) Foot-Form > > Dep(Tense)

Candidates	Ft-Form	Dep(Tense)
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ | | \ har.(mó. ni.) $\boxed{\text{y}}$ ous		**
b. $\boxed{\text{Tense}}$ | \ har. (mó ni.) $\boxed{\text{y}}$ ous	*!	*

The insertion of [Tense] yields lengthening of the vowel targetted by CiV Tensing. This fact is covered by a constraint termed Tense-to-Weight

[4] I focus on the trochaic foot system in this paper since English is trochaic. A more detailed discussion on the Foot-Form (trochaic) constraint appears below.

(TTW) (19). This constraint is responsible for the generalization that tense vowels in stressed position are always realized as bimoraic in English. This constraint implies that length is derivative from [Tense]. The relationship between [Tense] and length/weight is unidirectional. If vowels are tense and stressed, then they are long. However, the opposite is not the case. Long vowels do not always imply tense vowels. For example, vowels are long at pre-juncture position (Duanmu 1995). Increased duration does not necessarily require an articulatory gesture of tensing (or increased constriction).

(19) Tense-to-Weight (TTW): If tense, then bimoraic.

$\boxed{\text{Tense}}$
|
V
/ \
μ μ

I have used the Foot-Form constraint in a very broad sense. Let us now consider the Foot-Form constraint in more detail.[5] McCarthy and Prince (1993b) define the Foot-Form (Trochaic) constraint as an alignment of the left edge of a foot with the left edge of the foot-head, as in (20a). I propose an extension of the Foot-Form constraint to a constraint family of foot types, as in (20b). The scaled constraint family of foot types in (20b) is a hybrid characterization of Prince's (1990) Rhythmic Harmony Scale (20c) and an Alignment constraint of McCarthy and Prince (1993b). The Rhythmic Harmony Scale focuses on the harmonic organization of a foot. The original formulation of the Foot-Form constraint focuses on the placement of the head-member of a foot.

(20) a. Foot-Form(Trochaic): Align(Ft, L; Hd(Ft), L)
(McCarthy and Prince 1993b)

b. Extended Foot−Form (Trochaic):
(L′ L), (H′) >> (H′ L) >> (L′) >> (L′ H)

c. The Rhythmic Harmony Scale (Trochaic)
(L L), (H) > (H L) > (L) (Prince 1990)

[5] The logic for the trochaic foot system also holds for the iambic foot system. I focus on the trochaic foot system here, as mentioned above.

Let us now turn to a constraint ranking between Onset and the extended Foot-Form constraint. As seen in tableau (21), the Onset constraint dominates the Foot-Form constraint. The winner (21a) satisfies Onset, violating the most optimal Foot-Form constraint (L′ L). This candidate contains the (H′ L) foot which is the second most optimal foot constraint. On the other hand, the loser (21b) violates Onset and satisfies the (L′ L) constraint. If the (L′ L) foot constraint dominates the Onset constraint, then candidate (21b) would be the winner.

(21) Onset >> L′ L

Candidates	Onset	L′L, H′	H′L	L′	L′H
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ μ)		*		*	*
b. Ca. (ná di .) an (μ' μ)	*!		*	*	*

In (20b) above, I omitted the heavy trochee (H H) from the Foot Hierarchy. If we assume the Weight-to-Stress Principle, the spondee can be ruled out as a foot type.

(22) WSP: If heavy, then stressed. (Prince 1990)

A ranking between Onset and WSP is not motivated, as seen in (23) below. The winner (23a) satisfies both Onset and WSP, while the loser (23b) satisfies Onset but fails WSP.

(23) No Ranking between Onset and WSP

Candidates	Onset	WSP	L′L, H′	H′L	L′	L′H
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ μ)			*		*	*
b. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná di .) y an (μ' μ μ' μ)		*!	*	*	*	*

Moreover, optional vowel reduction provides indirect evidence for the view that the non-head position in the (V. Ci) foot is monomoraic. As seen in (24), if vowel reduction occurs, then the non-head position is totally deleted. However, if the non-head position were bimoraic, vowel reduction would yield schwa for the vowel. This argument, of course, is made on the assumption that vowel reduction deprives only one mora, not two moras.

(24) Ca. ná. d<i>yan: one mora reduction

Let us now consider an alternative way to avoid the unbalanced foot in which the strong syllable contains a lax vowel nucleus and the weak syllable contains a tense vowel nucleus: (V, V_{Tense}). The possible scenario is to position an alternative stress foot, as in (25). The tensed penult forms a degenerate stress foot. This foot violates a generalization regarding the English stress system.

(25) *Ca.na.dí:yan

$\boxed{\text{Tense}}$

Ca. na. (dí.) $\boxed{\text{y}}$ an

μ' μ

In English suffixed forms, a prosodic head falls on stems, with a few exceptions like *-ition* and *-ation*. When stress-sensitive suffixes are attached to stems, stress does not shift beyond the stem under consideration. For convenience, I term this stress pattern the Stem-Stress Generalization (26). This generalization blocks the foot parse in (25).

(26) Stem-Stress Generalization: Stems contain a prosodic head in suffixed forms.

As seen in tableau (27), no specific ranking between Onset and Stem-Stress Generalization is required. The winner (27a) satisfies both constraints whereas candidate (27b) satisfies Onset but violates Stem-Stress Generalization.

(27) No Ranking between Onset and Stem-Stress

Candidates	Onset	Stem-Stress	L′L, H′	H′L	L	L′H
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ μ)			*		*	*
b. $\boxed{\text{Tense}}$ Ca. na (dí .) y an (μ' μ)		*!		*	*	*

The TTW constraint dominates the Foot-Form constraint, as seen in (28) below. Candidate (28a) shows fewer violations of TTW than candidate (28b) does. For the Foot-Form constraint, candidate (28a) violates the most optimal foot type (L′ L), whereas candidate (28b) satisfies the most optimal foot type.

(28) TTW >> L′ L

Candidates	Onset	TTW	L′L, H′	H′L	L′	L′H
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ μ)		*	*		*	**
b. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ)		**!		*	*	**

The WSP constraint is ranked higher than the TTW constraint, as seen in (29). The winner (29a) satisfies WSP but violates TTW. Conversely, the loser (29b) violates WSP but satisfies TTW.

(29) WSP >> TTW

Candidates	WSP	TTW
☞ a. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná. di .) y an (μ' μ μ)		*
b. $\boxed{\text{Tense}}$ $\boxed{\text{Tense}}$ Ca. (ná di .) y an (μ' μ μ μ)	*!	

The constraint ranking for the proposed analysis of CiV Tensing is summarized in (30).

(30) a. Onset, Stem-Stress Generalization, WSP: highly ranked
b. Onset, TTW >> L′ L >> H′ L >> Dep(Tense)

c. WSP >> TTW >> L′ L
d. Max(V) >> Dep(Tense)

In the next section I will discuss previous analyses of CiV Tensing: SPE-like analyses and Burzio's metrical analysis.

5. Previous Analyses

5.1. SPE-like Analyses

Derivational analyses are represented by SPE, Rubach (1984) and Halle and Mohanan (1985). They present a description of CiV Tensing through rules in (31). Rule (31a) states that nonhigh vowels become tensed when followed by a stressless non-low front vowel which is in turn followed by a vowel. Rule (31b) has almost the same SD and SC as (31a), except for a specification of the last vowel as [+low] (CiV[+low]). Rule (31c) indicates that nonhigh vowels are lengthened before an unstressed high vowel, focusing on the change of vowel quantity, not of vowel quality.

(31) a. SPE

$$V \rightarrow [+\text{tense}] \;/\; [\overline{\text{-high}}]\; C \begin{bmatrix} \text{-low} \\ \text{-back} \\ \text{-cons} \\ \text{-stress} \end{bmatrix} V$$

b. Rubach (1984)

$$\begin{bmatrix} \text{+syll} \\ \\ \text{-high} \end{bmatrix} \rightarrow [+\text{tense}] \;/\; \_\_\_\; C \begin{bmatrix} \text{-cons} \\ \text{+high} \\ \text{-stress} \end{bmatrix} \begin{bmatrix} \text{+syll} \\ \text{+low} \end{bmatrix}$$

c. Halle and Mohanan (1985)

$$\begin{array}{ccccc} \text{Rime} & & \text{Rime} & & \\ | & & /\backslash & & \\ X & \longrightarrow & X\;\;X & / & [\text{-high}] \\ | & & \backslash/ & & \\ [\text{-cons}] & & [\text{-cons}] & & \end{array} \begin{bmatrix} \text{+high} \\ \text{-cons} \\ \text{-stress} \\ \text{-back} \end{bmatrix}$$

Although the derivational analyses correctly describe the environment of CiV Tensing, they have two major problems. First, they do not explain why tensing occurs in the given contexts. The occurrence of CiV Tensing is just accidental. Second, the rules contain a long-distance structural description. For example, in SPE and Rubach (1984), the long distance structural description spans four segments. The relation between the segments in the structural description and tensing is not captured. The long distance structure is just arbitrary in the derivational analyses.

Let us next consider Burzio's (1994) metrical analysis.

5.2. Burzio's (1994) Metrical Analysis

Burzio (1994), like the analysis I propose here, argues that CiV Tensing is metrically motivated, and notes the relevance of the onsetless second syllable in the Ci .V sequence.

CiV Tensing, according to Burzio, derives from the change from a (L L) foot, which is ill-formed in Burzio's stress system, to the well-formed foot (H L). Burzio's analysis is illustrated with the word *Canădian.* The second syllable *-nă-* becomes tense due to the change in metrical structure from Ca(n$\acute{a}_L$.di.a)nϕ, (LL) to Ca(n$\acute{a}_H$. di.a)nϕ, (HL).[6] Burzio takes the trisyllabic sequence *-na. di. a-* to be metrified as (L L) on the criterion of foot-weight. He assumes that onsetless syllables have insufficient weight, and thus claims that the CiV sequence (*-di. a-*) counts as a single light syllable in foot-weight based metrification. Simultaneously, he claims that in syllable-based metrification the same sequence CiV is disyllabic and thus the CVCiV sequence (*na. di. a*) is metrified as (σ_L σ_L σ_L).

Burzio's account has several problems. First, his analysis does not consider the immediate relation between CiV Tensing and Prevocalic Tensing. As discussed in section 3, Prevocalic Tensing is directly related to CiV Tensing.

A second problem with Burzio's analysis concerns his assumption that the onset contributes to syllable weight and thus onsetless syllables are weight-deficient. It has been argued in the literature (e.g., Halle and Vergnaud 1987 and Hayes 1995) that the onset is ignored in determining

[6] The symbol ϕ represents a null vowel, which is an abstract vowel with no content.

syllable weight. Even admitting the analysis of onsets as weight bearing, there is still a problem in Burzio's account. As pointed out by Burzio himself, word-initial onsetless syllables function to attract stress the same way as onsetted syllables, as exemplified in *émigràte*. The first onsetless syllable attracts stress. If onsetless syllables are weight-deficient, then the word-initial onsetless syllables would be also under the same umbrella. If the first onsetless syllable in *emigrate* is weight-deficient and can not attract stress without strengthening, it would be wrongly predicted that the first syllable is tensed: *(e:mi)(grate)=(HL)(HW).

A third problem with Burzio's analysis is that he distinguishes between foot-weight based metrification and syllable-counting based metrification. He presents no motivation for this distinction. Without relying on these two types of metrification, Burzio's analysis would not account for CiV Tensing. If the sequence iV were to count as a single syllable in metrification, Burzio's analysis would wrongly predict that the first syllable of *Canadian* attracts stress, i.e., *(Cánadia)nϕ. If the sequence iV counted as disyllabic in metrification, Burzio's analysis would not account for CiV Tensing because the footing of Ca(na.di.a)ϕ is legitimate in Buzio's foot system.

A fourth shortcoming to Burzio's analysis concerns his numerical foot-weight formula. Burzio takes the weight value 12 to be optimal. There is no basis for representing the foot value numerically, or for taking 12 as the optimal foot-weight. Burzio postulates a formula to evaluate foot-weight, based on syllable type (heavy (H), light (L), and weak (W)) and the position of a syllable in the foot: H=3, L=2, W=1; ($\sigma\sigma\sigma$)=(321), ($\sigma\sigma$)=(3 1.5). The Arabic numeral denotes the weight value for each syllable. The weight of a foot equals the sum of the multiplication of weight value and position value, according to Burzio. For example, the disyllabic foot (H L) has the weight value 12 (3×3 plus 2×1.5). Burzio tentatively takes the foot weight value 12 to be optimal as a weight value for a final foot. In the case of CiV Tensing, the sequence iV, which is taken as monosyllabic in weight counting, has the weight value 3. Thus, the CVCiV of *na.di.a* in Ca(na.di.a)nϕ contain the weight value 9, which is repaired to be (CVV CiV) of n[ey].di.a with the weight value 12. There is no ground for taking the weight value 12 as optimal, putting aside the numerical weight formula. Burzio's foot system includes feet other than the foot of the weight value 12; e.g., (HW)=10.5, (HLH)=15.

The analysis of CiV Tensing proposed here, as discussed above, takes into account (i) the immediate relation between CiV Tensing and Prevocalic Tensing and (ii) the relation between foot structure and syllable structure. In addition, the proposed account differs from Burzio's (1994) analysis in maintaining the standard view that onsets do not contribute weight (Halle and Vergnaud 1987 and Hayes 1995). Moreover, I do not posit an optimal foot with a single absolute numerical value. I adopt the relative ranking among feet.

6. Conclusion

I have argued that the effects of CiV Tensing derive from the interaction between syllable and foot structure. The prosodic basis of CiV Tensing involves a complex interaction between constraints. I have proposed a principled analysis of CiV Tensing through independently motivated constraints, not through phenomenon-specific rules.

The implications of the proposed analysis are (i) that CiV Tensing derives from universal properties of syllable and metrical structure, and need not be viewed as an English-specific phenomenon, (ii) that the feature [Tense] affects syllable prominence, and (iii) that OT provides a suitable account of what appears to be a complex chain reaction initiated by a phonological conspiracy between metrical and syllabic structure.

References

Bell, A. M. (1867) *Visible Speech,* London.

Borowsky, T. (1986) *Topics in the Lexical Phonology of English,* Ph.D. dissertation, University of Massachusetts, Amherst.

Borowsky, T. (1989) 'Structure Preservation and the Syllable Coda in English,' *Natural Language & Linguistic Theory* 7, 145-166.

Burzio, L. (1994) *Principles of English Stress,* Cambridge University Press, Cambridge.

Chomsky, N and Halle (1968) *The Sound Pattern of English,* Harper and Row, New York.

Davis, S. and M. Hammond (1995) 'On the Status of On-glides in American English,' to appear in *Phonology* 12.2.

Duanmu, S. (1995) 'The Phonology of Pre-juncture Lengthening,' paper presented at Mid-Continental Workshop on Phonology, the Ohio State University.

Gimson, A. C. (1980) *An Introduction to the Pronunciation of English,* 3rd edition, Edward Arnold, London.

Goldsmith, J. A. (1990) *Autosegmental and Metrical Phonology,* Blackwell, Oxford.

Halle, M. (1977) 'Tenseness, Vowel Shift and the Phonology of Back Vowels in Modern English,' *Linguistic Inquiry* 8, 611-625.

Halle, M. and W. Idsardi (1995) 'General Properties of Stress and Metrical Structure,' in J. Goldsmith ed., *The Handbook of Phonological Theory,* Blackwell, Cambridge and Oxford.

Halle, M. and M. Kenstowicz (1991) 'The Free Element Condition and Cyclic versus Noncyclic stress,' *Linguistic Inquiry* 22, 457-502.

Halle, M. and K. P. Mohanan (1985) 'Segmental Phonology of Modern English,' *Linguistics Inquiry* 16, 57-116.

Halle, M. and J.-R. Vergnaud (1987) *An Essay on Stress,* MIT Press, Cambridge.

Hayes, B. (1995) *Metrical Stress Theory: Principles and Case Studies,* The University of Chicago Press, Chicago and London.

Jakobson, R. and M. Halle (1956) *Fundamentals of Language,* Mouton, the Hague.

Jespersen, O (1909) *A Modern English Grammar on Historical Principles, Part 1: Sounds and Spellings,* Carl Winter, Heidelberg.

Kenyon, J. S. and T. A. Knott (1953) *A Pronouncing Dictionary of American English,* Merriam, Springfied, Massachusetts.

Kiparsky, P. (1973) 'Phonological Representations,' in O. Fujimura ed., *Three Dimensions of Linguistic Theory,* TEC Company, Tokyo.

Lass, R. (1976) *English Phonology and Phonological Theory,* Cambridge University Press, Cambridge.

Lee, J.-Y. (1996) *Some Aspects of English Phonology: An Optimality Theoretic Approach,* Ph.D. dissertation, Unversity of Illinois at Urbana-Champaign, published by Hanshin Publishing Co, Seoul.

McCarthy, J. and A. Prince (1993a) 'Prosodic Morphology I: Constraint Interaction and Satisfaction,' ms., University of Massachusetts, Amherst, & Rutgers University.

McCarthy, J. and A. Prince (1993b) 'Generalized Alignment,' ms., University of Massachusetts, Amherst, & Rutgers University.

McCarthy, J. and A. Prince (1995) 'Faithfulness and Reduplicative Identity,' ms., University of Massachusetts, Amherst, Rutgers University.

Myers, S. (1987) 'Vowel Shortening in English,' *Natural Language & Linguistic Theory* 5, 485-518.

Prince, A. (1990) 'Quantitative Consequences of Rhythmic Organization,' *Papers from the 26th Regional Meeting of the Chicago Linguistic Society,* 355-398.

Prince, A. and P. Smolensky (1993) 'Optimality Theory: Constraint Interaction in Generative Grammar,' ms., Rutgers University & University of Colorado at Boulder.

Rosenthall, S. (1994) *The Phonology of Vowels and Glides,* Ph.D. dissertation, University of Massachusetts, Amherst.

Rubach, J. (1984) 'Segmental Rules of English and Cyclic Phonology,' *Language* 60, 21-54.

Wiik, K. (1965) *Finnish and English Vowels,* University of Turku Press, Turku.

Wood, S. (1975) 'Tense and Lax Vowels-degree of Constriction or Pharyngeal Volume,' *Lund University Phonetics Laboratory Working Papers* #11, 109-133.

서울특별시 관악구 신림동 산 56-1
서울대학교 어학연구소
151-742