Faithfulness to Prosodic Heads[*]

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1. Introduction

1.1 Metrical Transparency of Epenthesis

It is a common observation that epenthetic vowels are transparent in word stress, transparent in a *physical* sense: they are not stressed when they fall into positions of canonical stress, and furthermore, they are not counted in the determination of stress. One clear example of metrically transparent epenthesis comes from the Mississippi Valley Siouan language, Dakota. In this language, stress regularly falls on the second syllable from the beginning of the word (1a). Epenthesis into the second syllable, however, for the purpose of syllabifying certain root-final consonants as onsets, creates exceptions to canonical second syllable stress (1b).

(1) Dakota (Shaw 1976, 1985)

a.	č^{h}i-kté	'I kill you'	b.	/ček/	—>	čéka	'stagger'
	ma-yá-kte	'you kill me'		/khuš/	—>	khúža	'lazy'
	wičhá-ya-kte	'you kill them'		/čap/	—>	čápa	'trot'
	o-wíčha-ya-kte	'you kill them there'					
	(cf. kté	's/he, it kills')					

If epenthetic /a/ is transparent (invisible) for the purposes of stress placement, the forms in (1b) are not truly exceptional. Disyllablic *čéka*, derived from an underlying CVC root, is treated on a par with *kté*.

Describing the above observations in nonderivational terms, i.e., in terms of a direct mapping from lexical to surface forms, involves stating a requirement on the relation between the input and the output.

(2)

Input		Output
/ček/	—>	[čéka]
/č^{h}ikte/	—>	[č^{h}ikté]

Stress typically falls on the vowel of the second syllable *č^{h}ikté*, yet when this vowel is not present underlyingly, stress falls elsewhere *čéka*. In sum, two requirements restricting the position of stress are necessary in the description of the full pattern. Stress falls on the second syllable, but more importantly, the stressed vowel must be present underlyingly. An informal description of the observed metrical transparency of epenthesis in Dakota can be given in nonderivational terms by making reference to underlying counterparts to stressed vowels.

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1.2 Identity Effects in Vowel Reduction

Remarkably, reference to counterparts in related strings will also provide a coherent vocabulary for stating certain observations governing stress related segmental processes like vowel reduction. Consider the following case in Russian, which can be reproduced in a wide range of languages (see below). In stressed positions, Russian licenses six vowel contrasts /i ɨ e a o u/, but in unstressed syllables, only the three peripheral vowels surface.[1] For example, the stem-internal mid vowel surfaces in the unsuffixed nominative form *stól*, yet in forms where stress is moved off the stem vowel, underlying /o/ lowers to [a], e.g. *stal-á*. Compare the alternations found in the declensions in (3a) with the examples in the verbal paradigms in (3b).[2]

(3) Russian (Jones and Ward 1969, Boyanus 1955, Kenstowicz and Kisseberth 1979)

a.	Nom. Sg.	stól	slóv-o	b.	glaž-ú	važ-ú	1 per. Sg.
	Gen.	stal-á	slóv-a		glóž-iš	vóž-iš	2 per.
	Dat.	stal-ú	slóv-u		glóž-it	vóž-it	3 per.
	Instr.	stal-óm	slóv-om				
	Loc.	stal-é	slóv-e		glóž-im	vóž-im	1 per. Pl.
					glóž-it'i	vóž-it’i	2 per.
	Nom. Pl.	stal-ý	slav-á		glóž-ut	vóž-∂t	3 per.
	Gen.	stal-óf	slóv		'gnaw'	'carry'	
	Dat.	stal-ám	slav-ám				
	Instr.	stal-ámi	slav-ámi				
	Loc.	stal-áx	slav-áx				
		'table'	'word'				

The above description may be recast in terms of input-to-output mappings by stating essentially the following. Mid vowels reduce (to [a] in the above cases, but to [∂] in other contexts discussed below). But stressed vowels don't undergo vowel reduction; they remain faithful to underlying featural contrasts.

(4) Input Output

/stól/ —> [stól]

/stol-á/ —> [stal-á]

Hence, crucial to the mapping of inputs to outputs is the observation that stressed vowels are always identical to their underlying counterparts. Vowel reduction only applies to mid vowels in unstressed syllables because of this relational requirement.

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[1]Russian shows some vestiges of the Indo-European pitch accent system (see e.g. Kiparsky and Halle 1977), which is assumed here to be encoded lexically.

[2]A complete description of Russian vowel reduction will note that nonhigh vowels rise to an allophone of /i/ before soft consonants (i.e. palatal or palatalized consonants), m’ič-ú, m’éč-iš, m’ếč-it 'throw'. But this interesting CV interaction will not be discussed here.

1.3 Discussion

All the phonology in the above descriptions occurs in the pairing of inputs with outputs, and this direct approach to the phenomena calls for certain statements governing the relation between the stressed vowel and its underlying counterpart. The requirement governing metrical transparency of epenthesis is given in (5a), and the top-ranked constraint negating the forces of vowel reduction is restated in (5b).

(5) a. Stressed vowels must have counterparts in the input
b. Stressed vowels must be identical to their input counterparts

Stated as such, metrically transparent epenthesis is related to vowel reduction in an indirect, but perfectly explicit way: both processes posit a requirement on the relation between the stressed vowel and its input segmental counterpart with the effect of suppressing general phonological patterns.

The ‘relational approach’ to these problems, which permits a direct mapping from input to observed output, may be contrasted with the more standard derivational analysis. In rule-based terms, Epenthesis which is invisible to word stress will counterfeed Stress, as the derivations in (6A) show. Stress-dependent vowel reduction also calls for a crucial rule ordering in which vowel reduction follows the assignment of stress (6B).

(6) A. Dakota Stress			B. Russian Vowel Reduction		
UR	/ček/	/č^{h}ikte/	UR	/stol/	/stol-a/
Stress	čék	č^{h}ikté	Stress	stól	stolá
Epenthesis	ték<u>a</u>	-------	Reduction	-----	stalá
PR	[čék<u>a</u>]	[č^{h}ikté]	PR	[stól]	[stalá]

In serialist operational terms, metrical transparency of stress and vowel reduction are completely unrelated. No fundamental categories or formal properties emerge as a way of connecting the two phenomena. In contrast, the relational approach reveals an integral element of two processes, namely the observed correspondence of stressed units and their input counterparts.

From this preliminary survey, a mode of analysis has been structured which differs from rule-based linguistic analysis in its nonderivational character. By giving the relational requirements in (5) top rank in the constraint system, the serial derivations shown in (6) become unnecessary. Further, these descriptions in terms of inputs and related outputs look promising in that they provide a means of relating the two classes of phenomena presented above.

1.4 Partial Metrical Transparency of Epenthesis

A third class of phenomena, related to metrical transparency of epenthesis, again suggests a nonderivational approach. There is a set of known stress systems in which epenthetic vowels are invisible (transparent) to the stress component as a sort of elsewhere case, yet they are stressed in certain limited contexts. A well-known example, to be explored in greater detail below in section 4, is the complicated stress-epenthesis interaction found in Mohawk (Lake Iroquoian). Stress regularly falls on the penultimate syllable in Mohawk (7a), unless the penultimate or ultimate syllable contains an epenthetic vowel, in which case stress falls on the antepenultimate syllable (7b); epenthetic vowels are stressed, however, in penults closed by oral (nonlaryngeal) consonants (7c).

(7) Mohawk (Michelson 1981, 1988)

a.	kohárha?	'I attach it'	b.	wákeras	'It smells'
	katirútha?	'I pull'		wa?kyé:rite?	'I accomplished it'
c.	tekahsutérha?	'I am splicing'			
	wakényaks	'I get married'			

To recapitulate, epenthesis into a biconsonantal cluster is transparent to stress, as it provides exceptions to the regular pattern of penultimate stress. Yet epenthesis into certain triconsonantal clusters is visible in word stress, for this type of vowel insertion produces epenthetic vowels which receive canonical stress. Epenthesis in Mohawk is therefore only partially transparent in word stress, as epenthetic vowels participate in the stress system in limited contexts. (Examples from other languages supporting partial metrical transparency of epenthesis are given below).

The derivational approach to partial metrical transparency effects is to posit two distinct rules of epenthesis, each crucially ordered with respect to stress assignment. Thus, in the Mohawk case, epenthesis into a closed syllable feeds a rule of stress placement, while epenthesis into a biconsonantal cluster, creating an open syllable, follows stress assignment. (This is a simplification of the analysis given in Michelson 1988).

(8)

UR	/katirutha?/	/wakras/	/tekahsutrha?/
e-Epenthesis / C_CC	-----------	--------	tekahsuterha?
Stress	katirútha?	wákras	tekahsutérha?
e-Epenthesis / C_C	-----------	wákeras	----------------
PR	[katirútha?]	[wákeras]	[tekahsutérha?]

The positing of more than one rule of epenthesis, however, misses a linguistically significant generalization, namely that the various instances of epenthesis are clearly related. In this example, both types are epenthesis appear to be motivated by syllable structure requirements (defined within prosodic theories of epenthesis starting from Selkirk 1981 and developed further in Itô 1986, 1989): epenthetic /e/ is inserted for the purpose of parsing unsyllabified consonants. Furthermore, ignoring epenthesis into final *C?* clusters, both epenthesis processes break up obstruent + resonant clusters (Chafe 1977, Mithun 1979). In positing two distinct rules of epenthesis, the rule-based analysis states these observations more than once.

The loss of generalization problem of course stems from the derivational nature of the rule-ordering analysis. It seems promising, therefore, to consider a nonderivational approach to partial metrical transparency of epenthesis. To anticipate the line of analysis pursued below, the transparency of epenthesis in open syllables will receive the same interpretation it does in Dakota: stressed vowels must be present underlyingly. Yet the constraint regulating this input-output relation is subordinate to an independent stress-related constraint, compelling the placement of stress on closed syllables. Partial metrical transparency is thus an effect of two essential tenets, namely that constraints on the placement of stress are ranked, and that the violation of a lower ranked constraint is necessary if it can lead to satisfaction of a more prominent constraint. The general approach to the problem, therefore, espouses the core ideas of Optimality Theory (Prince & Smolensky 1993, and McCarthy and Prince 1993a).

1.5 Overview

The remainder of this paper will examine stress-epenthesis interaction and stress-dependent feature minimization processes like vowel reduction in a wide range of languages, and provide a framework for describing these phenomena which avoids the problems identified above. Observations like “the stressed vowel is always present underlyingly” are shown to be tied to a specific hypothesis concerning the regulation of input and output relations. In particular, metrical transparency of epenthesis is accounted for within the Optimality Theoretic framework developed in McCarthy & Prince (1995), in which faithfulness of input to output is defined in terms of certain types of correspondence relations.

Section 2 introduces the fundamental concepts important to understanding the hypothesis that metrical transparency of epenthesis is linked to faithfulness, and then a constraint-based analysis of Dakota stress is presented as exemplification of this proposal. Section 2 also extends the horizons of this hypothesis by showing how metrical transparency effects can be seen in a similar light to the identity effects found in vowel reduction. Extending the factorical typology sketched in §2.2, section 3 examines the class of phenomena referred to as ‘partial metrical transparency of epenthesis’ in §1.4. Section 3 is organized into a set of case studies, giving fully formal constraint-based analyses of the stress-epenthesis interactions in Spanish and the Austronesian language Selayarese. Partial metrical transparency effects are a direct consequence of characterizing the avoidance of stressing (and counting) epenthetic vowels as a well-formedness constraint: different rankings of said constraint give a wide range of transparancy/opacity phenonema. Section 4 is an extended study of the interaction between stress and epenthesis in Mohawk. Section 5 includes a general summary of the results achieved in the paper, with some discussion of the implications which may be drawn from them.

A brief note regarding terminology should be made here as a means of avoiding confusion. In the above descriptions of stress-epenthesis interaction, the term ‘transparent’ was used to characterize epenthesis which is *invisible* in the stress system. Conversely, the term ‘opaque’ is used below to describe epenthetic vowels which are visible, or active, in word stress. This vocabulary has the unfortunate drawback that these terms are employed with the exact opposite interpretions in much of the pre-OT literature. In spite of this, I maintain the novel use of these terms. My justification is that I seek to distinguish their meaning here from the use of these terms in previous literature where they are defined explicitly in terms of rule interaction (see for example Kiparsky 1973). When we speak of metrically transparent epenthesis below, we speak of transparent *segments*, not processes of vowel insertion. Likewise, we will speak of phonologically opaque vowels as dull, not ‘see-through’ segments, i.e. segments which participate in and are visible to regular phonological processes.

2. Faithfulness to Prosodic Heads

Faithfulness is a fundamental notion in Optimality Theory (OT), as it is central to the claim that languages only differ with respect to constraint rankings (Prince and Smolensky 1993, P&S henceforth). But how is faithfulness of input to output, beyond the intuitive concept, given formal expression in constraint-based phonology? Recent work in OT (McCarthy and Prince 1994b, 1995, McCarthy 1995, Benua 1995, Beckman 1995, Selkirk 1994, 1995, Pater 1995, Lamontagne & Rice 1995, Urbanczyk 1995, 1996) has brought a wide range of empirical issues to bear on this formal question. This section reconsiders the observations presented in section 1, and introduces the hypothesis that prosodic categories like ‘the main stress foot’ or ‘the head syllable of the prosodic word’ play a role in the definition of constraints on input-ouput faithfulness.

2.1 Epenthesis in Correspondence Theory

As a direct account of a set of parallels observed between reduplicative copying and faithfulness of input to output, McCarthy & Prince (M&P henceforth) generalize the notion of correspondence developed in McCarthy and Prince (1993a) to input-output faithfulness. Correspondence is defined, quite generally, as a relation between two related strings, e.g. base/reduplicant, input/output, etc.

(9) Correspondence (McCarthy and Prince 1995)
Given two strings S_1 and S_2, **correspondence** is a relation $\Re$ from the elements of S_1 to those of S_2. Segments $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha\Re\beta$.

Faithfulness of input to output is thus engendered in a set of constraints on correspondent elements, e.g. segments. Two prominent constraints enforce the existence of correspondent segments in strings related as input/output or base/reduplicant.

(10) MAX (M&P)
Every segment of S_1 has a correspondent in S_2. Domain($\Re$) = S_1.
(No phonological deletion).

DEP (M&P)
Every segment of S_2 has a correspondent in S_1. Range ($\Re$)= S_2.
(Prohibits phonological epenthesis).

As specific instantions, MAX and DEP encourage the existence of segmental counterparts in input-to-output mappings, together establishing a symmetric correspondence relation between inputs and related outputs. These constraints are intended to take over much of the work done by P&S's PARSE and FILL (see M&P for discussion). MAX and DEP do not, however, regulate agreement with respect to the featural make-up of correspondent segments. That is the role of the IDENT(γF) family of constraints.

(11) IDENT(γF) (M&P)
Correspondent segments agree in the value for feature F.
If $\alpha\Re\beta$ and α is [γF], then β is [γF].

To summarize, three classes of phonological constraints are imposed in a generalized theory of correspondence relations which encompasses both reduplicative copying and faithfulness of input to output. MAX and DEP characterize one form of segmental faithfulness in that they require segments of a given string to have correspondents in structures related by some linguistic process. IDENT(γF) in turn characterizes featural faithfulness among correspondent segments, and penalizes input-to-output mappings which do not maintain said identity.

As a concrete illustration of how the constraints on correspondent segments are employed in the analysis of epenthesis, let us reconsider the Dakota example from §1.1. Recall that epenthetic /a/ is inserted into the second syllable of disyllabic forms like *čéka* for the purpose of syllabifying root-final consonants as onsets. *a*-Epenthesis therefore aspires to achieve perfect CV syllabification, indicating that NO-CODA (Itô 1989 *et seq*) is a high-ranking constraint (see Sietsema 1989: 339-340 for evidence concerning reduplicant shape and cluster reduction in support of the claim that codas are strongly avoided in Dakota). NO-CODA dominates DEP, the constraint prohibiting phonological insertion, which licenses a vowel in the output with no input correspondent.

(12) Epenthesis as the subordination of DEP

input: ček	NO-CODA	DEP
ček	*!	
☞ če.ka		*

Epenthesis, then, is analyzed as the subordination of DEP, which permits a violation of input-dependence as a means of syllabifying root-final consonants as onsets. Further, MAX necessarily dominates DEP, in order to rule out a third potential output, *če*, which also satisifies the syllable structure requirement NO-CODA.

(13) MAX dominates DEP

input: ček	MAX	DEP
c&e	*!	
☞ c&eka		*

The losing candidate violates MAX because the input contains the segment *k*, which has no segmental counterpart (correspondent) in the output. A constraint-ranking in which MAX dominates DEP will therefore prefer epenthesis to consonantal deletion, as it is better to violate input-dependence than it is to give an incomplete mapping from /c&ek/ to [c&e]. To close, the analysis of epenthesis in Correspondence Theory (CT) is not strikingly new; it involves constraint interaction among structural constraints (e.g. NO-CODA) and faithfulness constraints regulating input-output mappings. The novel element of the analysis is the way in which faithfulness is defined, i.e. as conditions on types of correspondence relations between elements of related strings.

2.2 Head Dependence

Now that the notion of a 'counterpart' has been defined and illustrated in the framework of CT, the observation governing metrical transparency of epenthesis may be interpreted in the following way. The avoidance of stressing epenthetic vowels shows an avoidance of stressing segments with no input correspondents. Since stress is rendered in metrically prominent prosodic categories, i.e. prosodic heads, avoidance of stressing epenthetic vowels may be interpreted as an avoidance of parsing them internal to a prosodic head. Metrical transparency of epenthesis, stated in this way, represents a specific form of input-dependence.

(14) HEAD-DEP
Every segment contained in a prosodic head in S_2 has a correspondent in S_1.
If β is contained in a prosodic head in S_2, then $\beta \in \mathrm{Range}(\Re)$.

The effect of HEAD-DEP is that prosodic heads are input-dependent; that is, only segments with input correspondents may occur in metrically prominent categories, e.g. the main stress foot of the prosodic word, or the syllabic head of the main stress foot. Since epenthetic vowels are introduced by Gen, they have no input correspondents, and hence the general claim is that parsing them internal to the prosodic head of the word will constitute a marked prosodic analysis cross-linguistically, a violation of head dependence.

It is perhaps best at this point to clarify the interpretation of HEAD-DEP by illustrating its effects in the context of a concrete example, namely metrically transparent epenthesis in Dakota. Recall from §1.1 that surface forms are characterized by second syllable stress, yet epenthesis into the second syllable correlates with initial stress. Thus, the crucial contrast supporting the claim that epenthesis is metrically transparent in Dakota is *č^{h}ikté* versus *čék<u>a</u>*. When /<u>a</u>/ is inserted into the second syllable, head dependence and the constraints responsible for second syllable stress will be in conflict. In a fully formal constraint-based approach to this problem, HEAD-DEP is ranked above the set of stress related constraints yielding canonical second syllable stress (abstractly referred to here as STRESS). This constraint ranking will therefore yield irregular stress whenever epenthetic vowels are inserted into positions of canonical stress.

(15) Metrical transparency of epenthesis: HEAD-DEP » STRESS

input: ček	HEAD-DEP	STRESS
če k<u>á</u>	<u>a</u>!	
☞ čé k<u>a</u>		*

In the above tableau, the losing candidate parses epenthetic /<u>a</u>/ internal to the head syllable of the word, and hence violates HEAD-DEP because the epenthetic vowel has no input correspondent. The result, then, is that stress falls on the initial syllable, in violation of the set of constraints restricting stress to the second syllable, as a means of satisfying head dependence. Furthermore, this result represents a general approach to the problem: metrical transparency of epenthesis implies a ranking where the requirement characterizing head input-dependence dominates (a subset of) the set of stress related constraints. All analyses of the observed metrical transparency of epenthesis presented below will be structured in this way.

As a formal point, it is necessary to consider the level of prosodic analysis relevant for the meaning of HEAD-DEP. In the above example, it seems that it is the head syllable of the prosodic word which is employed in restricting the set of segments targeted by head dependence: avoidance of epenthesis into the head syllable is essentially the characterization of the noncanonical initial stress pattern {čé.k<u>a</u>}, which is violated by the only other relevant output {če.k<u>á</u>} bearing regular second syllable stress. Specifying the meaning of HEAD-DEP will therefore involve setting a prosodic target, written here with parentheticals in the name itself. In the Dakota example, HEAD-DEP is assumed to be defined over syllables, thus HEAD(σ)-DEP is the proper instantiation of a more general formula.[3]

(16) HEAD(PCat)-DEP
Every segment contained in prosodic head PCat in S_2 has correspondent in S_1.
If PCat is a prosodic head in S_2, and PCat contains β, then $\beta \in \text{Range}(\mathfrak{R})$.

A different option, defining HEAD-DEP over prosodic feet, will be involved in account for a different set of observations governing stress-epenthesis interaction. In particular, the avoidance of counting epenthetic vowels in the determination of stress (distinct from the mere avoidance of stressing epenthetic vowels), may be viewed as the avoidance of *footing* segments with no input correspondent. With this is mind, consider the following set of patterns in the Austronesian language Selayarese (to be examined more closely in section 3). Selayarese regularly stresses the penultimate syllable, except when an epenthetic vowel occurs in the final syllable, in which case stress falls on the antepenultimate vowel.

(17) Metrical Transparency in Selayarese: failure to count epenthetic vowels

a.	állo	'day'	b.	ká:tal<u>a</u>	'itch'
	allónni	'this day'		pó:tol<u>o</u>	'pencil'

The relevance of the above contrast is that post-tonic epenthesis correlates with noncanonical stress, showing that the stress system does not count epenthetic vowels in the rendering of stress. This class of observations is empirically distinct from the class represented by the Dakota example, yet they both involve the same notion of head dependence given here, allowing a certain amount of freedom in specification of the meaning of HEAD-DEP. In the account given above, the avoidance of stressing epenthetic vowels in Dakota was achieved by targeting head syllables, i.e. employing the constraint HEAD(σ)-DEP. Assuming that regular stress in Selayarese is accounted for with a right-aligned trochee, e.g. [al{lónni}], irregular antepenultimate stress is analyzed as a slightly misaligned trochee, as in [{ká:ta}l<u>a</u>], compelled by the input-dependence requirement interpreted at the level of the prosodic foot (F). Thus, HEAD(F)-DEP, "Every segment in the head *foot* must have an input correspondent," is playing a decisive role in the system. HEAD(F)-DEP dominates alignment, yielding a repositioning of the main stress foot within the prosodic word. In summary, the two classes of observations fall under the rubric of head input-dependence, and yet the subtle empirical distinctions are made precise in the specification of the relevant prosodic target. A similar comparison is made in the following subsection, in which distinct patterns of vowel reduction are described within distinct prosodic domains along these lines.

[3]Alternatively, it seems plausible to target prosodic feet in the meaning of HEAD-DEP employed in the analysis of irregular initial stress in Dakota. Suppose foot binarity is dominated in this language. Initial stress may be represented as a monosyllabic foot over the first syllable [{čé}k<u>a</u>], compelled by a version of HEAD-DEP interpreted on the level of the stress foot.

One of the advantages of the constraint-based analysis presented above has over the more standard derivational analyses is that it avoids a problem identified in P&S: 28-32 concerning the staging of the organization of syllables into prosodic feet, referred to there as 'Bottom-Up Constructivism'. This kind of Bottom-Up prosodic layering, together with the view that epenthesis is prosodically governed, implies that epenthetic vowels will participate fully in word stress (see Broselow 1982 for a clear statement of the Bottom-Up Constructivist position). To see the extent of the problem, it is necessary to contrast the observations governing the interaction of stress and epenthesis in Dakota (where epenthesis is metrically transparent), with those in a language like Swahili. In Swahili, stress regularly falls on the penultimate syllable (18a); further, the (optional) introduction of epenthetic /i̲/ into the loans in (18b) provides no exceptions to canonical penultimate stress.

(18) Swahili (Ashton 1944, Polomé 1967, Broselow 1982)[4]

a.	jíko	'kitchen'	b.	tíket	~	tikéti̲	'ticket'
	jikóni	'in the kitchen'		rátli	~	ratí̲li	'pound'
	nilimpíga	'I hit him'					
	nitakupíga	'I shall hit him'					

Epenthetic /i̲/ is opaque (i.e. *visible*, see §1.5) in the assignment of word stress in Swahili: it is stressed and counted according to the regular stress pattern. In Bottom-Up Constructivist rationalizing, this follows from the bottom-up layering of syllables into stress feet: syllables are structurally subordinate to prosodic feet, thus it follows that epenthesis, as an effect of inserting an epenthetic syllable, is opaque (visible) to stress. The failure of the Bottom-Up Constructivist enterprise, however, is apparent in cases where prosodically-governed epenthesis is metrically transparent, as in the Dakota example. If the involvement of epenthetic vowels in word stress follows from the prosodic character of epenthesis, why is prosodically governed epenthesis invisible in word stress?

Nonderivational theories of prosodic representations like OT are neither Bottom-Up, nor Top-Down oriented. The prosodic analyses yielding syllable shapes and defining metrical prominence is determined *in parallel*, and therefore, the class of problems identified above does not arise. Metrical transparency of epenthesis in Dakota is accounted for through constraint domination, in particular, with a constraint ranking in which HEAD-DEP plays a role in positioning of the prosodic head within the larger prosodic word. The involvement of epenthesis in word stress, on the other hand, implies the opposite ranking, one in which the constraints responsible for canonical stress outrank HEAD-DEP. Thus, in the Swahili case, STRESS (which limits stress to the penultimate syllable) is ranked above HEAD-DEP, giving the result that epenthetic /i̲/ in a form like *ra.tí̲.li* is visible in metrical stress assignment.

(19) Metrical Opacity of Epenthesis: STRESS » HEAD-DEP

input: ratli	STRESS	HEAD-DEP
rá ti̲ li	*!	
☞ ra tí̲ li		*

[4]Both Ashton (1944) and Polomé (1967) note that loans from Arabic are liable to have antepenultimate stress. Thus, for example, while incorporated *ratí̲li* bears penultimate stress, speakers may chose to give the form antepenultimate stress: *ráti̲li*, which they describe as having an Arabic-like sound to it (Basilio Mungania, personal communication).

The involvement of epenthetic vowels in word stress is therefore a result of permuting HEAD-DEP to subordinate rank in the constraint hierarchy; since the set of requirements yielding canonical stress outrank HEAD-DEP, epenthesis is predicted to provide no exceptions to the regular stress pattern. Thus, to summarize the results reached above, the introduction of HEAD-DEP into the set of well-formedness constraints creates the factorial typology schematized below.

(20) Factorial Typology
•HEAD-DEP » STRESS: metrically transparent epenthesis, e.g. Dakota
•STRESS » HEAD-DEP: metrically opaque epenthesis, e.g. Swahili

A high-ranked HEAD-DEP, relative to (a subset of) the set of constraints yielding canonical stress, results in metrical transparency of epenthesis. And the opposite ranking, giving HEAD-DEP low ranked status, is the constraint ranking for a system in which epenthesis provides no exceptions (or at least only limited ones, see below) to the regular pattern of word stress. Interlinguistic variation follows, in the usual way, from constraint permutation, not from crucial rule orderings. Finally, within the OT conception of language typology, queries like those posed for Bottom-Up Constructivism do not arise.

Before moving to the next subsection, it is appropriate to clarify how subsequent discussion will elaborate on the factorial typology in (20). Essentially, the character of the analyses presented in sections 3 and 4 is that they treat the stress system as a hierarchical organization of constraints on prosodic analysis (following the insights of P&S), in which head dependence both dominates a constraint which is a member of the set of stress related constraints, and yet, is dominated by a distinct stress constraint.

(21) Partial Metrical Transparency of Epenthesis
$\mathbb{C}_{\text{STRESS}}$ » HEAD-DEP » $\mathbb{C}_{\text{STRESS'}}$

The effect of such a constraint ranking is to combine the results derived by the rankings in (20). In those contexts in which HEAD-DEP can be shown to be dominated, epenthetic vowels will be visible in the stress system. Conversely, where HEAD-DEP is dominant, the result is metrical transparency of epenthesis. Partial metrical transparency is thus an effect of a constraint ranking in which HEAD-DEP has an intermediate status in the constraint hierarchy.

One further schematic ranking is necessary, before moving on, which considers the typological implications of employing distinct prosodic targets, i.e. head syllable, and head foot, in the interpretation of head dependence.

(21.1) A Richer Typology

A. HEAD(σ)-DEP, HEAD(F)-DEP » STRESS: Total metrical transparency of epenthesis, i.e. avoidance of stressing and counting epenthetic vowels

B. HEAD(σ)-DEP » STRESS » HEAD(F)-DEP: Avoidance of stressing, but not counting, epenthetic vowels

C. HEAD(F)-DEP » STRESS » HEAD(σ)-DEP: Avoidance of footing, but not stressing, epenthetic vowels

D. STRESS » HEAD(σ)-DEP, HEAD(F)-DEP: Total metrical opacity of epenthesis, i.e. no avoidance of stressing or counting epenthetic vowels

If HEAD-DEP set for both the head syllable and the foot dominates the stress constraints, then total metrical transparency of epenthesis results, as in (21.1A). Conversely, if these two distinct constraints are both dominated, then total involvement of epenthetic vowels in stress will result, as observed in the Swahili case. The constraint rankings in B and C above yield one class of metrical transparency effect, without the other. All the analyses presented below will involve one of the constraint rankings given in (21.1).

2.3 Head Identity

The analysis of stress related vowel reduction will follow a similar mode of analysis as transparency of epenthesis in word stress. Drawing of the example presented in §1.2, Russian exhibits a general pattern of vowel reduction in which underlying /o/ surfaces as /a/ in unstressed syllables, e.g. /stol-á/ —> [stal-á]. Yet this pattern is repressed in stressed syllables, as evidenced by examples like *stól*. Vowel reduction is analyzed as the domination of faithfulness constraints by certain featural markedness constraints, which effectively reduces the set of vowel contrasts (P&S §9). Head identity constraints are then introduced to regulate featural faithfulness between the segments in an output prosodic head and their input counterparts. It is thus the ranking of head identity above the featural markedness constraints that yields feature minimization only in unstressed positions, a paradigmatic observation.

Russian vowel reduction is more complicated than the binary pattern of /o/ to [a] exemplified above. Upon further investigation, it appears that vowel reduction to low vowels, /stol-á/ —> *stal-á*, only occurs in the syllable directly preceding the stressed syllable (the pre-tonic syllable henceforth). All vowels reduce to [∂] in unstressed, non pre-tonic syllables (Reformatskij 1955, Jones and Ward 1969: 194-195). Exemplification of this more aggressive pattern of reduction is given below for the back mid vowel /o/.

(22)	v[ó]d∂j	nom. pl.	z[a]vót	'winding mechansim'
	v[a]dá	nom. sing.	z[∂]vad'ít'	to bring, wind up'
	v[∂]davóz	‘water carrier’		
	'water'		sk∂v[a]rót	gen. pl. ‘frying pan’
			sk∂v[∂]radá	nom. sing.

The nominative plural form *vód∂j* is fully faithful to the stem vowel under stress, yet with the gradual rightward migration of stress, a two level reduction process is observed: /o/ goes to [a] in the pre-tonic position *vadá*, and reduces further to [∂] elsewhere *v∂davóz*. How shall the notion of head identity be enriched to account for this three-way division in vowel reduction, aggregrated with respect to distance from the stressed syllable?[5] The answer to this question will involve arguing for a set of head identity constraints which target distinct prosodic constituents, along the lines proposed in §2.2 for the family of head dependence constraints.

Taking the pattern of rising amplitude over the pre-tonic syllable as the guide to the metrical structure (Jones & Ward 1969, Hamilton 1980), let us assume that the pre-tonic and stressed syllables together support an iambic foot in Russian.[6] Thus, the prosodic analysis responsible for the placement of stress in *vadá* and *v∂davóz* is [(vadá)] and

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[5]A three-way dividing up of the word is also mentioned in stress related vowel reduction in Chamorro (see Chung 1983 for a crisp account). The set of relevant prosodically determined environments may be stated as (i) primarily stressed syllable, (ii) secondarily stressed syllable, (iii) unstressed syllables.

[6]Halle and Vergnaud (1987) present an argument in defense of a right-headed disyllable foot: syncope triggered by a following full vowel accompanies retraction of stress to the initial syllable: *zajóm* 'loan nom. acc.' bears second syllable stress, while genitive *zájma* has initial stress. Syncope effectively shrinks the disyllabic iamb in the latter form, forcing stress to be placed on the only remaining member of the stress foot: /{zajó}ma/ —> [{záj}ma].

[v∂(davóz)], respectively. The environment for lowering of mid vowels to [a] may now be stated as the main stress foot of the word. Furthermore, reduction to [∂], i.e. suppression of all vowel features, is the domain characterized as being outside the main stress foot. In other words, mid vowels are only licensed in stressed syllables, and only the peripheral vowels are licensed in the stress foot. Let's work through the details of the analysis step by step.

Featural identity is not always perfect: mid vowels reduce in unstressed positions. Following P&S, mid vowels are suppressed by means of the feature minimization constraint *MID.

(23) *MID (from P&S)
No mid vowels, e.g. *[Phar, Dor]

The markedness of mid vowels is evident from typological studies (see Maddieson 1984 for comprehensive work). For example, the presence of a mid vowel series in a segmental inventory of a given language implies the presence of the peripheral high and low vowels. The specific implementation of *MID assumed here is that the markedness of mid vowels follows from the marked featural complex *[Phar, Dor], as proposed in P&S. The feature classification system employed in their formulation, and in the subsequent analysis, is shown below for the Russian five vowel system.

(24) Major Articulator Theory of Vowel Contrasts (Selkirk 1991)

	Cor		Lab
Dor	i		u
Dor/Phar	e		o
		∂	
Phar		a	

The low vowel [a] is featurally simplex, composed of a simple [Phar] specification. Also, I assume that schwa, is characterized as an empty root node, which does not dominate any articulator features.

Starting with the feature minimization component of vowel reduction, loss of dorsal features in (unstressed) stem vowels follows from a constraint ranking in which the feature markedness constraint, *MID, dominates the general featural identity constraint.[7]

(25) Vowel Reduction as Feature Minimization

input: stol-á dp	*MID	IDENT(F)
stol-á dp	*!	
☞ stal-á p		*

The markedness of mid vowels outweighs featural identity, resulting in vowel lowering, which is a form of unfaithfulness to input featural contrast. Also, the persistence of [Phar] in the above outputs is assumed to be a result of a high-ranked IDENT[Phar], independent

[7] Loss of labial features, concomitant with the loss of [Dor] will be the result of an additional ranking of *[Phar, Lab] alongside *MID. As the behavor of [Lab] will play no role in the analysis of Russian vowel reduction, it will not be represented in the featural combination for back vowels.

from IDENT(F), abstracting away from the details of this distinction. Because of this persistence of [Phar], the stem vowel in the above tableau surfaces as /a/, rather than /u/.

The elaboration suggested in the above discussion is that distinct prosodic units (PCat) may be specified in the meaning of the head identity constraints. This move will permit the formulation of independent featural identity constraints, which will therefore allow distinct rankings of head dependence constraints with respect to the feature minimization constraints. The general formula for the head identity constraints is given below.

(26) HEAD(PCat)-IDENT(F)
Correspondent segments in prosodic heads PCat agree in value for feature [F].
If PCat is a prosodic head, PCat contains ß, and aℜß, then α and ß agree in the value of F.

The first instantiation of the schema structured above will be to specify the head syllable as the prosodic head relevant to HEAD-IDENT(F). Thus all primary features employed in the vowel classification system given above are maintained in the head syllables of the output, even of the phonologically marked feature combination characterizing mid vowels.

(27) Head Syllable Identity

input: vód∂j dp	HEAD(σ)-IDENT(F)	*MID
vá.d∂j p	*!	
☞ vó.d∂j dp		*

HEAD(σ)-IDENT(F) dominates *MID, yielding preservation of underlying mid vowels in tonic positions.

Lowering of /o/ to [a] in *vadá* is a result of the feature minimization constraint outlawing mid vowels. The loss of vowel features in *vadá* is not total, however, which would result in a schwa, because of an additional constraint ranking, this time specifying head identity to the larger stress foot.

(28) Head Identity in the Main Stress Foot

input: vod-á dp	*MID	HEAD(F)-IDENT(F)	*[Phar]
{vodá} dp	*!		
{v∂dá}		**!	
☞ {vadá} p		*	*

[Phar] contrasts are preserved in the weak position of the iambic foot, because the head identity constraint which targets the segments of the main stress foot outranks the markedness constraint suppressing pharyngeal contrasts. *[Phar] will do some work in the analysis, however, even in its low ranked position in the constraint hierarchy.

(29) By way of Summary

input: vodavóz dp p dp	HEAD(σ)-IDENT(F)	*MID	HEAD(F)-IDENT(F)	*[Phar]	IDENT(F)
vo{davóz} dp p dp		**!		***	
vo{daváz} dp p p	*!	*		***	
va{davóz} p p dp				***!	*
və{dəvóz} dp			*!		***
☞ və{davóz} p dp				**	**

Exclusion from the stress foot means that underlying featural contrasts present in the input are no longer protected by the head identity constraints. /o/ in the syllable before the pre-tonic syllable will thus reduce to schwa as a means of satisfying *[Phar]. The higher ranking constraints are included in the above tableau as a means of summarizing the effects derived directly above.

The constraint ranking describing the three-way pattern of vowel reduction in nonhigh vowels is given below.

(30) Russian Vowel Reduction
HEAD(σ)-IDENT(F) » *MID » HEAD(F)-IDENT(F) *[Phar] » IDENT(F)

The dominance relation between the two head identity constraints has a set to superset relation, whereby every violation of HEAD(σ)-IDENT(F) entails a violation of HEAD(F)-IDENT(F). This follows from the prosodic organization of stressed syllables into feet. Furthermore, looking back over the results of section 2.2, an obvious parallel is observed. The distinct prosodic categories, head syllable, main stress foot, are actively employed in the interpretations for both head identity and head dependence constraints. The three-way pattern of vowel reduction observed in Russian indeed required meanings for head identity defined over distinct levels of prosodic analysis, just as the two classes of observations governing the interaction between stress and epenthesis required at least a two member set of head dependence constraints.

Abstracting away for this necessary enrichment of the theory can lead to an even deeper comparison between the two results. Vowel reduction limited to unstressed positions, is accounted for with a constraint ranking in which the head faithfulness constraint, in this case featural faithfulness, dominates a phonological constraint on featural markedness. Compare this ranking argument with the ranking logic central to the account of metrical transparency of epenthesis.

(31) Metrical Transparency of Epenthesis: HEAD-DEP » STRESS
Head Identity in Vowel Reduction: HEAD-IDENT(F) » Feature Markedness

In both cases, a constraint enforcing a form of faithfulness to prosodic heads in the output negates the effects of the subordinate phonological well-formedness constraint. Thus, it a formally precise way, metrical transparency effects are shown to be related to feature minimization processes dependent on stress. Constraints regulating faithfulness between correspondent elements in prosodic heads play a dominant role in determining systematic phonological patterns.

2.4 Summary and Implications

The above discussion makes a contribution to Correspondence Theoretic approaches to the definition of faithfulness between lexical and surface forms. Evidence has been provided calling for reference to metrically prominent prosodic units in restricting the meanings of dependence and featural identity constraints. Distinct prosodic categories have been specified in the interpretation of head faithfulness constraints which unified the analysis of empirically distinct, but intuitively similar phenomena, e.g. the avoidance of stressing epenthetic vowels with the avoidance of counting them. Further, reference to prosodic heads in the formulation of constraints on correspondent elements provides a basis for comparing seemingly unrelated phenomena like the metrical transparency of epenthesis and stress dependent vowel reduction. In so far as these comparisons are coherent and successful, the CT approach developed here may be distinguished from the standard rule-based accounts of these problems, and further, from nonderivational accounts within Containment-based Optimality Theory (Kennedy 1994, Ikawa 1995).

Let's focus now on the implications of introducing head dependence constraints into the set of universal well-formedness constraints, Con. The implications are many, and will serve to foreshadow subsequent discussion and point to avenues for further research.

Firstly, the general approach taken here is to account for the observed metrical transparency of epenthesis in languages like Dakota with a well-formedness constraint. As demonstrated in section 1, this marks a departure from traditional rule-based accounts in which metrical transparency of epenthesis is derived through crucial rule orderings. Invisibility of epenthesis in word stress as the well-formedness constraint HEAD-DEP implies that HEAD-DEP will freely interact with the complement set of structural constraints embodied in Con. The null hypothesis is that head dependence is not 'universally ranked' with respect to complementary constraints, so we take the null hypothesis. As shown above, permuting HEAD-DEP to top-ranked or bottom-ranked positions in the constraint hierarchy yields strict metrical transparency or opacity effects, respectively. Moreover, free constraint interaction entails that HEAD-DEP may assume a medial position in the constraint hierarchy. Giving head dependence intermediate rank in the constraint system is instrumental to the analysis of partial metrical transparency effects, as briefly sketched above. This particular consequence of the constraint-based approach is explored in the following two sections.

A second implication involves considering the meaning of head dependence alongside P&S's NONFINALITY, the optimality theoretic constraint yielding extrametricality effects. The notion of head dependence developed above disqualifies epenthetic segments from occupying positions internal to a prosodic head. Head dependence is therefore similar in character to NONFINALITY, which also disallows segmentism of the head from occupying a final position ("No head of PrWd is final in PrWd"). The inclusion of these two constraints in OT stress theory therefore implies the following result.

(32) A Hard Universal[8]
Epenthesis into an extrametrical element will never be metrically transparent.

Another way of stating the above prediction is that vowel insertion into an extrametrical unit will never correlate with exceptional stress. The reason for this is strikingly clear. Suppose some language has final syllable extrametricality, and a rightward-oriented syllabic trochee. Canonical stress in such a language will have the following pattern: ... $(\acute{\sigma}\ \sigma) \langle \sigma \rangle$#. In P&S's stress theory, antepenultimate stress is due to a constraint

[8]The prediction was pointed out to me by Alan Prince.

ranking in which NONFINALITY dominates alignment. Because the final syllable is not employed in the formation of the final trochee, it follows that epenthesis into this syllable will not lead to a metrical transparency result by head dependence, ... (σ́ σ) ⟨ σ ⟩#; both head dependence and head nonedgeness are satisfied in this configuration, predicting that the epenthetic element will not lead to a irregular stress pattern. The 'synergism' observed between head dependence and NONFINALITY therefore leads to a hypothesis concerning possible and impossible metrical transparency effects. In sum, a hard universal emerges from the nature of constraint inventory, implied by the combined efforts of HEAD-DEP and NONFINALITY.

Next, let's consider potential constraint conflicts between head dependence and alignment, and the plausible consequences of this constraint interaction. As mentioned above in §2.2, the domination of alignment by HEAD-DEP, defined over the entire stress foot, will effect a repositioning of prosodic feet within the larger prosodic word. In the Selayarese examples above, regular penultimate stress is shown to be unobtainable in forms with final epenthetic vowels, as this would lead to a violation of the top-ranked HEAD-DEP.

(33) A. Canonical Stress through perfect alignment

```
   X x
[al{lónni}]
```

B. Noncanonical Stress through imperfect alignment

```
  X x
[{ká:ta}la]
```

Thus, through constraint domination, HEAD-DEP may necessitate noncanonical positions of head constituents within the word.

In this context, it is worth mentioning the well-known case of stress-epenthesis interaction found in Winnebago (Mississippi Valley Siouan), as this kind of head repositioning induced by epenthesis resembles the analysis given for the stress system of this language originally in Hale and White Eagle (1980), and also in Halle and Vergnuad (1987). Winnebago stress (whose chief acoustic correlate is relatively high pitch) is generally rendered on the third mora from the beginning of the word (Miner 1979, 1993, Susman 1944).[9] For example, in forms not containing epenthetic vowels, stress falls on the third light syllable in a form like *haracábra*. Further, the examples below show that when epenthetic vowels occur in an initial syllable, or in the position of expected accent, stress is assigned according to the regular conventions of the language (34b). This is further supported by the forms with heavy (birmoraic) syllables; stress falls on the light syllable directly following the initial heavy syllable, regardless of whether this syllable contains an epenthetic vowel (34c,d).

(34) Winnebago (Miner 1979, 1993, Hayes 1995)

a.	haracábra	'the taste'	b.	šawažókjĩ	'you mash hard'
	hasãjéja	'on the far side'		xorojíke	'hollow'
				hojisána	'recently'
				hirupíñĩ	'twist'
c.	xjaanáne	'yesterday'	d.	boopéres	'sober up'
	taanížu	'sugar'		maašárac	'you promise'

[9]In forms with diphthongs in the second syllable, stress falls on the most sonorous vowel, whether it be dominated by the second or third mora, necessitating Miner's (1979) qualification that Winnebago stress is mora counting, but syllable accenting.

Within the framework of ideas developed here, it follows then, that epenthetic vowels are *opaque* to stress in Winnebago because they are counted and stressed according to the regular principles of the language. Thus, Winnebago compares with Swahili in that the set of stress constraints dominate head dependence, implying that irregular accent patterns arise out of a different component of the constraint system. This is essentially the conclusion arrived at independently in Miner (1993), Hayes (1994), and Alderete (1995). These authors appeal to principles of tone shift (Hayes) or prosodic constraints on the output of the epenthesis process itself (Alderete), in the analysis of these apparently aberrant examples. Therefore, it seems that the Winnebago example—while it has been argued to provide strong evidence in favor a serialist model of rule relations (Halle and Vergnaud 1987: 178)—is handled rather straightforwardly within parallelist OT, as a case of metrical opacity (visibility) of epenthesis along the lines sketched above.

Now that the theory of stress-epenthesis interaction has been laid out in detail, and a set of implications has been presented, we may move to a series of case studies, all of which employ the notion of head dependence in describing partial metrical transparency of epenthesis.

3 . Case Studies I: Partial Metrical Transparency Effects

This section explores one consequence of characterizing metrical transparency of epenthesis as the well-formedness constraint HEAD-DEP, namely that it may freely interact with the set of stress constraints available in a constraint system. Various rankings give HEAD-DEP intermediate rank among the stress constraints, yielding partial metrical transparency effects.

3.1 Spanish

Spanish has productive epenthesis in a wide range of contexts (see Harris 1980 for a brief survey), one of which is before *sC* clusters word-initially (Harris 1969 *et seq*). The systematic absence of words beginning with *sC* clusters in Spanish, the fact that loans with these clusters invariably receive /e̲/, e.g. *esnob* and *esmoking*, and the alternations below (drawn from Harris 1983) all support the claim that /e̲/ is epenthetic in these forms.

(35)	/hemi-sfera/	—>	hemisfera	'hemisphere'
	/sfera/	—>	e̲sfera	'sphere'
	/yugo-slavo/	—>	yugoslavo	'Yugoslav'
	/slavo/	—>	e̲slavo	'Slavic'
	/inspirar/	—>	inspirar	'to breath in'
	/spirar/	—>	e̲spirar	'to breath'

It has also been noted in the literature that epenthetic /e̲/ create exceptions to the regular stress pattern. For example, Harris (1970?) notes that singular and third person plural forms in present tense forms of *estar* have exceptional final stress.

(36)	a. Indicative		b. Subjunctive		
	e̲stóy	hábio	e̲sté	háble	1 per. Sing.
	e̲stás	háblas	e̲stés	hábles	2 per.
	e̲stá	hábla	e̲sté	háble	3 per.
	e̲stámos	hablámos	e̲stémos	hablémos	1 per. Plur.
	e̲stáis	habláis	e̲stéis	habléis	2 per.
	e̲stán	háblan	e̲stén	háblen	3 per.

Further, Harris makes the observation (in the form of p.c. to McCarthy 1980: 243) that, with the exception of demonstratives like *éste*, no Spanish word has a stressed /é̲/ in the context #__*sC*..., which strongly supports the claim that epenthesis contributes to distortions of the regular stress pattern. Indeed, epenthesis into this context may produce nouns with rare final stress on an open syllable: *e̲skí* 'ski'. If Harris' claim is correct, epenthesis into the initial syllable in the forms in (36) is transparent in word stress in a way rather on a par with the stress-epenthesis interaction observed in Dakota. The regular pattern of stress in the singular present tense forms is on the penult,[10] yet certain forms unexpectedly bear final stress. If epenthetic /e̲/ is transparent to stress, however, stress in these forms conforms to a systematic pattern.

[10]It is true that some verbal paradigms show final stress in Spanish, e.g. the future tense: *hablaré* 'I will speak' and the simple preterit: *hablé* 'I spoke', but the forms in (43) do not fall into any of these classes, thus it is fair to expect a regular pattern of penultimate stress.

The analysis of epenthesis in word-initial contexts has a straightforward prosodic analysis (Harris 1982), which appears to extend to cases of epenthesis into triconsonantal clusters in the following forms (see Harris 1977).

(37)	/aBr-ir/	—>	aBrír	'to open'
	/aBr-tura/	—>	aBertúra	'opening'
	/aBr-to/	—>	aBjérto	'open'
	/kuBr-ir/	—>	kuBrír	'to cover'
	/koBr-tura/	—>	koBertúra	'cover, covering'
	/kuBr-ta/	—>	kuBjérta	'lid, cover'
	/liBre/	—>	líBre	‘free’
	/liBr-tad/	—>	liBertád	‘freedom’
	/liBr-tador/	—>	liBetadór	‘liberator’

The general observation is that epenthetic /e/ is introduced for the purpose of syllabifying the underlying /Brt/ clusters according to the phonotactics of the language, strongly suggesting that the type of epenthesis observed in (37) is related to the one presented directly above. Having established this assumption, it is interesting to point out that epenthetic /e/ is stressed when it occurs in the penultimate syllable of the nonverbal forms in (37).[11] To outline the general problem, epenthesis before initial *sC* clusters is transparent in word stress, creating irregularites in the pattern of penultimate verbal stress, e.g. *está*. Epenthetic /e/ in medial /Brt/ clusters of nouns and adjectives, however, is not transparent to the stress component, as it is stressed in the penult according to the regular pattern of penultimate stress: *abjérto*. Any analysis of the interaction between stress and epenthesis in Spanish will therefore need to account for the observed partial metrical transparency of epenthetic /e/.

Within the correspondence theoretic framework provided above, the observation that epenthetic vowels are transparent in stress shows that HEAD-DEP dominates at least one stress-related constraint. One approach to the metrical transparency of epenthesis in the disyllabic forms like *está* is to claim that FOOT BINARITY (FT-BIN) is the dominated constraint, and that head dependence compels the construction of a final monosyllabic foot, as justified in the following tableau.[12]

(38) Metrical Transparency of Word-Initial Epenthesis

input: st-a	HEAD-DEP	FT-BIN
(és.ta)	e!	
☞ es.(tá)		*

By positing a marked nonbinary foot, the optimal output candidate satisfies HEAD-DEP, the top-ranked constraint. Avoidance of stressing the epenthetic vowel therefore follows from the domination of the foot size requirement. This result may be compared with the one derived above in §2.2 for noncanonical initial stress in Dakota, the only difference stemming from the site of epenthesis, and the resultant permutations of the head syllable.

[11]Stressed /e/ is also observed to diphthongize in these forms, but this is part of a thorny pattern of diphthongization under stress, which will not concern us here. See Harris (1977) for details.

[12]Alternatively, head dependence defined over head syllables could compel the formation of a noncanonical iamb, but the general structure of the constraint ranking is the same.

Stress in nonverbal forms, i.e. nouns, adjectives, and adverbials, falls into two classes of patterns, and then a set of exceptions is admitted. The first pattern, Type A, is the unmarked pattern (Hooper and Terrell 1976: 67, Harris 1982). In Type A forms, primary stress falls on the final syllable if it is closed by a consonant other than /s/, and on the penult otherwise (39a). The second pattern, Type B, pushes primary stress back one syllable in the first two sets of forms, with primary stress falling on the penult if the final syllable is closed, and on the antepenultimate syllable when both the penult and the ultimate syllable are open (39b). In both classes of patterns, if the penultimate syllable is closed, and the final is open, stress falls on the penult. Following Dunlap (1991) and Rosenthall (1994), closed syllables are interpreted as bimoraic, and hence as supporting heavy syllables; open syllables are analyzed as monomoraic light syllables. The notational conventions used directly below and throughout are "H" for a heavy syllable, and "L" for light syllables.

(39) Type A (unmarked pattern) / Type B

a. ...H́#		b. ...σ́ H#	
barríl	'barrel'	lápiz	'pencil'
rapáz	'thievish'	móBil	'mobile'
matadór	'matador'	karákter	'character'
...Ĺ L#		...σ́ L L#	
cabéza	'head'	tímido	'timid'
moréno	'brown'	sáBana	'bedsheet'
kalaBása	'pumkin'	téknico	'technical'
...H́ L#		—same as Type A—	
kanásta	'basket'		
estudiánte	'student'		
xiVánte	'gigantic'		

Forms with stressed final light syllables, e.g. *café* 'coffee' and *Panamá* 'Panama', are treated as exceptions, as are forms with antepenultimate stress and heavy penultimate or ultimate syllables, e.g. *alíquota* 'aliquot' or *régimen* 'regime'.

Following Dunlap (1991) and Rosenthall (1994), a requirement is assumed which enforces moraic trochee foot form (FOOT FORM). The two classes of patterns are therefore distinguished solely by the status of extrametricality (NONFINALITY) in the stress system. Type A is characterized as a right-aligned moraic trochee, yielding ultimate stress in the case of a final heavy syllable, and penultimate with a pair of final lights; heavy penults are parsed as slightly mal-aligned trochees, compelled by a high-ranked FOOT FORM requirement. Type A is distinguished systematically from Type B stress by promoting NONFINALITY in the constraint hierarchy such that the final mora may not be used in the formation of the weak member of the main stress foot. Consider the following prosodic analyses that the constraint-based moraic trochee analysis provides for Type A and Type B stress in Spanish.

(40) Dunlap (1991) and Rosenthall (1994)

Type A	Type B
...(H́)#	...(σ́ Hμ) μ#
...(Ĺ L)#	...(σ́ L) L#
...(H́) L#	...(H́) L#

Returning to the transparency/opacity observations presented above, it is clear that the stress pattern of *abié̲rta* conforms to the canonical patterns, of both Type A and Type B, as stress falls on the heavy penult in a form with a final sequence ...H L#. Epenthetic /e̲/ in *abié̲rta* is opaque to stress in that it is stressed according to the regular patterns observed elsewhere in the language. Yet /e̲/ has been shown above to induce metrical transparency effects in very similar environments. To see the crux of the problem here, note the structural similarities between *abié̲rta* and *e̲stá*:

(41)	H̲ Ĺ	...H̲́ L
	e̲stá	abjé̲rta

Both of the above forms involve the word-final sequence, ...H L#, and both involve epenthesis into a heavy penult, yet stress falls on the final syllable in *e̲stá*, and on the penult in *abié̲rta*. How then, is it possible to distinguish the two cases?

The answer to this question will exploit a difference between verbal stress and stress on nouns and adjectives, namely that final stress is extremely rare in nonverbal forms, while it is the expected pattern in certain verbal paradigms. Thus, the simple preterite and future forms bear regular final stress (see fn.XX), while forms like *café* are truly exceptional in both Type A and Type B stress patterns. To characterize this difference between verbal and nonverbal stress patterns, the following constraint is proposed.

(42) NONFINALITY(σ)
The final syllable in nouns, adjectives, and adverbs is not a head.

NONFINALITY(σ) is a more specific form of NONFINALITY, relativized to the syllable level and also restricted to certain morphological classes, which seems unavoidable given the state of affairs in Spanish.

Now that the relevant stress-related constraints have been presented, the observed opacity of epenthesis in cases like *abié̲rta* will be derived by ranking these constraints relative to HEAD-DEP. Recall that the formation of a final unary foot in verbs like *e̲stá* was sanctioned with a constraint ranking in which HEAD-DEP dominates FT-BIN. The same option is not available, however, with adjectives like *abié̲rta* because of the high-ranked status of NONFINALITY in this word class.

(43) Opacity of Epenthesis in Nonverbal forms

input: abr-ta	NONFINALITY(σ)	HEAD-DEP
a.bie̲r (tá)	*!	
☞ a (bié̲r) ta		e̲

In an effort to avoid placing stress on the epenthetic vowel, the losing candidate must stress the final light syllable (retraction leftwards would incur alignment violations, which will be discussed directly). This incurs a fatal NONFINALITY(σ) violation, leading to the metrical opacity result in the winning candidate. Hence, the outcome here is consistent with the general approach taken in this paper: metrical opacity of epenthesis follows from the domination of HEAD-DEP.

Of course, nouns with heavy ultimate syllables bear final stress, even when the penultimate syllable would support a well-formed trochee in being heavy: *compás* 'compass', *barríl* 'barrel', and *cansjón* 'song'. The constraint restricting stress from the final syllable will therefore be subordinate to the alignment constraint, enforcing alignment of the main stress foot to the right edge of the prosodic word (Rosenthall's ALIGN).

(44) An Alignment effect

input: compas	ALIGN	NONFINALITY(σ)
{(cóm)}(pas)	*!	
☞ com {(pás)}		e

ALIGN dominates NONFINALITY(σ), restricted to nonverbs, thus maintaining the insight of Dunlap and Rosenthall's moraic trochee analysis, while deriving the desired metrical opacity result in (43).

In summary, the ranking arguments constructed above in the analysis of Spanish stress-epenthesis interaction are listed below.

(45) Summary of Constraint Rankings
•HEAD-DEP » FT-BIN: metrical transparency of initial epenthesis, e.g. *está*
•NONFINALITY(σ) » HEAD-DEP: metrically opaque epenthesis into heavy penultimate syllables, as in *abiérta*
•ALIGN » NONFINALITY(σ): availability of final heavy syllable in e.g. *compás*

Partial metrical transparency effects derive from a constraint ranking in which HEAD-DEP assumes intermediate rank among the stress constraints. In particular, HEAD-DEP was shown to be crucially ranked with respect to a parochial NONFINALITY constraint and a general requirement on the size of the prosodic foot.

(46) Partial Metrical Transparency of Epenthesis in Spanish
NONFINALITY(σ) » HEAD-DEP » FT-BIN

To close, the explanation of these effects derives from ideas very much at the heart of OT, namely that constraints are ranked and violable.

3.2 Selayarese

In Selayarese (Austronesian), stress regularly falls on the penultimate syllable (47A), yet epenthesis into the final syllable[13] correlates with antepenultimate stress (47B).

(47) Selayarese (Mithun and Basri 1985)

A. Canonical Stress		B. Metrical Transparency of Epenthesis	
állo	'day'	ká:tala	'itch'
allónni	'this day'	pó:tolo	'pencil'
pá: o	'mango'	maNkássara	'Macassar'
pa ó:ku	'my mango'	lámbere	'long'
já:ma	'work'	tú:lisi	'write'
ri lassipañjama?ámba	'when we were about to work for each other'	tú:lusu	'go straight'

Contrasting words like *allónni* with, for example *ká:tala*, it is noted that post-tonic epenthesis correlates with irregular antepenultimate stress. Assuming that epenthetic vowels are transparent to stress hence makes the description of the stress-epenthesis interaction more tractable: the stress component does not count epenthetic vowels in the determination of penultimate stress.

Epenthetic vowels are visible to stress in one context, however, namely in the penultimate syllable. Final /a/ in (48a) correlates with antepenultimate stress, showing that /a/ is an epenthetic vowel, copied from the preceding stem. Combining the bare form *sá:hala* with a set of possessive suffixes, however, gives regular penultimate stress, with stress falling on the epenthetic vowel (48b).

(48)

a.	sá:hala	'profit'	b. sahalákku	'my profit'
			sahalá?mu	'your (fam.) profit'
			sahalátta	'your/our profit'
			sahalá?ba	'our (excl.) profit'

That the stressed vowels in the forms in (48b) are truly epenthetic is evident from the observation that they do not undergo tonic lengthening, a consistent pattern in the language. Typically, stressed vowels are lengthened in open syllables, as seen in the weight contrast of the initial syllable of e.g. *[sá:]hala* versus *[sa]halákku*. Yet the weight requirement for epenthetic vowels under stress is satisfied either by post-tonic glottal stop insertion, as in *sahalá?mu*, or gemination into the stressed syllable from the following consonant, e.g., /sahal-ta/ —> *sahalátta*.[14] The failure of epenthetic vowels to undergo tonic lengthening has been observed in other languages, for example in Yapese (Jensen 1977, analyzed in Hayes 1989, and Hung 1989).

To summarize the description presented above, epenthesis in Selayarese is only partially transparent in the stress system: the involvement of the epenthetic vowel in stress

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[13]The epenthesis process itself involves copying a preceding vowel into word-final position after an (underlyingly) final continuant consonant (Mithun and Basri: 238). In light of the general avoidance of independent Place features in the coda, also observed in a related language, Makassarese, a look to coda licensing promises to shed some light on the analysis of epenthesis.

[14]The two ways of meeting the bimoraic requirement on stressed vowels shows the general equivalence of [?C] and [CC].

depends on its position in the prosodic word. Epenthesis into the final syllable leads to antepenultimate stress, e.g. *maNkássara*, indicating that the epenthetic vowel is not counted in the determination of stress in this context. But epenthetic vowels are stressed (and therefore counted) in the penult: *sahalákku*. The analysis presented below accounts for the observed partial metrical transparency effect by employing the constraint HEAD-DEP (which enforces input-dependence on the main stress foot of the word), and giving this constraint a medial position in the constraint hierarchy of Selayarese.

In order to describe the interaction between stress and epenthesis in a precise fashion, it is necessary to specify the formal account of canonical stress. The constraint-based analysis of regular penultimate stress is given directly below, moving subsequently to the stress-epenthesis interactions. For reasons tied to the analysis of the metrical transparency of the final syllable, the assumption is made that penultimate stress is characterized by the alignment of a disyllabic trochaic foot with the right edge of the prosodic word. The trochaic requirement is formalized in McCarthy and Prince's (1993b) Generalized Alignment (GA) Theory, in which the prominence of the initial syllable is derived via left-edge matching of the relevant phonological categories. The requirement that prosodic feet be disyllabic receives a direct interpretation in the constraint FOOT BINARITY (Prince 1983, McCarthy and Prince 1986 *et seq*, Hayes 1987), relativized to the syllable level.

(49) Disyllabic Trochee

ALIGN-L ($\acute{\sigma}$, F)
The left edge of all syllabic heads must coincide with the left edge of some prosodic foot.

FOOT BINARITY (FTBIN)
Feet must be binary at the syllable level of prosodic analysis.

The above constraints shape the prosodic foot in the necessary way, and the following alignment constraints, also formulated within GA theory, posit the main stress trochee at the right edge of the prosodic word (PrWd). The ranking of PARSE-SYLL above ALIGN-R (F, PrWd) yields iterative right-to-left footing parsing (McCarthy & Prince 1994a). And the alignment constraint regulating the main stress foot, "{F}", places stress on the penultimate syllable by requiring every PrWd to have some {F} at its right edge.

(50) Right Alignment

PARSE-SYLL
Syllables must be parsed by prosodic feet.

ALIGN-R (F, PrWd)
The right edge of all feet must coincide with right edge of some PrWd.

ALIGN-R (PrWd, {F})
The right edge of all PrWd must coincide with the right edge of some main stress foot.

To recapitulate, the combination of requirements restricting the position of stress gives the following analysis for a seven syllable word such as *lassipañjama?ámba*.

(51)

					x			Stress
	x		x		x			Foot
	x	x	x	x	x	x		Syllable

[las (sipañ)(jama){(?ámba)}]$_{PrWd}$

All feet are disyllabic and the syllabic heads of all prosodic feet are aligned to the left edge of the foot; all syllables, except the initial one, are parsed into well-formed feet, despite the ALIGN-R (F, PrWd) violations this incurs; and the right edge of the PrWd coincides with the right edge of the main stress foot. Initial *las* is assumed to be unfooted for reasons tied to the analysis about to be presented.

The observation that epenthesis into the final syllable is metrically transparent, i.e., not counted in the determination of the stressed syllable, may now be interpreted as an effect of a relatively high-ranked HEAD(F)-DEP, defined over prosodic feet, along the lines of the sketch given in §2.2. The disyllabic stress foot is regularly aligned to the right edge of the PrWd, yet epenthesis into the final syllable creates a structure in which perfect alignment cannot be obeyed, without a violation of head dependence. It is therefore the subordination of ALIGN-R (F, PrWd) to HEAD(F)-DEP that accounts for irregular antepenultimate stress in this case.

(52) Metrical Transparency of the Final Syllable

input: maNkassar	HEAD(F)-DEP	ALIGN-R (F, PrWd)
(maNkas){(sára)}	a!	
☞ maN {(kássa)}ra		ra

The losing candidate here maintains perfect alignment with the right edge of PrWd, yet in doing so, epenthetic /a/ is parsed in the weak syllable of the main stress foot. Since /a/ has no input correspondent, the first candidate incurs a violation of HEAD-DEP, which enforces input-dependence for all segments contained in the head of the prosodic word. The second candidate therefore best satisfies the constraint hierarchy by moving the main stress foot one syllable to the left, forming the main stress foot over segmentism with counterparts in the input.

Epenthetic vowels are stressed in the penultimate syllable, e.g. *sahalákku*, which, in this framework indicates a violation of HEAD-DEP. Such a prosodic analysis is compelled, however, with a constraint ranking in which Align-R (PrWd, {F}) dominates HEAD-DEP. To see this, it is necessary to consider the set of possible positionings of the main stress foot alongside the subordinate prosodic feet, also present in the representation.

(53) ALIGN-R (PrWd,{F}) gives Stress Window Effect

input: sahal-ku	ALIGN-R (PrWd,{F})	HEAD-DEP
{(sá:ha)}(laku)	(lakku)!	
☞ (saha){(lákku)}		a

The main stress foot may parse the first two syllables of a four syllable word, as in the first candidate in the above tableau. Yet in such an output, the main stress foot is separated from the right edge of the prosodic word by an entire foot, leading to a violation of ALIGN-R (PrWd,{F}). Hence, the second candidate is more harmonic with respect to the constraint ranking, because it posits the main stress foot flush with the right edge of PrWd. It is important clarify a technical point here, as this is not the standard way of reckoning violations in GA, where alignment is defined for segments. Evaluation of output structures with respect to ALIGN-R (PrWd,{F}) is done at the level of the prosodic foot. Succinctly, the meaning of ALIGN-R (PrWd,{F}) is that the stress foot of the prosodic word must be the final foot of the word.

Considering the problem more generally, the high-ranked ALIGN-R (PrWd,{F}) relative to head dependence constitutes a hypothesis for the three syllable Stress Window observed in these forms. The impact of epenthesis in the final syllable can be to push the main stress foot one syllable back in the word (54c), as in this configuration, the stress foot is not separated from the right edge of the prosodic word by another prosodic foot. Contrast this with the prosodic analysis in (54b): epenthesis into the penult will not effect a permutation of the stress foot to a pre-antepenultimate syllable, as this entails that the stress foot will not be flush with the right edge of PrWd at the relevant level of analysis, i.e. the level of the prosodic foot grid marks.

(54) Three Syllable Stress Window

```
   a.                       b.                       c.
            x                   x                          x        Stress
    x       x                   x      x                   x        Foot
    x  x    x   x               x  x   x  x         x      x  x  x  Syllable
   (saha){(lákku)}          *{(sá:ha)}(laku)        maN {(kássa)}ra
```

Crucial to the distinction between the structures in (54b) and (54c) is the distinct levels of prosodic analysis superordinate to the syllable, and subordinate to the PrWd. The same distinction is made in the analysis of final stress in Spanish and stress window effects in Mohawk (sections 4.2, 4.3), and thus these distinct levels of prosodic analysis do have independent empirical support.[15]

The following tableau demonstrates the internal consistency of the pair of ranking arguments offered as an account of the stress-epenthesis correlation found in *sahal<u>á</u>kku*.

(55) Summary Tableau

input: sahal-ku	ALIGN-R (PrWd,{F})	HEAD(F)-DEP	ALIGN-R (F, PrWd)
{(sá:ha)}(l<u>a</u>ku)	(l<u>a</u>kku)!		
sa {(há:l<u>a</u>k)} ku		<u>a</u>	ku!
☞ (saha){(l<u>á</u>kku)}		<u>a</u>	

The argument that ALIGN-R (PrWd, {F}) dominates HEAD-DEP ensures that stress will never fall on a pre-antepenultimate syllable. That is, the main stress foot will never be separated from the right edge of PrWd by a disyllabic foot, as discussed directly above. In evaluating the remaining output candidates which satisfy ALIGN-R (PrWd, {F}), both candidates violate HEAD-DEP in parsing the epenthetic vowel in a strong or weak position

[15]Stress feet, distinct from subordinate prosodic feet, are also employed in Alderete (1995a) in a constraint-based analysis of foot extrametricality.

of the main stress foot.[16] The subordinate constraint, ALIGN-R (F, PrWd), will therefore choose [(saha){(l$\underline{á}$kku)}], which exhibits perfect alignment with respect to the specifications of this constraint. It is important to note that neither the second candidate in (55), nor the optimal candidate in tableau (52) above, violate the high ranking ALIGN-R (PrWd, {F}). Because the final syllable is left unparsed in these outputs (FTBIN dominates PARSE-SYLL), the right edge of the main stress foot coincides with the right edge of PrWd at the relevant level of prosodic analysis, i.e. the level of prosodic feet.

There is the viable output form [{(sá:ha)}l$\underline{a}$.ku], however, which performs remarkably well with respect to HEAD-DEP, and indeed, ALIGN-R (PrWd, {F}). Pre-antepenultimate stress is sanctioned in this case by leaving the final two syllables unparsed: the stress foot is not separated from the right edge of PrWd by a fully formed prosodic foot, and so it is flush with the right edge of the word at the relevant level of analysis. In ruling out this case, it is sufficient to require the maximal parsing of the two final syllables into feet, which would in turn, incur a fatal violaton of ALIGN-R (PrWd, {F}), as justified above. Yet a simple ranking of PARSE-SYLL above HEAD-DEP will not do: although this ranking will effectively rule out [{(sá:ha)}l$\underline{a}$.ku] by compelling the footing of *l$\underline{a}$.ku* (which leads to the violation of ALIGN-R (PrWd, {F})), it will in turn take away the metrical transparency result derived above in forms with final syllables containing epenthetic vowels. These syllables are left unfooted as a means of satisfying HEAD-DEP, but if PARSE-SYLL is high ranking, they must be parsed by feet, leading also to a violation of the high-ranked ALIGN-R (PrWd, {F}).

(56) a. σ (σ σ) σ (σ) (σ σ) (σ)
[maN{(kássa)}r$\underline{a}$] —> [(maN){(kássa)}(r$\underline{a}$)] (Not optimal)

b. (σ σ) σ σ (σ σ) (σ σ)
[{(sá:ha)}l$\underline{a}$.ku] —> *[{(sá:ha)}(l$\underline{a}$.ku)] (Not optimal)

Notice that both the above structures involve two violations of PARSE-SYLL in their initial state, but they differ in the *locality* of violations. [maN{(kássa)}r$\underline{a}$] warrants two stars by leaving the nonadjacent syllables unfooted; [{(sá:ha)}l$\underline{a}$.ku] gets two stars as well, but intuitively, this prosodic analysis is worse off because it leaves two adjacent syllables unparsed.

The two cases can be distinguished formally, by employing the notion of Local Conjunction of constraint violation (Smolensky 1995). Violaton of PARSE-SYLL is not enough to require footing of the final syllable in *maNkássar$\underline{a}$* because HEAD-DEP and ALIGN-R (PrWd, {F}) both dominate PARSE-SYLL.

(57) Head Dependence, at the expense of Syllable Parsing

input: maNkassar	ALIGN-R (PrWd, {F})	HEAD-DEP	PARSE-SYLL
(maNkas){(sár$\underline{a}$)}		$\underline{a}$!	
(maN){(kássa)}(r$\underline{a}$)	(r$\underline{a}$)!		
☞ maN {(kássa)}r$\underline{a}$			**

[16] The possibility of distinguishing the performance of these output structures on the basis of input-dependence on weak/strong positions within the stress foot is obviously not relevant here. Thus, HEAD(σ)-DEP is necessarily dominated in this system, and will play not role in the analysis.

The two losing candidates fatally violate either head dependence or alignment of the main stress foot by footing the final syllable. Thus, the result is that HEAD-DEP moves the position of the head of the prosodic word one syllable to the left, leaving the final syllable unfooted. (Recall the the optimal form above does not violate the top-ranked alignment constraint because the final syllable is unfooted).

While PARSE-SYLL is dominated by HEAD-DEP, as defended directly above, the local conjunction of PARSE-SYLL violations can be argued to negate the effects of the relatively high-ranked HEAD-DEP. Violations of PARSE-SYLL in adjacent syllables is assumed to represent an independently rankable constraint PARSE-ADJ-SYLL, and its domination of HEAD-DEP compels the maximal parsing of the final two syllables (see Kager 1994 for a different use of essentially the same constraint).[17]

(58) Locally Conjoined PARSE-SYLL dominates HEAD-DEP

input: sahal-ku	ALIGN-R (PrWd, {F})	PARSE-ADJ-SYLL	HEAD-DEP
{(sáha)}(l<u>a</u>kku)	(l<u>a</u>kku)!		
{(sáha)} l<u>a</u>kku		(* *)!	
☞ (saha){(l<u>á</u>kku)}			<u>a</u>

By leaving the two final syllables unfooted, the second candidate incurs violations of the locally conjoined PARSE-SYLL, which is fatal, given the constraint ranking above in which PARSE-ADJ-SYLL dominates HEAD-DEP. The necessity of appealing to the local conjunction of PARSE-SYLL in this input-output pairing provides one more example in which violations of a lower ranking constraint in adjacent positions leads to the cancellation of higher ranking constraints (see Smolensky 1995 and M&P for discussion).

Abstracting away from the role of PARSE-SYLL in the results derived immediately above, the ranking arguments giving the partial metrical transparency result in Selayarese are summarized as follows.

(59) Summary of Ranking Arguments
- ALIGN-R (PrWd, {F}) » HEAD-DEP: Epenthesis does not yield pre-antepenultimate stress: *sahal<u>á</u>kku*, not *sá:hal<u>a</u>kku*
- HEAD-DEP » ALIGN-R (F, PrWd): Epenthesis into final syllable gives antepenultimate stress: *maNkássar<u>a</u>*

Thus, the constraint-based approach to the stress-epenthesis interaction in Selayarese is characterized by a constraint-ranking in which HEAD-DEP has intermediate rank among the set of stress related constraints, in this particular case, the constraints enforcing proper alignment of feet.

(59.1) Partial Metrical Transparency of Epenthesis in Selayarese
ALIGN-R (PrWd, {F}) » HEAD-DEP » ALIGN-R (F, PrWd)

The intermediate rank of HEAD-DEP inherent to the account of partial metrical transparency entails constraint ranking and the violability of HEAD-DEP. Thus the explanation of the interaction between stress and epenthesis in Selayarese relies crucially on essential tenets of Optimality Theory, as is the case in the above study of Spanish.

[17]This is to give formal characterization of one component of Itô and Mester's (1992) Maximal Parsing, as implied in the above description.

4. Case Study II: Stress-Epenthesis Interaction in Mohawk

The complicated stress-epenthesis interaction observed in Mohawk has an extensive literature (Postal 1968, Chafe 1977, Michelson 1981, 1983, 1988, 1989, Pigott 1995), which comprehends many aspects of Mohawk phonology (and Northern Iroquian in general, see in particular Michelson 1988). Partial metrical transparency effects of epenthetic /<u>e</u>/ are derived directly below within the purview of the correspondence theoretic framework employed thus far.

The ensuing discussion is structured as follows. Firstly, the basic observations to be accounted for are fleshed out and summarized. The metrical invisibility of epenthesis is then described with constraint rankings in which HEAD-DEP plays a dominant role in the formation of the main stress foot within larger Mohawk words. Metrical opacity of epenthesis is subsequently explained as a correlate to heavy syllable weight, leading to the domination of HEAD-DEP. Thus, in the now familiar fashion, partial metrical transparency effects follow from a set of ranking arguments which conjoin to give head dependence a medial position in the constraint hierarchy.

4.1 Observations

The observations governing the interaction between stress and epenthesis read like a series of complications on the canonical penultimate stress pattern, which is exemplified in (60A). (The following data sets are compiled largely from Michelson's work (M), but also from Gunther Michelson's (1973) (GM) word list, and from Piggot (1995) (P). As morphological analysis and data sources may be relevant to future studies, this information is listed, top to bottom, in a separate footnotes for each column of forms. /V/ represents a central mid vowel like the one found in English *put*).

(60) A[18] ... σ́ σ #

khará:tats	I am lifting it up a bit
kohárha?	I attach it
waka?shé:wV	I already separated t.chaff
katirútha?	I pull
wakharatá:tu	I am holding it up
sanuhwaró:rok	Put on your hat!

18/k-haratat-s/, M 1988: 53 (1a); /k-ohar-ha?/, M 1988: 53 (5a); /wak-a?shew-U/, M 1988: 138 (26b); /k-atirut-ha?/, M 1988: 53 (4b); /wak-haratat-u/, M 1988: 53 (1b); /sa-nuhwar-orok-0/, M 1988: 53 (3a).

Distortions of regular pattern of penultimate stress involve epenthesis into post-tonic positions. Thus, epenthesis into the ultimate or penultimate syllable, when the penult is not closed by an oral consonant, correlates with antepenultimate stress (61B and B'). An additional transparency effect is observed in the set of forms in (61C): if the penult and the antepenultimate syllables are not closed by an oral consonant, and both the antepenultimate and ultimate syllables contain an epenthetic vowel, stress falls of the fourth syllable from the end of the word. As subsequent observations will show, it is necessary to refer to syllables not closed by oral consonants (i.e. every consonant except /h/ and /?/), as light (monomoraic) syllables. Syllables closed by oral consonants will, conversely, be referred to as heavy (bimoraic) syllables. Following the notational convention employed above, "L" denotes a light syllable, "H" a heavy syllable, and "σ" is ambiguous with respect to syllable weight.

(61)

B[19] ...σ́ L <u>σ</u> #	B'[20] ...σ́ <u>L</u> σ #	C[21] ...σ́ <u>L</u> L <u>σ</u> #
V ! kya?k<u>e</u>? I shall cut	ték<u>e</u>riks I put them next to e. o.	ón<u>e</u>raht<u>e</u>? leaf
wa?kyé:rit<u>e</u>? I accomplished it	yo?áw<u>e</u>yV dew	wà:k<u>e</u>riht<u>e</u>? I cooked it
Vkatáhseht<u>e</u>? I'll hide	wakátt<u>e</u>ru I'm dangerous	wa?tkatát<u>e</u>nak<u>e</u>? I scratched myself
Vwá:kok<u>e</u>? I'll have a blister	wakatyán<u>e</u>ru?s I feel spooky	takatáw<u>e</u>ya?t<u>e</u>? I entered
	tVkahsút<u>e</u>rV? I'll splice it	

19 /U-k-ya?k-?/, I shall cut, M 1981: 322 (16); /wa?-k-yerit-?/, I accomplished it, M 1988: 136 (18); /Uk-at-ahseht-?/, I'll hide, M 1988: 137 (24a); /U-wak-ok-?/, I'll have a blister, M 1988: 138 (25a).

20 /te-k-rik-s/, I put them next to e. o., M 1988: 133 (1); /v-k-r-U?/, I'll put it in a container, M 1988: 134 (6); /wak-attr-u/, I'm dangerous, M 1988: 141 (40); /yo-?awyU-0/, dew, M 1988: 141 (43); /t-U-k-ahsutr-U?/, I'll splice it, M 1988: 142 (49b); /wak-atyanru?-s/, I feel spooky, M 1981: 322 (17).

21 /o-nraht-?/, leaf, P 1993: 11 (12e); /wa?-k-ri-ht-?/, I cooked it, M 1988: 140 (36); /wa?-t-k-atat-nak-?/, I scratched myself, M 1988: 140 (37); /t-a-k-atawya?t-?/, I entered, M 1981: 324 (19).

The above observations concerning the transparency of epenthesis should be contrasted with the following observations in which epenthetic vowels appear to be visible in the stress system. If the penultimate syllable contains an epenthetic vowel and is closed by an oral consonant (i.e. it is a heavy syllable), it is stressed (62D). Furthermore, when the antepenultimate and ultimate syllables both contain an epenthetic vowel, and the antepenultimate is closed by an oral consonant, stress falls on the antepenultimate syllable (62E). The general observation appears to be that syllable weight, induced by oral coda consonants, contributes to the metrical opacity of epenthetic /e̲/ (cf. Piggott 1995).

(62)

D[22] ...H̲́ σ #		E[23] ...H̲́ σ σ̲ #	
sé̲rhos	You coat it with s.t.	Vké̲nyV?te̲?	I shall come
ké̲hrha?	I fill it in	watè̲:skute̲?	a roast
aké̲tshe?	my container, jar	Vké̲the?te̲?	I will pound
waké̲nyaks	I get married--get ref.		
wa?ké̲rho?	I coated		
tekahsuté̲hrha?	I splice it		

The observations governing partial metrical transparency of epenthesis in Mohawk may be summarized as follows. Epenthesis into post-tonic (light) syllables syllables contributes to a noncanonical stress pattern (II); the observation in (61B-C) is that these instances of epenthesis are not counted in the rendering of word stress. As a complication on the observed inertness of epenthesis in stress, the observations in (62D-E) suggest that epenthesis into a heavy syllable, i.e. a syllable closed by oral consonants, attracts stress: they are stressed in positions which are otherwise invisible to the stress system; contrast (61B') with (62D), and (61C) with (62E).

(63) Summary of Observations

I. Canonical Stress	II. Metrical Transparency	III. Metrical Opacity
(A) ... σ́ σ #	(B) ...σ́ L σ̲ #	
	(B') ...σ́ L̲ σ #	(D) ...H̲́ σ #
	(C) ...σ́ L̲ L σ̲ #	(E) ...H̲́ σ σ̲ #

The ensuing analysis accounts for this series of complications of the canonical stress pattern step by step, starting first with an account of the metrical transparency of /e̲/ (§4.2), and moving subsequently to the the analysis of the opacity of /e̲/ in heavy penultimate and antepenultimate syllables (§4.3).

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[22]/s-rho-s/, P 1993: 12 (13c); /k-r-ha?/, M 1988: 133 (2); /ak-tshe-?/, M 1989: 42 (7g); /wa?-k-rh-o? (?)/, GM 1973: 96; /te-k-ahsutr-ha?/, M 1988: 142 (49a).

[23]/U-k-nyU?t-? (?)/, GM 1973: 88; /w-at-?skut-?/, M 1989: 42 (7c); /U-k-the?t-?/, M 1989: 42 (7g).

4.2 Canonical Stress and Metrical Transparency of Epenthesis

As mentioned above, the Mohawk stress system has some of the elements found in Selayarese stress. In particular, the two languages have canonical penultimate stress, and further, in both systems, epenthesis into the final syllable is transparent (inert) to stress. One further parallel can be drawn in connection to certain limits on the distance of the stressed syllable from the right edge of the word (Stress Window), but this will only become apparent in the context of particular examples. A natural starting place, then, in the analysis of canonical stress, will be to posit a similar set of requirements restricting canonical stress to penultimate position, as is done below.

(64) Canonical Stress in Mohawk

A. Requirements on the shape of the prosodic foot
- •ALIGN-L (σ́, F): trochaic requirement
- •FT-BIN: disyllabic requirement

B. Requirements on the alignment of feet relative to PrWd
- •PARSE-SYLL » ALIGN-R (F, PrWd): right-to left iterative foot parsing
- •ALIGN-R (PrWd, {F}): gives an 'End Rule Right' effect

The representation in (65) illustrates the prosodic analysis for canonical penultimate stress in a form like *katirútha?* (see section 3.2 for an explanation of how the constraints in (64) yield the representation below).

(65)

```
             x                 Stress
  x          x                 Foot
  x  x       x   x             Syllable
[ (ka ti) {(rútha?)} ]PrWd
```

With these assumptions in place, the observation that epenthesis into the final syllable is transparent to word stress, as in *wa?kyé:rite?*, follows from the constraint ranking given for the same problem in Selayarese.

(66) Metrical Transparency of the Final Syllable

input: wa?kyerit?	HEAD(F)-DEP	ALIGN-R (F, PrWd)
(wa?kye){(rí:te?)}	e!	
☞ wa?{(kyé:ri)}te?		te?

By enforcing input-dependence for the main stress foot, the top-ranked HEAD(F)-DEP compels the misalignment of the main stress foot by one syllable, yielding antepenultimate stress in this example.

The Mohawk patterns differ from those found in Selayarese in that epenthesis into a (light) penultimate syllable is also metrically transparent (this is observation from 61B' above). As an example, antepenultimate stress correlates with epenthesis into the penult in *yo?áwe̲yV*. The markedness of stressing epenthetic vowels inherent to a formulation of head dependence suggests that HEAD(σ)-DEP, relativized to the syllable level, may play a decisive role in the positioning of the stress foot.

(67) HEAD(σ)-DEP dominates ALIGN-R

input: yo?awyV	HEAD(σ)-DEP	ALIGN-R (F, PrWd)
(yo?a){(wé̲yV)}	*!	
☞ yo{(?áwe̲)} yV		yV

The winning candidate is more optimal than the first potential output form because it positions the head syllable of the main stress foot on the antepenultimate syllable, effectively avoiding a HEAD(σ)-DEP violation at the syllable level of prosodic analysis. (Notice that any further positioning of the stress foot leftward will, necessarily, be suppressed by a high ranked ALIGN-R (PrWd, {F}), in a way analogous to the account of the trisyllabic Stress Window observed in Selayarese. Parsing pre-antepenultimate syllables as the stress foot will violate this high ranking constraint: *[{(yó?a)}(we̲yV)], as the main stress foot is separated from the right edge of PrWd by *we̲yV*).

While this approach to the problem gives an adequate account of the forms with an epenthetic vowel in the penultimate syllable, it will not extend to the case of metrically transparent epenthesis occurring in both the antepenultimate and the ultimate syllables (this is observation (62C) from §4.1). In such a case, exemplified with a form like *óne̲rahte̲?*, head dependence will not be decisive in the necessary way: because of the alternating pattern of epenthesis, only two candidates satisfy head dependence at the syllable level; hence, the responsibility for choosing the optimal output will fall to the alignment constraint, ALIGN-R (PrWd,{F}), which incorrectly choses the output with penultimate stress.

(68) ALIGN-R falsely predicts penultimate stress

input: onraht?	ALIGN-R (PrWd,{F})	HEAD(σ)-DEP
{(óne̲)}(rahte̲?)	(rahte̲?) !	
❽ (one̲){(ráhte̲?)}		

Only performance with respect to main stress foot alignment is relevant in cases like *óne̲rahte̲?*, falsely predicting penultimate stress in this case (but making correct predictions in the Selayarese example §3.3).[24]

[24]For the sake of thoroughness, it may be noted that analyses appealing to the formation of monsyllabic feet as a way of satisfying HEAD-DEP (like the one employed in the above discussion of Spanish) will not be descriptively adequate either. Suppose, for example, that FT-BIN is dominated by HEAD-DEP in Mohawk such that the construction of a one syllable stress foot is sanctioned over the antepenultimate syllable, e.g. [yo {(?á)} we̲ yU]. The domination of FT-BIN will invariable lead to the formation of a monsyllabic foot in the case of *óne̲rahte̲?* as well: *[o ne̲ {(rá)} te̲?], because of the role the alignment constraints play in the positioning of the main stress foot in the language.

The question one might ask at this juncture is, if metrical transparency of epenthesis implies the domination of some stress-related constraint by HEAD-DEP, what is the dominated constraint in Mohawk? One approach, which has its predecessors in syntactic theory (see Huck and Ojeda 1987 for references, and also Blevins 1990), is that HEAD-DEP compels the formation of a discontinuous prosodic constituent. That is, the input-dependence constraint may be interpreted as compelling a prosodic analysis of syllables containing epenthetic vowels in which said syllables are 'skipped' in the layering of syllables into prosodic feet. Thus, let us consider the representations in (69) as a potential means of satisfying HEAD-DEP.

(69) a. PrWd_{abcd}
F_{bd}
σ_a σ_b σ_c σ_d
yo {(?á) we (yV)}

b. PrWd_{abcd}
F_{ac}
σ_a σ_b σ_c σ_d
{(ó) ne (rah)} te?

The indices indicate which syllables form a constituent with superordinate prosodic categories. Thus, the second and fourth syllables support the prosodic foot in (69a), leaving the medial penultimate syllable unfooted, which, in turn, satisfies HEAD-DEP by leaving the epenthetic vowel unparsed by the stress foot. The main stress foot in (69b) skips the second syllable, which contains the epenthetic vowel, and in doing so, also satisfies HEAD-DEP. Of course, the formation of discontinuous prosodic constituents will need to be constrained in a formal way.

(70) CONTIG-SYLL
Each syllable dominated by a prosodic foot F_X, must be contiguous with at least one other syllable parsed by F_X.

CONTIG-SYLL is intended to do this directly by enforcing contiguity of syllables parsed by the same foot. Thus CONTIG-SYLL permits the foot structures in (71a) and (71c),[25] but will disallow the analysis in (71b), where both the second and the fourth syllables are not contiguous with the syllable they are paired with in the prosodic foot.

```
(71) a.  ... F ...          b.  *... F ...          c.   ... F ...
             / \                     /   \                   / | \
      ... σ  σ  σ  σ ...      ... σ  σ σ σ ...       ...  σ  σ σ σ ...
```

Returning to the matters at hand, metrical transparency of epenthesis may now be interpreted as the formation of a discontinuous prosodic foot, compelled by a high ranked HEAD(F)-DEP, necessarily defined over metrical stress feet.

(72) Metrical Transparency of Epenthesis in the Penult as Discontinuous Feet

input: yo?awyV	HEAD(F)-DEP	CONTIG-SYLL
X x (yo?a){(wéyV)}	e !	
☞ X x yo {(?á) we (yV)}		*

---

[25]It is of course possible to rule out ternary feet (71c) by requiring syllables to be contiguous to all other syllables in the word (as in Halle and Vergnaud 1987). The empirical issue here is whether or not all languages which outlaw discontinuous prosodic feet also show an avoidance for positing ternary feet, which would sanction the more general meaning for CONTIG-SYLL.

Thus, by excluding the segments of the penultimate syllable in the formation of the main stress foot, the winning candidate in the above tableau satisfies HEAD(F)-DEP, giving the desired metrical transparency effect for epenthesis into the penult.

Metrical transparency of epenthesis as the formation of a discontinuous foot extends naturally to the analysis of *óne̲rahte̲?*. HEAD(F)-DEP forces the first and third syllables to be organized into the main stress foot.

(73) Metrical Transparency of Epenthesis into Ultimate and Antepenultimate syllables

input: onraht?	HEAD-DEP	CONTIG-SYLL
X x (on$\underline{e}$){(ráht$\underline{e}$?)}	$\underline{e}$!	
X x {(ón$\underline{e}$)}(raht$\underline{e}$?)	$\underline{e}$!	
X x ☞ {(ó) n$\underline{e}$ (ra)} t$\underline{e}$?		*

The result here is invisibility of the syllables containing epenthetic vowels, achieved by the domination of CONTIG-SYLL. Also, the optimal output is one in which the main stress foot is a discontinuous prosodic foot, and misaligned by one syllable from the right edge of PrWd, thus HEAD(F)-DEP dominates both CONTIG-SYLL, and ALIGN-R (F, PrWd) as proposed above in (66).

As a brief note before concluding, it is important to discuss the role of CONTIG-SYLL in the analyses of the languages discussed so far. Do Selayarese or Spanish permit the formation of discontinuous constitutents for the purpose of satisfying head dependence? The answer is clearly no. In Selayarese, when an epenthetic vowel falls into the penultimate syllable, it is stressed according with the regular pattern of penultimate stress (see observations in §3.2). If CONTIG-SYLL was low ranking in the constraint hierarchy, we might except the result achieved above in Mohawk, namely an exceptional pattern of antepenultimate stress. But this is not the observed pattern, and hence, CONTIG-SYLL dominates HEAD-DEP in this language. The general point is that one means of suppressing the construction of discontinuous feet is by giving CONTIG-SYLL high rank in the constraint system.

Another potential means of constraining discontinuous constituency is by promoting Prince's (1983) *CLASH in the constraint hierarchy.[26] Suppose an attempt is made to skip a pair of syllables in the formation of a disyllabic foot: [{(σ) σ σ (σ)}]. The medial pair of syllables must be parsed as a foot because syllables must be maximally parsed into prosodic feet (see rationale given above in §3.2). Regardless of the headedness of the feet involved, a *CLASH violation will ensue because the head of the medial foot will be adjacent to the head of the discontinuous stress foot. Thus, skipping more than one syllable in the formation of discontinuous foot may be minimized by giving *CLASH high rank.

[26]This point was brought to my attention by Jill Beckman.

To close this module of the discussion, the results achieved above are consistent with the mode of analysis employed throughout this paper, namely, metrically transparent epenthesis follows from a constraint ranking in which HEAD-DEP dominates at least one stress related constraint. ALIGN-R (F, PrWd) and CONTIG-SYLL are the dominated constraints, leading to metrical transparency of epenthesis in post-tonic positions.

(74) Summary of Results
- •HEAD-DEP » ALIGN-R (F, PrWd): metrical transparency of epenthesis into the final syllable, e.g. *wa?kyé:rite?*
- •HEAD-DEP » CONTIG-SYLL: metrical transparency as discontinuous foot formation, e.g. *yo?áweyV*

4.3 Syllable Weight and Metrical Opacity of Epenthesis

Epenthetic /e/ is only partially transparent in word stress, as shown in §4.1 above. Epenthetic /e/ is stressed in penultimate and antepenultimate syllables which are closed by oral (nonlaryngeal) consonants.

(75)

A. Metrical Opacity		B. Metrical Transparency	
...H́ σ #		...σ́ L σ #	
wa?kérho?	'I coated'	wakátteru	'I'm dangerous'
tekansutéhrha?	'I splice it'	yo?áweyV	'dew'
...H́ σ σ #		...σ́ L L σ #	
VkényV?te?	'I shall come'	ónerahte?	'leaf'
Vkéthe?te?	'I will pound'	takatáweya?te?	'I entered'

The forms from (75A) contrast with those in (75B). For example, epenthesis into a triconsonantal cluster, as in *wa?kérho?*, is visible for the assignment of stress, while epenthesis into biconsonantal clusters, e.g. *tékeriks*, is transparent to stress. The condition that the syllable be closed by an *oral* consonant is evident from the simple observation that no stressed syllables are (unequivocally) closed by laryngeals. Furthermore, the claim that laryngeals don't close the syllable for the purpose of attracting stress is be supported by forms like *ónerahte?*, where the penult does not attract stress.[27]

The observation that (ante)penultimate syllables containing epenthetic vowels are stressed only when they are closed by oral consonants suggests the following interpretation within the framework employed here. Syllables closed by oral consonants are bimoraic, and as such constitute heavy syllables (assuming a moraic theory like that developed in Hyman 1985). The observed metrical opacity in heavy syllables is thus an effect of the constraint ranking in which Prince's (1990) Weight-to-Stress Principle (WSP) ("If heavy, then stressed.") dominates head dependence.

(76) Metrical Opacity of Epenthesis in Heavy Syllables

input: wa?hrho?	WSP	HEAD(F)-DEP
{(wá?.) her (ho?)}	*!	
☞ wa?{(hér.ho?)}		e

[27]The process of laryngeal lengthening described in Michelson (1981, 1988), when properly understood, seems to support the claim that laryngeals do not contribute to the overall weight of the syllable.

The first candidate in the above tableau avoids a HEAD(F)-DEP violation by forming a discontinuous prosodic foot, shown to be a viable strategy elsewhere for satisfying the head dependence constraint. This output, however, violates WSP in not stressing the heavy penult. The result of the proposed constraint ranking is, therefore, that WSP compels a HEAD-DEP violation, making the syllable containing the epenthetic vowel visible in word stress.

The analysis of forms like *wa?kérho?* given directly above, nothing else said, appears to make a false prediction for the location of stress in a slightly different class of forms. Suppose that both the penultimate and antepenultimate syllables are heavy, and the penult contains an epenthetic vowel, as in the hypothetical form [war.her.ho?]. Any stressing of such a form will lead to a violation of WSP (stressing the heavy penult leaves the antepenult unstressed, and vice versa). The responsibility for choosing the optimal output will therefore fall to the lower ranked HEAD(F)-DEP in such a situation, falsely predicting antepenultimate stress (while no crucial forms are available at present, Michelson's description strongly implies penultimate stress in such a context). An effort must be made, therefore, to avoid this bad result in Mohawk, and one potential avenue of analysis is to exploit the alignment constraint yielding End Rule Right effects, namely Align-R (PrWd, {F}).

Antepenultimate stress in [{(wár)}(her.ho?)] is predicted by an analysis in which the main stress foot is supported by the initial heavy syllable, in order to avoid parsing the penult as the weak syllable of the main stress foot, which would in turn incur a HEAD(F)-DEP violation. (This shows that WSP dominates FT-BIN, though this is not important here). In the following tableau, this analysis is contrasted with one in which the final two syllables are parsed as the stress foot of PrWd.

(77) An End Rule Right Effect

input: warhrho?	ALIGN-R (PrWd,{F})	WSP	HEAD(F)-DEP
{(wár)}(her.no?)	(her.no?) !	*	
☞ (war){(hér.no?)}		*	*

Both outputs violate WSP, but only the second one satisfies the stress foot alignment constraint, and thus, it may be chosen among the set of potential output candidates, provided that ALIGN-R (PrWd, {F}) dominates HEAD(F)-DEP. Notice the parallel to this result in Selayarese: ALIGN-R (PrWd, {F}) dominates HEAD(F)-DEP in this language as well, predicting that foot head dependence will not trigger rampant mis-alignment such that the main stressed syllable falls outside of the trisyllabic Stress Window, a descriptive term characterized in the specifications of ALIGN-R (PrWd, {F}).

It seems that the ranking of ALIGN-R (PrWd, {F}) above HEAD(F)-DEP is independently necessary, in the account of a case of stress-epenthesis interaction that has been neglected so far. The forms below show that epenthesis into the two final (light) syllables of a word correlates with antepenultimate stress (90).

(78)[28] ... σ́ σ σ #

yV! :kewe?	I will get there
yótere?	It's in the dish or glass
turé:sere?	It boiled over
tewakahsú:tere?	I've already spliced it

Ignoring the rest of the constraint system, it would seem that the analysis so far would predict pre-antepenultimate stress, as an effect of HEAD-DEP. HEAD-DEP is dominated, however, by ALIGN-R (PrWd, {F}), suggesting that minimal support from the syllables containing epenthetic /e/ is preferable to a prosodic analysis which perfectly satisfies head dependence; this is because the latter incurs a fatal alignment violation.

(79) Stress Window Effect with Epenthesis in Adjacent Syllables

input: turesr?	ALIGN-R (PrWd,{F})	HEAD-DEP
{(tú:re)}(sere?)	(sere?) !	
☞ tu {(ré:se)} re?		*

The violation of HEAD-DEP in this case is, of course, minimal, due to the independently motivated constraint ranking, from (67) above, in which HEAD-DEP dominates ALIGN-R (F, PrWd).

(80) Minimal Violation of HEAD-DEP

input: turesr?	HEAD-DEP	ALIGN-R (F, PrWd)
(tú:re){(sére?)}	e e!	
☞ tu {(ré:se)} re?	e	re?

The second candidate violates the alignment constraint, but that's okay, as it minimally violates HEAD-DEP by moving stress to the antepenultimate syllable.

It turns out that ALIGN-R (PrWd, {F}) and WSP are also crucially ranked as well, the former dominates the latter, in the analysis of forms schematized as follows [H L L]. Michelson's description implies penultimate stress in such forms, which is predicted by the constraint ranking in which ALIGN-R (PrWd, {F}) » WSP.

(81) Another Stress Window Effect

input: H L L	ALIGN-R (PrWd,{F})	WSP
{(H́)} (L L)	(L L) !	
☞ (H) {(Ĺ L)}		*

[28]Information for (78): /y-v-k-w-?/, M 1989: 65 (40b); /yo-t-r-?/, M 1989: 65 (40c); /t-a-w-aresr-?/, M 1988: 141 (38); /te-wak-ahsutr-?/, M 1988: 143 (49c).

It should be noted that the above result is not a stipulated one, designed to avoid certain problems stemming from the inherent tenets of the analysis. Ranking of alignment constraints relative to WSP is needed in a variety of languages in which WSP effects cancel out effects of the alignment constraints (e.g. Munster Irish, Alderete 1994, Pirahã, Everett 1988, P&S). The result here simply represents a system characterized by the reverse ranking.

One last ranking argument needs to be made, banning final stress on words ending in heavy syllables. While, some loan words carry final stress (Bonvillain 1973), final stress is systematically avoided, including when the final syllable is a heavy syllable. This observation suggests the domination of WSP by P&S's NONFINALITY, relativized to the syllable level. This ranking has the effect of making the final syllable unavailable as a syllabic head of PrWd.

(82) An Extrametricality Effect

input: ...σ H	NONFINALITY(σ)	WSP
...σ {(H́)}	*!	
☞ ...{(σ́ H)}		*

The following list summarizes the results reached in this subsection. It can be seen from this summary that special attention was given to the relative ranking of HEAD-DEP, WSP, and ALIGN-R (PrWd,{F}). Also, these results are logically consistent. That is, two arguments, namely (83c) and (83a), imply by transitivity that ALIGN-R (PrWd, {F}) dominates HEAD-DEP, and this ranking is important to one of the results achieved above (83b).

(83) Summary of Results

a. WSP » HEAD-DEP: Syllable weight contributes to metrical opacity of epenthesis, e.g. *wa?kế̲rho?*
b. ALIGN-R (PrWd,{F}) » HEAD-DEP: penultimate stress in [H H̲́ σ]
c. ALIGN-R (PrWd,{F}) » WSP: penultimate stress in [H Ĺ L]
d. NONFINALITY(σ) » WSP: penultimate stress in [...σ́ H]

The overall structure of the constraint system developed above may now be represented with the following constraint hierarchy.

(84) Partial Metrical Transparency of Epenthesis in Mohawk

ALIGN-R (PrWd,{F}) » WSP » HEAD-DEP » ALIGN-R (F, PrWd),
NONFINALITY(σ) CONTIG-SYLL

The analysis of stress-epenthesis interactions in Mohawk proposed here has the following properties: (i) it accounts for the transparency/opacity of epenthetic /e̲/ in word stress by giving head dependence intermediate rank, (ii) it posits a Stress Window by giving the stress foot alignment constraint relatively high rank, and (iii) it permits the formation of a discontinuous prosodic constituent by giving CONTIG-SYLL relatively low rank in the constraint system.

5. Conclusion

This paper has argued that a notion of head dependence, that is, dependence defined for prosodic heads, is necessary and sufficient in the description of stress-epenthesis interaction cross-linguistically. Specific types of constraint rankings were employed in particular analyses of this class of problems, and before closing, it will be useful to give an analytic summary of these constraint interactions.

To begin, constraint rankings were extensively employed in the above discussions which pitted head dependence against different alignment constraints. The subordination of alignment of prosodic feet to the prosodic word was necessary in the analysis of certain metrical transparency effects in Spanish, Selayarese, and Mohawk. Head dependence, relativized to the level of the prosodic foot, was used in the account of the observation that the stress system failed to count epenthetic vowels in these examples, and head dependence for the head syllable was employed in the analysis of the case of Dakota. The domination of head dependence by the alignment constraints was used for an opposite effect in the cases of Swahili and Winnebago; in these examples, proper alignment of the relevant phonological units enforced canonical stress patterns, even when this lead to a violation of HEAD-DEP. Finally, the analysis of stress window effects in Selayarese and Mohawk called for the domination of head dependence, this time by the specific alignment constraint regulating the position of the main stress foot. In general, permuting the rankings of different kinds of alignment constraints relative to the set of HEAD-DEP constraints was necessary to account for the full range of phenomena examined here.

Other constraint rankings at play in the above case studies involved constraint conflicts between head dependence and requirements on the general shape of the prosodic foot. For example, the analyses of noncanonical stress in Dakota and Spanish involved the domination of the foot structure constraints, FOOT BINARITY and FOOT FORM. Also, the complicated cases of metrically transparent epenthesis in Mohawk was analyzed as the violation of the constraint calling for syllable contiguity within the larger prosodic foot. Again, constraints on foot structure may be dominated, as assumed in these cases, but they may also be given high rank, effectively maintaining canonical foot shape, as was the case in the analysis of Selayarese where the stress foot was assumed to be, under normal circumstances, disyllabic. Lastly, the domination of head dependence by stress-attracting constraints like the WSP lead to another kind of metrical opacity result in Mohawk, where bimoraic syllable weight was observed to be a correlate to stress.

One final observation was made regarding the absence of constraint conflict among head dependence and NONFINALITY constraints. The combined efforts of these two sets of constraints in disallowing segments from occupying head positions was shown to imply a universal truth concerning the absence of stress-epenthesis interaction in extrametrical units. In summary, a wide range of constraint rankings seem to be attested in these example cases. Otherwise, given the nature of the constraints involved, the ranking of said constraints will not have observable effects in any stress system.

Moving now to the more general properties of the analyses developed above, it is necessary to emphasize that the results derived therein applied principles which are central to Optimality Theory. Firstly, the analysis of metrical transparency of epenthesis in Mohawk, and also in Spanish and Dakota, posited prosodic structure which is not uniform with the set of structures involved in the regular stress patterns (see Prince 1993 on the Thesis of Non-Uniformity). That is, the prosodic analysis responsible for the rendering of stress in these cases was derived solely on the basis of constraint rankings, rather that putative canonical representations preserved through a series of phonological operations. As a example, recall that metrically transparent epenthesis in the penultimate syllable in Mohawk was represented by the formation of a discontinuous prosodic foot, which is obviously not uniform with the pattern of syllable contiguity observed elsewhere in the language. Furthermore, head dependence was argued to compel the construction of a unary, monosyllabic foot in Spanish, and a foot type reversal in Dakota. These results also entailed positing noncanonical prosodic structure, according to the constraints operative elsewhere in these languages.

Secondly, the principle of Minimal Violation was employed at various junctures above, most perspicuously in the context of alignment effects. The analysis of Stress Window in Selayarese and Mohawk relied crucially on the minimal violation of alignment constraints universally quantified over the stress feet of the PrWd. Also, minimal violation of featural markedness constraints was actively employed in the ternary pattern of vowel reduction found in Russian. Lastly, the formation of discontinuous prosodic constituency necessarily obeys this general principle of constraint violation, as the skipping of a single syllable (not more) is only allowed in the contexts examined above.

A final point, which has supported a general theme throughout sections 3 and 4, is that the partial metrical transparency effects derived here are only possible in a system of constraint evaluation in which constraints both are ranked, and violable. All cases of partially transparent epenthesis in word stress were characterized in a constraint hierarchy in which head dependence assumed intermediate status among the set of structural constraints on prosodic analysis. The successes of these analyses, therefore, reflects the success of the OT program in general.

Lastly, let us consider the overall architecture of the grammar which employs constraints on correspondent segments which are relativized to prosodic heads. One of the main purposes of this paper has been to advocate and exemplify the use of head dependence constraints, constraints on the relation between output head segmentism and its input correspondents. Arguments for the necessity of a notion of head dependence has centered around a study of the interaction between word stress and epenthesis, but a more general theory involving faithfulness to prosodic heads is indeed quite plausible. This trend toward a more general theory has been pursued in this paper with a discussion of how a notion of head identity may be applied to the analysis of head identity effects in stressed units (see also McCarthy 1995 for further applications of head identity). Featural identity and segmental dependence, applied generally to categories like the stressed syllable or main stress foot of a word, enabled us to establish a far-reaching relationship between metrically transparent epenthesis and stress-dependent vowel reduction. This connection, it was argued, can only be made in correspondent theoretic OT, as these are fundamental notions employed only in the implementation of faithfulness in this framework. Furthermore, the definition of head faithfulness within the CT model extends straightforwardly to head maximization, employed in McCarthy (1995) in a nonderivational analysis of positive prosodic circumscription, and also in Alderete (1995b) in an analysis of lexically-governed stress inventories. The ideas central to this paper therefore find a natural place in nonderivational constraint-based phonology which employs the notion of correspondence in the definition of faithfulness.

6. References

Alderete, J. (1994). "Munster Irish Stress," Ms. University of Massachusetts, Amherst.

Alderete, J. (1995a). "Winnebago Accent and Dorsey's Law," In J. Beckman, Urbanczyk, S. and Walsh, L. (eds.) *University of Massachusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory. Amherst, MA: Graduate Linguistic Student Association.

Alderete, J. (1995b). "Deriving Root Stress Inventory and Recessive Affixal Stress in Cupeño," Ms. University of Massachusetts, Amherst.

Ashton, E. O. (1944). *Swahili Grammar (Including Intonation)*. Burnt Hill, Harlow: Longman Group Ltd.

Beckman, J. (1995). "Shona Height Harmony: Markedness and Positional Identity," In J. Beckman, Urbanczyk, S. and Walsh, L. (eds.) *University of Massachusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory. Amherst, MA: Graduate Linguistic Student Association.

Benua, L. (1995). "Identity Effects in Morphological Truncation," In J. Beckman, Urbanczyk, S. and Walsh, L. (eds.) *University of Massachusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory. Amherst, MA: Graduate Linguistic Student Association.

Blevins, J. (1990). *Syntactic Complexity: Evidence for Discontinuity and Multidomination*. Doctoral Dissertation, University of Massachusetts, Amherst.

Bonvillain, N. (1973). *A Grammar of Akwesassne Mohawk*. Mercury Series, Ethnology Division Paper No. 8. Ottawa: National Museum of Man.

Boyanus, S.C. (1955). *Russian Pronunciation. The Russian System of Speech Habits in Sounds, Stress, Rhythm, and Intonation*. Vol. I. Cambridge: Harvard University Press.

Broselow, E. (1982). "On the interaction of stress and epenthesis," *Glossa* 16: 115-132.

Chafe, W. (1977). "Accent and Related Phenomena in the Five Nations Iroquois Languages," in L. Hyman (ed.) *Studies in Stress and Accent, Southern California Occasional Papers in Linguistics* 4, Department of Linguistics, University of Southern California, Los Angeles.

Chung, S. (1983). "Transderivational Relationships in Chamorro Phonology," *Language* 59: 35-66.

Dunlap, E. (1991). *Issues in the Moraic Structure of Spanish*. Doctoral Dissertation, University of Massachusetts, Amherst.

Everett, D. (1988). "On Metrical Constituent Structure in Pirahã," *Natural Language and Linguistic Theory* 6: 207-46.

Hale, K. and J. White Eagle (1980). "A Preliminary Metrical Account of Winnebago Accent," IJAL 46: 117-32.

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

Hamilton, W.S. (1980). *Introduction to Russian Phonology and Word Structure*. Columbus: Slavica Publishers, Inc.

Harris, J. (1969). *Spanish Phonology*. Cambridge: MIT Press.

Harris, J. (1970). "A Note on Spanish Plural Formation," *Language* 46: 928-930.

Harris, J. (1977). "Remarks on Diphthongization in Spanish," *Lingua* 41: 261-305.

Harris, J. (1980). "Nonconcatenative Morphology and Spanish Plurals," *Journal of Linguistic Research* 1.1. Bloomington: Indiana University Linguistics Club.

Harris, J. (1982). *Syllable Structure and Stress in Spanish*. Cambridge: MIT Press.

Hayes, B. (1980). *A Metrical Theory of Stress Rules*. Ph.D. Dissertation, MIT.

Hayes, B. (1987). "A Revised Parametric Metrical Theory," *Northestern Linguistic Society* 17: 274-289.

Hayes, B. (1989). "Compensatory Lenthening in Moraic Phonology," *Linguistic Inquiry* 20: 253-306.

Hayes, B. (1995). *Metrical Stress Theory. Principles and Case Studies*. Chicago: The University of Chicago Press.
Hooper, J. and T. Terrell (1976). "Stress Assignment in Spanish: A Natural Generative Analysis," *Glossa* 10.1: 64-110.
Huck, G. and A. Ojeda (eds.) (1987). *Discontinuous Constituency*. Vol. 20. Syntax and Semantics. Orlando: Academic Press.
Hung, H. (1989). "[ATR] Harmony in Yapese," *McGill Working Papers in Linguistics* 6: 48-64.
Hyman, J. (1985). *A Theory of Phonological Weight*. Dordrecht: Foris.
Ikawa, H. (1995) "On Stress Assignment, Vowel-Lengthening, and Epenthetic Vowels in Mohawk and Selayarese: Some Theoretical Implications," Ms. University of California, Irvine.
Itô, J. (1986). *Syllable Theory in Prosodic Phonology*. Doctoral Dissertation, University of Massachusetts, Amherst. Published by Garland Press, New York, 1988.
Itô, J. (1989). "A Prosodic Theory of Epenthesis," *Natural Language and Linguistic Theory* 7: 217-260.
Itô, J. and A. Mester (1992). "Weak Layering and Word Binarity," Linguistics Research Center report: LRC-92-09, University of California, Santa Cruz.
Itô, J. and A. Mester (1993). "Licensed Segments and Safe Paths," Linguistics Research Center report: LRC-93-05, University of California, Santa Cruz.
Jensen, J. (1977). *Yapese Reference Grammar*. Honolulu: University of Hawai Press.
Jones, D. and D. Ward (1969). *The Phonetics of Russian*. Cambridge: Cambridge University Press.
Kager, R. (1994). “Alignment and Ternary Stress,” Ms. Utrecht University.
Kennedy, C. (1994). "Morphological Alignment and Head Projection," In Merchant, J. *et al* (eds.) *Phonology at Santa Cruz* 3: 47-64.
Kenstowicz, M. and C. Kisseberth (1979). *Generative Phonology: Description and Theory*. New York: Academic Press, Inc.
Kiparsky, P. (1973). “Abstractness, opacity and global rules,” in O. Fujimura (ed.), *Three Dimensions of Linguistic Theory*, pp. 1-136. Tokyo: Taikusha.
Kiparsky, P. and M. Halle (1977). “Towards a Reconstruction of the Indo-European Accent,” in L. Hyman (ed.) *Studies in Stress and Accent*, *Southern California Occasional Papers in Linguistics* 4, Department of Linguistics, University of Southern California, Los Angeles.
Lamontagne, G. and K. Rice (1995). "A Correspondence account of coalescence," In J. Beckman, Urbanczyk, S. and Walsh, L. (eds.) *University of Massachusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory. Amherst, MA: Graduate Linguistic Student Association.
Maddieson, I. (1984). *Patterns of Sound*. Cambridge: Cambridge University Press.
McCarthy, J. (1980). "The Role of the Evaluation Metric in the Acquisition of Phonology," In Baker, C.L. and J.J. McCarthy (eds.) *The Logical Problem of Language Acquisition*. Cambridge: MIT Press.
McCarthy, J. (1995a). "Extensions of Faithfulness: Rotuman Revisited," Ms. University of Massachusetts, Amherst.
McCarthy, J. (1995b). “Some Remarks on Phonological Opacity,” Ms. University of Massachusetts, Amherst.
McCarthy, J. and A. Prince (1986). "Prosodic Morphology," Ms. University of Massachusetts, Amherst, and Brandeis Unversity, Walthan, Mass.
McCarthy, J. and A. Prince (1993a). *Prosodic Morphology: Constraint Interaction and Satisfaction*. Ms., University of Massachusetts, Amherst, and Rutgers University. [Forthcoming MIT Press].
McCarthy, J. and A. Prince (1993b). "Generalized Alignment," in Booij, G. and J. van Marle (eds.), *Yearbook of Morphology 1993*. Dordrecht: Kluwer.

McCarthy, J. and A. Prince (1994a). "The emergence of the Unmarked: Optimality in Prosodic Morphology," in Gonsàles, M. (ed.), *Proceedings of the North East Linguistic Society* 24: 333-379.
McCarthy, J. and Prince (1994b). "Prosodic Morphology: An Overview," Papers presented as the University of Utrecht.
McCarthy, J. and A. Prince (1995). "Faithfulness and Reduplicative Identity," In J. Beckman, Urbanczyk, S. and Walsh, L. (eds.) *University of Massachusetts Occasional Papers in Linguistics* 18: Papers in Optimality Theory. Amherst, MA: Graduate Linguistic Student Association.
Michelson, G. (1973). *A Thousand Words of Mohawk*. Ethnology Division Paper No. 5. Ottowa: National Museums of Canada.
Michelson, K. (1981). "Stress, Epenthesis and Syllable Structure in Mohawk," In Clements, N. (ed.) *Harvard Studies in Phonology* Vol. II, pt.2.
Michelson, K. (1983). *A Comparative Study of Accent in the Five Nations Iroquian Languages*. Unpublished Ph.D. Dissertation, Harvard University.
Michelson, K. (1988). *A comparative study of Lake Iroquoian accent*. Dordrecht: Kluwer.
Michelson, K. (1989). "Invisibility: Vowels without a Timing Slot in Mohawk," in Gerdts, D. and K. Michelson (eds.) *Theoretical Perspectives on Native American Languages*. Albany: SUNY Press.
Miner, K. (1979). “Dorsey’s Law in Winnebago-Chiwere and Winnebago Accent,” *International Journal of American Linguistics* 45: 25-33.
Miner, K. (1993). “Winnebago Accent: the Rest of the Data,” in *Indiana University Linguistics Club Twenty-Fifth Anniversary Volume*. Bloomington, IULC.
Mithun, M. (1979). "Iroquoian," In L. Campbell and M. Mithun (eds.) *The Languages of Native America*. Austin: University of Texas Press.
Mithun, M. and Basri, H. (1985). "The Phonology of Selayarese," *Oceanic Linguistics* 25.1-2: 210-254.
Pater, J. (1995) "*NC. ," (title unknown) to appear in Kager, R. H. van der Hulst, and W. Zooneveld (eds.) *Proceedings of the Workshop on Prosodic Morphology*.
Piggott, G. (1995). "Epenthesis and Syllable Weight," *Natural Language and Linguistic Theory* 13.2: 283-326.
Polomé, E. C. (1967). *Swahili Language Handbook*. Washington D. C.: Cetner for Applied Linguistics.
Postal, P. (1968). *Aspects of Phonological Theory*. Hew York: Harper & Row.
Prince, A. (1983). "Relating to the Grid," *Linguistic Inquiry* 14.X: 19-100.
Prince, A. (1990). Quantitative Consequences of Rhythmic Organization," *Parasession on the Syllable in Phonetics and Phonology*, Chicago Linguistic Society, pp. 355-98.
Prince, A. (1993). “Minimal Violation,” paper presented at ROW, Rutgers University, New Brunswick.
Prince, A. and P. Smolensky (1993). *Optimality Theory: Constraint Interaction in Generative Grammar*. Ms. Rutgers University and University of Colorado at Boulder. [Forthcoming MIT Press].
Reformatskij, A. (1955, [1967]). *Voprosy Jazikoznanie*. Moscow.
Rosenthall, S. (1994). *Vowel/ Glide Alternation in a Theory of Constraint Interaction*. Doctoral Dissertation, University of Massachusetts, Amherst.
Selkirk, E. (1981). "Epenthesis and Degenerate Syllables in Cairene Arabic," *MIT Working Papers in Linguistics* 3: 209-32.
Selkirk, E. (1991). “Vowel Height,” Ms. Univeristy of Massachusetts, Amherst.
Selkirk, E. (1994). "Positional licensing as positional (conditional) Parse vs. Align (F;Gcat). Class notes from Linguistics 730, University of Massachusetts, Amherst.
Selkirk, E. (1995). "Surface Restriction in the Distribution of Lexical Constrasts: The Role for Root Faithfulness," Handout to class presentation in Ling 751, University of Massachusetts, Amherst.

Sietsema, B. (1989). *Metrical Dependencies in Tone Assignment.* Doctoral Dissertation, MIT.

Shaw, P. (1976). *Theoretical issues in Dakota phonology and morphology*, Ph.D. Dissertation, University of Toronto.

Shaw, P. (1985). "Modularism and substantive constraints in Dakota lexical phonology," *Phonology Yearbook* 2: 173-202.

Smolensky, P. (1995). "On the Internal Structure of the Constraint Component *Con* of UG," Handout to talk presented at University of California, Los Angeles.

Susman, A. (1943). *The Accentual System of Winnebago*. Doctoral Dissertation, Columbia University.

Urbanczyk, S. (1995). "The case of the migrating suffix: Out-of-control in Salish," Ms., University of Massachusetts, Amherst.

Urbanczyk, S. (1995) *Reduplication and Prosodic Morphology in Lushootseed.* Doctoral Dissertation, University of Massachusetts, Amherst.

Wiltshire, C. (1992). *Syllabification and Rule Application in Harmonic Phonology*. Ph.D. Dissertation, University of Chicago.