A Stratal OT Analysis of the Sanskrit Nominal Accent Paradigm

by

Lisa Marston
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Current contact information:
Enrolled in Linguistics PhD program, University of Southern California
lmarston@usc.edu

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Abstract

Stratal Optimality Theory posits constraint evaluation at three distinct levels or strata: stem, word and phrase level. This multi-level variation of the original OT model may provide more economical and elegant explanations of problems involving opacity, derived environment effects and paradigmatic effects than other Parallel OT theories that have been developed to address these issues.

Alternations of pitch accent placement within the Vedic Sanskrit nominal inflectional and derivational paradigms provide evidence supporting Stratal OT. First, two major accentual patterns surface upon inflection; accent may remain fixed on a stem syllable in all cases or may shift to the inflectional ending in "weak" cases only. Second, for all nominals, the vocative is not accented, except when it appears at the beginning of a phrase; in that case, the accent is always on the initial syllable, regardless of the position of the accent on the stem or other inflected forms. Finally, accentual variation of primary and secondary derived stems and words is seen; accent may remain on the root (or primary stem) or may fall on the derivational ending; in either case, accent remains fixed throughout inflection (i.e., no accent shift).

In this analysis, a system of well-grounded morphological, prosodic, identity and alignment constraints are proposed for the stem, word and phrase levels to explain these alternations. It is argued that inflection takes place at the word level while derivation occurs at the stem level. Constraints at the three levels follow a consistent ranking pattern, while remaining relevant to the prosodic and morphological requirements of the specific level. The highest ranked identity constraint at the stem and word levels are substantively identical: MAX-IO(Accent)$_{HEAD}$. Crucially, however, the head is different at each level, with the derivational suffix being the head at the stem (derivational) level, while the stem or root is the head at the word (inflectional) level. This allows for a principled explanation of the various accentual phenomena and, additionally, provides evidence for the operation of distinct stem and word levels.

Numerous constraint tableaux are presented; in each case, the winner is the correct surface form. These data indicate that Stratal OT effectively captures the Sanskrit nominal accentual paradigms using a small number of well-grounded constraints. Importantly, it is demonstrated that Parallel OT is unable to generate the correct surface forms for all the relevant alternations without the introduction of exotic and otherwise unnecessary constraints. Further cross-linguistic and theoretical research into the Stratal OT model is needed to establish its universality and superiority to other models.

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1.0 Introduction

After the publication of Prince and Smolensky's landmark monograph in 1993, Optimality Theory (OT) ascended in short order to become the favored approach to phonology and morphophonology. OT provided an explanation for the previously mysterious occurrence of "conspiracy" within languages, allowed for easily verifiable typological predictions, and shifted focus from underlying abstract forms to surface forms, a significant advantage over previous approaches with respect to learnability. The excitement over OT resulted in an abundance of literature, providing ample data to support its main tenets. However, it soon became apparent that OT was unable to adequately deal with several critical phonological and morphophonological phenomena, including opacity, derived environment effects and paradigmatic effects.

A significant number of variations to the original OT model have been proposed to address these areas. After reviewing four of these proposals, I will present the Stratal OT model and discuss why it may be more economical and well-grounded than alternative models. I will then detail a constraint system using the Stratal OT framework that provides a principled explanation for the majority of inflectional and derivational alternations in the Vedic Sanskrit nominal accentual paradigm. I will compare my analysis to a pre-OT rule-based solution, as well as to the Parallel OT approach. I will demonstrate that Parallel OT is unable to generate correct surface forms for large classes of words without introducing exotic and powerful new constraints. Finally, I will suggest further research that is worthy of attention to support the validity and universality of the Stratal OT model and to assert its superiority over alternative OT approaches.

2.0 Background – Parallel OT

2.1 Architecture of the original OT model

The outstanding success of OT in the areas mentioned above (explanation of conspiracies, predictive typology and ease of learnability) is a consequence of the architecture of the model. The following three aspects are particularly important for the purposes of this paper (my purpose is not to provide a general summary of Optimality Theory, so I will not discuss other aspects of the model, such as Gen, Eval, etc., which I take for granted as part of any OT model, including Stratal OT):

1. Input-Output Constraint Evaluation: UG consists of a universal set of violable input-output constraints whose ranking is language-specific; higher ranked constraints always dominate lower ranked constraints ("strict domination"); constraints hold at the level of the output, never at the level of the input ("richness of the base"). Particularly important to this paper is the fact that output candidates are evaluated against input (underlying) forms and not against any intermediate or other output forms.
2. Markedness & Faithfulness Constraints: There are only two types of constraints: markedness and faithfulness. Markedness constraints serve to reduce markedness, in terms of articulation and perception, of output forms; there are a number of types of markedness constraints, including featural markedness, prosodic markedness, etc. Faithfulness constraints, on the other hand, serve to maintain lexical contrast of output forms by preserving faithfulness to the underlying (input) form. The tension between these two types of constraints is resolved through the ranking schema; the

patterns arising from varying ranking schemes are descriptive and predictive of specific language typologies.

3. Parallelism: All constraints interact in a single hierarchy. Thus, there are no intermediate levels of representation as there are in derivational phonology/morpho-phonology. From the point of view of learnability, this is a highly desirable feature, as there is no need to explain how a learner discovers abstract intermediate representations.

(Prince and Smolensky 2002; Kager 1999)

2.2 Limitations of the original OT model

The original OT model has substantial problems explaining opacity, derived environment effects and paradigmatic effects. Needless to say, an inability to handle such important and pervasive phenomena seriously compromises the OT program. Following is a brief summary of the issues faced in each of these areas.

2.2.1 Opacity

Perhaps the most troublesome issue for OT is opacity. As Kager (1999:377) states, "Opacity is OT's Achilles' heel." Prior to OT, it was understood that phonological rules may be ordered in a counterfeeding or counterbleeding manner, the result being that they are opaque at the level of surface representation. Pre-OT derivational phonology handled opacity in a facile manner; rules simply needed to be ordered appropriately to produce transparent or opaque surface representations. The original OT model, on the other hand, having no intermediate representations and being crucially dependent on the output form, is actually unable to select the appropriate winner in such cases. McCarthy (2007:sxn. 2.3.3) demonstrates that, in cases of

counterbleeding, there will always be a candidate that is more faithful and less marked than the actual surface form (this is the candidate that would surface if rules were ordered transparently), while in counterfeeding, the appropriate candidate can be selected only if faithfulness constraints are strengthened to a degree that is undesirable and otherwise unnecessary.

2.2.2 Derived environment effects

There is a class of lexical phonological rules that apply only to strings that have been derived from prior rule application (either phonological or morphological), but do not apply to underlying forms; thus, these rules are known as "derived environment rules". It was discovered that derived environment rules are cyclic, (i.e., they apply at each stage of derivation), in contrast to non-cyclic, post-lexical rules. Lexical Phonology resolved problems involving derived environments through a multi-level morphophonological model, with cyclic rules applying at each level of derivation. The original OT model, on the other hand, is unable to handle problems involving derived environments precisely because it cannot differentiate between surface representations that are derived and non-derived; OT sees only input and output forms. With only one level of constraints, the system selects both the derived and non-derived candidate using the same criteria, resulting in the selection of the wrong candidate in one or the other case.

2.2.3 Paradigmatic effects

Finally, the original OT model is insufficient to satisfactorily model paradigms, that is, inflectionally related words based on the same underlying lexical stem. OT's input-output evaluation inadequately captures the situation where multiple outputs (that is, the entire paradigm) seem to be compared to each other (output-output comparison) and faithfulness to the paradigm is encouraged (McCarthy 2003).

2.3 Alternative Parallel OT models

Clearly, issues that are so central to phonology and morphophonology must be resolved or OT cannot be considered a viable model of UG. Researchers have been attempting to modify the original model in a variety of ways so that it will handle one or more of these problematic areas without altering the basic architecture in a way that compromises the initial accomplishments of the theory. I will briefly describe four such variations on the OT theme.

2.3.1 Sympathy

McCarthy (1998) proposed a system of "Sympathy" to explain opacity within OT. The selection of the winning candidate is determined not only by constraints demanding faithfulness to the input, but also by a constraint that demands faithfulness to another candidate. McCarthy states that the "sympathy candidate" is "the most harmonic member of the set of candidates obeying some designated input-output faithfulness constraint, the selector" (1998:8). That is, all candidates either satisfy or violate the selector constraint; out of those that satisfy it, the optimal candidate becomes the sympathy candidate. The constraint hierarchy includes a "sympathy constraint" demanding faithfulness to some characteristic of the sympathy candidate. When all candidates are evaluated, the opaque candidate emerges as the winner, as it satisfies the sympathy constraint, whereas the transparent candidate that would have won under a non-Sympathy model loses because it violates the sympathy constraint.

Thus, Sympathy deviates from the original model in terms of input-output constraint evaluation. The sympathy constraint demands output faithfulness to another candidate rather than the input (underlying) form; it is therefore a type of "output-output" constraint.

2.3.2 Local Conjunction

Local Conjunction (LC), originally conceived by Smolensky (Kager 1999:393; Lubowicz 2002:sxn. 1), posits that two constraints (which can be two faithfulness constraints, two markedness constraints or one of each) can be conjoined into a single constraint that is ranked higher than either of the individual constraints. This constraint will be violated if and only if both constraints are violated within a single domain (e.g., segment, syllable, morpheme, etc.). Lubowicz (2002) demonstrates that LC can explain derived environment effects, both phonological and morphological.

Although LC generally adheres to the principles of input-output constraint evaluation and markedness-faithfulness constraints, it introduces the possibility of constructing complex constraints, a quite powerful addition to OT architecture. As Kager notes (1999:400), this may compromise the principle of strict domination, a key tenet of the original OT model.

2.3.3 Optimal Paradigms

McCarthy's Optimal Paradigms (OP) model (2003) encompasses significant modifications to the basic principles of OT in order to deal with inflectional paradigms. He states, "The OP model presupposes a distinction between inflectional morphology, which is organized into paradigms, and derivational morphology, which is organized hierarchically by the relation "is derived from"...in paradigms, all members are co-equal in their potential to influence the surface phonology of other members of the paradigm" (2003:6) Thus, this model is relevant only to analysis of inflectional paradigm and does not have wider applications. His major proposals are: 1) candidates comprise entire inflectional paradigms, not just individual output forms; 2) the stem of each paradigm member is in a correspondence relationship with the stem of every other member, therefore, there is no distinct "input" form; rather, each member of the

paradigm is compared to every other member; and 3) OP-constraints are output-output faithfulness constraints that regulate the paradigm correspondence relationship (2003:5). The OP system thus represents major revisions of the original OT model in order to accommodate inflectional paradigms.

2.3.4 Anti-Faithfulness

Alderete (1999, 2001) analyzes the accentual systems of several languages (Vedic Sanskrit is not one of these languages, but the accentual systems of the languages he analyzes are similar to Sanskrit). To explain these accentual paradigms, he proposes a new type of constraint: "Anti-faithfulness". Anti-faithfulness constraints are the negation of faithfulness constraints. While faithfulness constraints require identity between some characteristic of the input and the output, anti-faithfulness constraints specifically require there to be a difference with respect to this characteristic, ostensibly to "force an alternation in the paradigm which has the effect of marking and re-enforcing salient morphological distinctions" (1999:8). As with OP, Anti-faithfulness represents a significant modification of basic OT principles in order to analyze paradigmatic effects (in this case, accentual paradigms).

These four models are representative of major approaches intended to strengthen the original OT model. What is apparent is that they all aim to modify one or both of the first two aspects of OT architecture mentioned in section 2.1 above: Input-output constraint evaluation and markedness-faithfulness constraint types. That is, they all approach the issue from the perspective of constraints by 1) modifying the straightforward input-output mapping of the original OT model through the addition of often complex output-output correspondences (Sympathy, Optimal Paradigms) or a more complicated constraint ranking schema (Local

Conjunction), and/or 2) adding powerful and exotic new constraints to the system that stretch the definitions of "markedness" and "faithfulness"; such constraints (Sympathy constraints, OP constraints, Anti-faithfulness constraints, etc.) are not as well-grounded as other basic constraints and are otherwise unnecessary.

The key aspect of OT architecture that such models do not modify is the third one mentioned in section 2.1: Parallelism. Therefore, these approaches (as well as the original OT model) may all be referred to by the term "Parallel OT". Parallelism is precisely the target of Stratal OT.

3.0 The Stratal OT model

3.1 Architecture of the Stratal OT model

Stratal OT has been pioneered in large part by Paul Kiparsky (2000, 2003, 2008), one of the founders of Lexical Phonology. Its innovation is quite straightforward: The complete parallelism of the original OT model is modified to allow for levels of constraint systems. Kiparsky limits the levels to precisely three: the stem, word and phrase levels. The output of one level is the input to the next level, with the underlying lexical representation being the input to the stem level. Constraints in Stratal OT are limited to the basic input-output and markedness-faithfulness constraints of the original model, without recourse to exotic and powerful new constraints or mechanisms (as required by all Parallel OT approaches). Opacity arises in the system as a consequence of "inter-level constraint masking" (Kiparsky 2000:1) and derived environment effects are a natural outcome of a system consisting of multiple levels. As Kiparsky states, "On the phonological side, Stratal OT accounts for opacity and paradigmatic transfer phenomena. Although constraint interaction is locally parallel and transparent, the interleaving of

phonology and morphology and the intrinsic seriality of strata gives rise to 'derivational' effects" (2008:1).

It is important to understand that constraints at each level operate in a parallel fashion, so parallelism as a key component of the theory is not entirely rejected, rather, full parallelism is modified in favor of a stratified model. A large amount of evidence has accrued for the operation of stem, word and phrase (or post-lexical) levels in phonology and morphophonology since the advent of Lexical Phonology, including level ordering, derived environment effects and the Strict Cycle Condition. Rather than ignoring or rejecting such evidence, Stratal OT builds on it, adapting the original OT model in a relatively simple and elegant way.

Perhaps the most persuasive argument in favor of Stratal OT is that it is able to explain all three problematic areas (opacity, derived environment effects and paradigmatic effects) while adhering to all of the tenets of the original OT model except for full parallelism. Kiparsky has demonstrated Stratal OT's effectiveness and superiority at solving 1) opacity and paradigmatic effects in well-known Arabic data involving epenthesis and deletion (2000); 2) opacity, cyclicity and accentual paradigmatic effects in Ancient Greek phonological, prosodic and morphological data (2003); and 3) opacity and derived environment effects in Sanskrit reduplication (2008). In all cases, his solutions appear to be more economical and elegant than Parallel OT analyses of similar phenomena.

The present analysis will provide further evidence that Stratal OT can model inflectional and derivational paradigmatic effects, with respect to pitch accent, in a more straightforward manner than Parallel OT alternatives. Additionally, I will present evidence that the highest ranked identity constraints at the stem and word level refer to the head of the domain. This motivates the inclusion and ranking pattern of these particular constraints in the constraint

system, provides a principled explanation for observed accentual alternations, and is persuasive evidence for the operation of distinct stem and word levels.

3.2 An alternative derivational OT model (CC-OT)

McCarthy, who pioneered the Sympathy and Optimal Paradigm models, tellingly states in his 2007 publication regarding opacity in OT, "This book's principal thesis is that the best theory of opacity – and of phonology generally – is a synthesis of Optimality Theory with derivations" (3). He additionally states that "OO [output-output] faithfulness's inadequacy as a theory of opacity is not entirely unexpected. OO faithfulness is a reasonable theory of phonological similarity among morphologically related forms, but this is a far cry from opacity's hidden generalizations" (2007:47). Thus, McCarthy (2007) supports the notion that derivational principles, particularly intermediate representations, are required, at least with respect to opacity.

His proposal entails the construction of "candidate chains" (thus, the theory is called "CC-OT"). He states, "I argue that a candidate in OT includes not just a surface form but also a series of intermediate forms, each of which is minimally different from the form that immediately precedes it. A candidate, then, supplies information about the sequence of operations needed to link the underlying and surface forms…Every form in a chain is more harmonic than its predecessor, relative to the constraint hierarchy of the language in question" (2007:3-4). It appears that CC-OT adds quite a complex mechanism to OT architecture. Unless future research proves otherwise, Stratal OT appears to be far more economical than the CC-OT approach.

Additionally, CC-OT has been proposed solely to deal with opacity. Stratal OT on the other hand is able to deal with opacity, derived environment effects, and paradigmatic effects. Its

ability to resolve all these problematic areas in a uniform fashion greatly recommends Stratal OT over a model which addresses only one of these issues.

McCarthy details specific problems with the Stratal OT model and presents data that he claims cannot be handled by Stratal OT. These criticisms do need to be addressed; I discuss this in section 7, "Suggestions for further research".

4.0 Stratal OT analysis of the Sanskrit nominal accent inflectional paradigm

I will now present my analysis of the Sanskrit nominal accentual paradigm using the Stratal OT model. First, I will analyze the basic inflectional paradigm in this section; then, in section 5, I will analyze the main derivational paradigms.

4.1 A brief introduction to Sanskrit

Sanskrit is a highly inflected daughter language of Proto-Indo-European; the nominal paradigm has eight cases, three numbers and three genders. Nouns and adjectives are indistinguishable with regard to inflection and are here considered jointly as "nominals".

Vedic Sanskrit, the oldest form of documented Sanskrit, is a pitch accent language (not stress); Vedic texts mark accent position. The primary accent is called *udatta*, which is a raised pitch. With very few exceptions, both inflected and derived nominals contain one *udatta* accent; the syllable on which the *udatta* is placed varies according to the stem and the suffix. Unsurprisingly, clitics and many particles are unaccented.

4.2 The Sanskrit nominal accent inflectional paradigm

Table 1 below gives the basic Sanskrit nominal accent inflectional paradigm (adapted from Whitney 1924:sxn. 391). This is representative of accent placement for the majority of inflected nouns and adjectives (other paradigms exist for differing stem classes; I will not analyze these here).

Table 1. The basic Vedic Sanskrit nominal inflectional paradigm

	FIXED ACCENT	**ACCENT SHIFT**
	marút (m) *wind*	pád (m) *foot*
Singular		
Nom	marút	pā́d
Acc	marútam	pā́dam
Ins	marútā	padā́
Dat	marúte	padé
Abl/Gen	marútas	padás
Loc	marúti	padí
Voc	marut (márut)	pād (pā́d)
Dual		
Nom/Acc	marútāu	pā́dāu
Ins/Dat/Abl	marúdbhyām	padbhyā́m
Gen/Loc	marútos	padós
Voc	marutāu (márutāu)	pādāu (pā́dāu)
Plural		
Nom	marútas	pā́das
Acc	marútas	padás
Ins	marúdbhis	padbhís
Dat/Abl	marúdbhyas	padbhyás
Gen	marútām	padā́m
Loc	marútsu	patsú
Voc	marutas (márutas)	pādas (pā́das)

There are two accentual patterns. In the noun *marut*, the same syllable of the stem (the second syllable) is accented in each form, with the exception of the vocative. The vocative is unaccented except when it is in phrase initial position, in which case *marut* is accented on the initial syllable (shown in parentheses). Phrase initial accent for all the other cases is the same as their inflected form (that is, on the "u" in the second syllable).

Now compare the accentual pattern of *pad*. The "a" of the stem is accented only in some of the cases. In the words in the shaded boxes (excluding the vocative), the accent is not on the stem but on the suffixed ending. Traditionally, the cases where accent shifts to the suffix are called "weak cases" and, conversely, cases where accent remains on the stem (all nominative forms and the accusative singular) are "strong cases". The vocative follows the same pattern as it did with *marut*; it is unaccented except when it is phrase initial, in which case the accent is on the initial syllable (the form shown in parentheses).

To summarize the observations regarding the nominal inflectional paradigm:

- Upon inflection, accent may remain on the accented stem syllable in all cases or it may shift onto the suffixed ending in weak cases only.
- The vocative is not accented, except when it appears at the beginning of a sentence. In that case, the accent is always on the initial syllable, regardless of the position of the accent on other inflected forms.

4.3 Underlying representations

For the present analysis, it is first necessary to specify whether the various stems and inflectional suffixes are underlyingly accented or unaccented. I propose that the underlying representations are as follows:

- Stems that do not shift accent are underlyingly accented.
- Stems that shift accent are underlyingly unaccented.
- Endings that accept accent (weak cases) are underlyingly accented.
- Endings that do not accept accent (strong cases) are underlyingly unaccented.

Table 2 summarizes the underlying representations I have proposed and the surface forms that result from their combination.

Table 2. Proposed underlying representations and observed surface forms

	Stem		*Suffix*		*Surface Form*
Underlyingly Accented Stem	marút	+	as *(strong case)*	=	marútas
	marút	+	ā́ *(weak case)*	=	marútā
Unaccented Stem	pad	+	as *(strong case)*	=	pā́das
	pad	+	ā́ *(weak case)*	=	padā́

4.4 Proposed word and phrase level constraint system

Table 3 below lists the constraints I am proposing for the word and phrase levels. As I will discuss in section 5.3, inflection occurs at the word level. As I am focusing solely on the inflectional paradigm in this section, I am purposely omitting stem level constraints. It is sufficient for the analysis of the inflectional paradigm to know that the input stems are underlying accented (*marut*) or unaccented (*pad*).

Table 3. Proposed constraints – Word and phrase level

Constraint	*Description*	*Constraint Type*
WORD LEVEL		
• *Clitic Accent >>	No clitic accent	*Morphological Constraint*
• GrWd = PrWd >>	Grammatical word is a prosodic word	*Prosodic Constraint*
• MAX-IO(Accent)$_{STEM}$ >>	Stem input accent must have output correspondent	*Identity Constraint*
• IDENT-IO(Accent) >>	Output accent is the same as input accent	*Identity Constraint*
• ALIGN-LEFT(Accent)	Align accent leftmost in word	*Alignment Constraint*
PHRASE LEVEL		
• Phrase Initial Word = PrWd >>	Phrase initial word is a prosodic word	*Prosodic Constraint*
• IDENT-IO(Accent) >>	Output accent is the same as input accent	*Identity Constraint*
• ALIGN-LEFT(Phrase Initial Accent)	Align accent leftmost in phrase	*Alignment Constraint*

4.5 Prosodic and morphological requirements

Before demonstrating how these constraints interact, I will discuss the grounding and justification for the constraints specifying prosodic and morphological requirements (the morphological, prosodic and alignment constraints). The identity (faithfulness) constraints are consistent with identity constraints found in Kager (1999); I will discuss and justify these in more detail in section 5.4 below.

4.5.1 A prosodic word has one *udatta* accent

Two constraints (GrWd = PrWd and Phrase Initial Word = PrWd) require a word to be a prosodic word, that is, to carry one, and only one, *udatta* accent. This requirement is consistent with the culminative property which states that, typically, languages have a single prosodic peak for a constituent (Kager 1999:152).

4.5.2 Default accent in Sanskrit is assigned constituent-initially

Two constraints (ALIGN-LEFT(Accent) and ALIGN-LEFT(Phrase Initial Accent)) require accent to be placed in the leftmost position. This requirement is consistent with the demarcative property, which states that stress tends to be placed near the edges of constituents (Kager 1999:167).

4.5.3 Clitics are unaccented (morphological constraint on vocative)

There is one morphological constraint (*Clitic Accent) that disallows accent on clitics. This constraint requires explanation and justification. As mentioned previously, clitics and many particles do not possess accent. Of course, this is not unique to Sanskrit but is extremely common cross-linguistically.

Importantly, both Whitney (1924) and MacDonnell (1916) report that the vocative behaves as a clitic, both grammatically and phonologically, within phrases and compounds. From the phonological perspective, Whitney notes that "a word, or more than one word, qualifying a vocative [such as an adjective]…constitutes, so far as accent is concerned, a unity with the vocative" (1924:108). This contrasts with the independent accentual status of other cases. From the grammatical perspective, Whitney states that the "vocative forms no syntactical part of the sentence to which it is attached, but is only an external appendage to it" (1924:224).

Clearly, the vocative is behaving, grammatically and phonologically, in a different manner than the other case forms. Following Whitney and MacDonnell, I have chosen to characterize this behavior as "clitic" in nature, using the broad definition of a clitic as a grammatically independent but phonologically dependent word. I have chosen to represent the

well-known cross-linguistic tendency for clitics to be unaccented as a morphological markedness constraint (*Clitic Accent), on the assumption that the unmarked clitic form is accentless.

Kiparsky discusses "morphologically determined accent and intonation" in his Stratal OT analysis of Ancient Greek accent and syllable structure (2003:9). He states:

> In final syllables too, the intonation is largely predictable, but this time by morphological conditions. The most important one is stated (for the time being as a descriptive generalization) in (19):
>
> > (19) A two-mora word-final syllable is acute in nominative and accusative case forms (the direct cases).
>
> This morphological acute pre-empts the circumflex otherwise required by ALIGN, which surfaces in other case forms (genitive, dative, vocative), verbs, and elsewhere…Therefore it is not an inherent property of any particular case morpheme, but a morphophonological property associated with the direct cases, *qua* morphological categories. Just how it should be handled is difficult to decide: perhaps by a morphologically triggered alignment constraint, or by a floating accent anchored to the right edge of the word.

Thus, Kiparsky recognizes that morphological categories influence phonological properties, but stops short of positing the "morphologically triggered" constraint and constructing the relevant tableau.

I take the view that morphological constraints will prove to be essential to morphophonological analyses of inflectional paradigms, just as prosodic constraints are essential to phonological analyses of syllables and words. As with all other constraints, they should be well-grounded, although the basis for such grounding needs to be developed. (See section 7, "Suggestions for further research," below).

For this analysis, I have chosen to characterize the vocative as a clitic and have proposed a constraint that is cross-linguistically applicable to clitics; I believe this is a justifiable and well-grounded approach, based on the evidence mentioned above, whereas specifying the vocative directly in a constraint would certainly be stipulative and ungrounded.

However, it seems that it could be justifiable to reference cases directly when there is grounding for doing so, that is, when they form a natural "domain". For example, the "direct"

cases Kiparsky mentions above correspond to the "strong" cases in Sanskrit; this makes sense, as the nominative and accusative cases intuitively form a natural domain within nominative-accusative case systems. Note as well that an unmarked status for these cases may also be expected and lends support to the proposal that the underlying representations of these forms are unaccented. This approach is equivalent to how the domain of "stem" or "syllable" are referenced in constraints now, and thus does not represent a change to the basic architecture of OT. In this view, even a single case could be considered a domain if sufficiently grounded.

4.6 Constraint tableaux

Now I will construct the tableaux that demonstrate how the proposed constraints interact. I will present tableaux (tables 4 - 9) for a representative strong case (nominative plural), weak case (instrumental singular), and the vocative (plural) for *marut* and *pad*.

Table 4. Constraint tableau – *marut* strong case

Nominative (plural)
marútas

WORD LEVEL

Input: marút-as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. marutas		*!	*	*	*
b. márútás		*!		*	
c. marútás		*!		*	*
d. márútas		*!		*	
e. márutás		*!	*	*	
f. márutas			*!	*	
g. ☞ marútas					*
h. marutás			*!	*	*

PHRASE LEVEL

Input: marútas	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. marutas	*!	*	*
b. márútás	*!	*	
…	*!	*	
f. márutas		*!	
g. ☞ marútas			*
h. marutás		*!	*

When combined with an unaccented suffix, we see that the underlying stem accent on *marút* is retained at the word level as *marútas* is the only prosodically acceptable form (i.e., one and only one *udatta* accent) that does not violate MAX-IO(Accent)$_{STEM}$. This form is ensured at the phrase level by the identity constraint IDENT-IO(Accent).

Table 5. Constraint tableau – *marut* weak case

Instrumental (sing.)
marútā

WORD LEVEL

Input: marút-ā́	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. marutā		*!		*	*
b. márútā́		*!		*	
c. marútā́		*!			*
d. márútā		*!		*	
e. márutā́		*!		*	
f. márutā			*!	*	
g. ☞ marútā				*	*
h. marutā́			*!	*	*

PHRASE LEVEL

Input: marútā	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. marutā	*!	*	*
b. márútā́	*!	*	
…	*!	*	
f. márutā		*!	
g. ☞ marútā			*
h. marutā́		*!	*

Here we see the interaction of an underlyingly accented stem with a weak case (underlyingly accented) ending. At the word level, we see that the grammar prefers to retain underlying stem accent, as MAX-IO(Accent)$_{STEM}$ ensures that the prosodically acceptable form which retains stem accent wins. Once again, this form is ensured at the phrase level by the identity constraint IDENT-IO(Accent).

Table 6. Constraint tableau – *marut* vocative

Vocative (plural)
marutas (márutas)

WORD LEVEL

Input: marút-as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. ☞ marutas		*	*	*	*
b. márútás	*!	*		*	
c. marútás	*!	*		*	*
d. márútas	*!	*		*	
e. márutás	*!	*	*	*	
f. márutas	*!		*	*	
g. marútas	*!				*
h. marutás	*!		*	*	*

PHRASE LEVEL

Input: marutas	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. marutas	*!		*
b. márútás	*!	*	
…	*!	*	
f. ☞ márutas		*	
g. marútas		*	*!
h. marutás		*	*!

Now the highest ranked word level constraint *Clitic Accent, which was not applicable in the last two tableaux, comes into play. Because *Clitic Accent dominates GrWd = PrWd, the unaccented form, *marutas*, beats prosodically acceptable forms and becomes input to the phrase level. Since the prosodic requirement Phrase Initial Word = PrWd dominates the identity constraint at this level, *marutas* cannot emerge as the winner. Rather the form with leftmost accent, *márutas* , is the winner, due to the "default" alignment constraint, ALIGN-LEFT(Phrase Initial Accent).

Table 7. Constraint tableau – *pad* strong case

Nominative (plural)
pā́das

WORD LEVEL

Input: pad-as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. pādas		*!			*
b. pā́dás		*!		*	
c. ☞ pā́das				*	
d. pādás				*	*!

PHRASE LEVEL

Input: pā́das	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. pādas	*!	*	*
b. pā́dás	*!	*	
c. ☞ pā́das			
d. pādás		*!	*

Turning to the underlyingly unaccented stem *pad*, we see that MAX-IO(Accent)$_{STEM}$ is not applicable, as the input form does not contain an accent. Both prosodically acceptable forms violate the identity constraint IDENT-IO(Accent). The form with leftmost accent, *pā́das,* finally emerges as the winner due to the alignment constraint. The identity constraint at the phrase level ensures *pā́das* wins here as well.

Table 8. Constraint tableau – *pad* weak case

Instrumental (sing.)
padā́

WORD LEVEL

Input: pad-ā́	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. padā		*!		*	*
b. pádā́		*!		*	
c. pádā				*!	
d. ☞ padā́					*

PHRASE LEVEL

Input: padā́	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. padā	*!	*	*
b. pádā́	*!	*	
c. pádā		*!	
d. ☞ padā́			*

When we looked at the interaction of *marut* with a weak case (underlyingly accented) suffix, we saw that the grammar preferred to retain underlying stem accent due to the action of MAX-IO(Accent)$_{STEM}$. However, this constraint is not applicable to an unaccented stem such as *pad*. The next constraint, IDENT-IO(Accent), which demands faithfulness to any and all accent in the input form is satisfied by *padā́* which retains the accent carried by the input suffix. Thus, we now see that the grammar prefers underlying stem accent over underlying suffix accent, which is preferred over "default" leftmost accent (MAX-IO(Accent)$_{STEM}$ >> IDENT-IO(Accent) >> ALIGN-LEFT(Accent)). As before, the identity constraint at the phrase level ensures that the same form emerges as the winner here.

Table 9. Constraint tableau – *pad* vocative

Vocative (plural)
pādas (pā́das)

WORD LEVEL

Input: pad-as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. ☞ pādas		*			*
b. pā́dás	*!	*		*	
c. pā́das	*!			*	
d. pādás	*!			*	*

PHRASE LEVEL

Input: *pādas*	Phrase Initial Word = PrWd	IDENT-IO (Accent)	ALIGN-LEFT (Phrase Initial Accent)
a. pādas	*!		*
b. pā́dás	*!	*	
c. ☞ pā́das		*	
d. pādás		*	*!

Finally, we see the same result from *Clitic Accent at the word level as we did with *marut*. All accented forms are disqualified by this high ranking constraint. The unaccented form, *pādas*, is input to the phrase level, where it is disqualified by the prosodic constraint. Therefore, as with *marut*, the prosodically acceptable form with leftmost accent wins because of the alignment constraint.

5.0 Stratal OT analysis of Sanskrit nominal accent derivational paradigms

The constraint system proposed in section 4 successfully selected the correct surface form in the six tableaux presented. As these tableaux were representative of fixed and shifting stems, strong and weak cases, and the vocative case, we can conclude that the Stratal OT model is able to capture the accentual alternations of the basic Sanskrit nominal inflectional paradigm using a small number of well-grounded constraints.

I will now examine Sanskrit derivational nominal morphology to determine if the same system can be successfully extended to generate correct derivational surface forms.

5.1 Introduction to Sanskrit nominal morphology

Sanskrit verbal and nominal stems are both formed through the affixation of roots, traditionally regarded as "verbal" roots. In order to provide a sufficiently clear overview of Sanskrit nominal morphology that will illustrate and support my discussion, I have provided representative examples in Tables 10a - 10c, showing the formation of words from root stems (no derivational suffixes added to root) and derived stems (derivational suffix(es) attached to root). The underlying representations for the inflectional endings are assumed to be unaccented in strong cases and accented in weak cases, as discussed in section 4.3 above. The underlying accentuation posited for the derivational suffixes is discussed after presentation of the table in sections 5.6 – 5.7.

Examples are shown inflected with one strong case and one weak case ending (in these examples, the nominative plural, usually *-as*, and the instrumental/dative/ablative dual, *-bhyā́m*). The shaded cells in the "finished word" column contain words that display accent shift to the inflectional ending (as seen for *pad* in section 4).

Note that *sandhi* changes are apparent in the formation of the nominal stem and the final word. These do not affect my analysis, which is solely concerned with the syllable upon which *udatta* accent falls. Table 10 is derived primarily from Whitney (1924), with information regarding roots taken from Lanman (2004) and Monier-Williams (2006).

Table 10a. Overview of Sanskrit Nominal Morphology: Root Words

I. "ROOT WORDS" Root + Inflectional Ending ("No demonstrable element added to a root", Whitney 1924:143)						
Root	→	"Root Stem"[1]	+	Inflection-al Ending	→	Finished Word
1. mar**ú**t[2] *'wind'*	→	mar**ú**t *'wind'*	+	-as -bhy**ā́**m	→	mar**ú**tas mar**ú**dbhyām
2. √pad *'go, step'*	→	p**á**d *'foot'*	+	-as -bhy**ā́**m	→	p**ā́**das padbhy**ā́**m
3. tri-√vṛt *'three'-'turn'*	→	triv**ṛ́**t[3] *'three-fold'*	+	-i -bhy**ā́**m	→	triv**ṛ́**nti triv**ṛ́**dbhyām
4. √vac *'say, speak'*	→	v**ā́**c *'voice'*	+	-as -bhy**ā́**m	→	v**ā́**cas vāgbhy**ā́**m
5. √jan *'to be born'*	→	j**ā́** *'progeny'*	+	-as -bhy**ā́**m	→	j**ā́**s j**ā́**bhyām
6. √bhū *'become'*	→	bh**ú**[4] *'progeny'*	+	-as -bhy**ā́**m	→	bh**ú**vas bhūbhy**ā́**m
7. go[1] *'cow'*	→	g**ó** *'cow'*	+	-as -bhy**ā́**m	→	g**ā́**vas g**ó**bhyām
8. √dhī *'think'*	→	dh**ī́** *'thought'*	+	-as -bhy**ā́**m	→	dh**ī́**yas dhībhy**ā́**m

[1] See section 5.8 for a discussion of "root stems" and the textual convention for marking them with *udatta* accent.
[2] *marut* and *go* are not derived from a "verbal" root.
[3] "ṛ" is vocalic r.
[4] Note that the accented "u" in the stem bhū is actually long ("ū"). Due to the lack of a typographic character showing both length and accent, I have opted to show the accent, as this is the relevant characteristic for this analysis.

Table 10b. Overview of Sanskrit Nominal Morphology: Primary Derivative Words

II. PRIMARY DERIVATIVE WORDS Root + Primary Suffix + Inflectional Ending								
Root	+	Primary Suffix	→	1° Nominal Stem	+	Inflectional Ending	→	Finished Word
1. √kam *'desire'*	+	-a	→	k**á**ma *'love, desire'(noun)*	+	-as -bhy**á**m	→	k**á**mās k**á**māBhyām
2. div[1] *'sky, heaven'*	+	**-á**	→	dev**á** *'god'*	+	-as -bhy**á**m	→	dev**á**s[2] dev**á**bhyām
3. √ aś *'come to, arrive at'*	+	-a	→	**á**śva *'horse'*	+	-as -bhy**á**m	→	**á**śvās **á**śvābhyām
4. √ bal[3] *'breathe, live'*	+	-a	→	b**á**la '*strength'*	+	-as -bhy**á**m	→	b**á**lās b**á**lābhyām
5. a + √ mṛt *'no/not'* + *'die'*	+	-a	→	amṛ́ta '*immortal'*	+	-as -bhy**á**m	→	amṛ́tās amṛ́tābhyām
6. √ prī *'gladden'*	+	**-á**	→	prīy**á** '*dear'*	+	-as -bhy**á**m	→	prīy**á**s prīy**á**bhyām
7. √ man *'think'*	+	-as	→	m**á**nas '*mind'*	+	-aṃsi -bhy**á**m	→	m**á**nāṃsi m**á**nobhyām
8. √ śakrá *'be strong, be able'*	+	-r**á**	→	śakr**á** *'mighty'*	+	-as -bhy**á**m	→	śakr**á**s śakr**á**bhyām
9. √ag *'move tortuously, wind'*	+	-n**í**	→	agn**í** *'fire'*	+	-as -bhy**á**m	→	agn**á**yas agn**í**bhyām

[1] *div* is not a "verbal" root.

[2] It is important to note that the stem final accent in *dev**á*** is not shifting to the suffixal ending in *dev**á**s*; due to *sandhi*, the stem final "a" and the suffix "–as" combine to form "ās". The remainder of the paradigm (e.g., dev**á**bhyām) confirms that there is no accent shift (accent has remained fixed on the stem final "a").

[3] Sanskritists do not definitively connect bála with this verbal root.

Table 10c. Overview of Sanskrit Nominal Morphology: Secondary Derivative Words

III. SECONDARY DERIVATIVE WORDS Primary Stem + Secondary Suffix (+ Secondary Suffix(es)) + Inflectional Ending								
Primary Stem	+	2° Suffix	→	2° Nominal Stem	+	Inflection-al Ending	→	Finished Word
1. **á**śva *'horse'*	+	**-í**n	→	aśv**í**n *'horseman' ('possessing horses')*	+	-as -bhy**ā́**m	→	aśv**í**nas aśv**í**bhyām
2. b**á**la *'strength'*	+	**-í**n	→	bal**í**n *'strong' ('possessing strength')*	+	-as -bhy**ā́**m	→	bal**í**nas bal**í**bhyām
3. m**á**nas '*mind'*	+	-m**á**ya	→	manasm**á**ya *'spiritual'*	+	-as -bhy**ā́**m	→	manasm**á**yās manasm**á**yābhyām
4. am**ṛ́**ta '*immortal'*	+	-tv**á**	→	amṛtatv**á** *'spiritual'*	+	-as -bhy**ā́**m	→	amṛtatv**ā́**s amṛtatv**ā́**bhyām
5. bh**á**ga *'rich master; lord'*	+	-vant	→	bh**á**gavant *'fortunate'*	+	-as -bhy**ā́**m	→	bh**á**gavantas bh**á**gavadbhyām
6. prīy**á** '*dear'*	+	-tara	→	prīy**á**tara *'dearer'*	+	-as -bhy**ā́**m	→	prīy**á**tarās prīy**á**tarābhyām
7. prīy**á** '*dear'*	+	-tama	→	prīy**á**tama *'dearest'*	+	-as -bhy**ā́**m	→	prīy**á**tamās prīy**á**tamābhyām
8. dev**á** *'god'*	+	**-tā́**	→	dev**á**tā *'divinity'*	+	-as -bhy**ā́**m	→	dev**á**tās dev**á**tābhyām
9. v**á**su *'excellent, good'*	+	**-tā́**	→	vas**ú**tā *'divinity'*	+	-as -bhy**ā́**m	→	vas**ú**tās vas**ú**tābhyām
10. p**ú**ruṣa *'man'*	+	**-tā́**	→	puruṣ**á**tā *'divinity'*	+	-as -bhy**ā́**m	→	puruṣ**á**tās puruṣ**á**tābhyām
11. bal**í**n *'strong'*	+	-tama	→	bal**í**ntama *'strongest'*	+	-as -bhy**ā́**m	→	bal**í**ntamās bal**í**ntamābhyām
12. dev**á**tā *'divinity'*	+	-m**á**ya	→	devatām**á**ya *'containing all deities'*	+	-as -bhy**ā́**m	→	devatām**á**yās devatām**á**yābhyām

The terms "primary" and "secondary" derivational suffixes are traditional. There are several dozen of each of these types of suffixes (Whitney 1924:422, 457). A primary derivational

suffix combines with a verbal root to form a nominal stem, although it is possible to nominalize a root without adding a suffix, as is seen in the "root words".

Secondary derivational suffixes combine with a nominal stem to form a new stem; the suffixes have generally predictable meaning (although lexical drift certainly occurs). For example, the secondary suffixes *–mant/-vant* and *–in* usually form possessive or substantive adjectives (e.g., *balin*, 'strong, possessing strength', from *bala*, 'strength'), while *–maya* indicates 'made of' or 'filled with' (e.g., *ānanda-maya*, 'filled with joy'). Note that some primary suffixes are able to act as secondary suffixes as well (e.g., primary stem *manas* + *-a* → *manasa*, "mental").

5.2 Observations and questions regarding nominal morphology

Table 10 reveals certain patterns in the nominal morphology. First, instances of accent shift (that is, shift of accent to weak case inflectional endings, as discussed in section 4) are only found among so-called "root words" (table 10a), that is, words built from root stems (stems that have no derivational suffix, either primary or secondary, attached). Root words may display accent shift or fixed accent on a stem syllable (the majority of stems in this class are monosyllabic, with a few polysyllabic stems such as *marut* and *trivṛt*). By contrast, accent is fixed throughout inflection for nominals that have undergone primary or secondary derivation (with some exceptions pertaining to the "middle cases", which I will not address in this analysis).

Second, for primary derivational suffixes (table 10b), the stem accent may be fixed on either the root syllable or on the suffix (i.e., the thematic vowel). For example, *kā́ma* is accented on the root syllable, while *devá* is accented on the suffix (stem final *-a*).

Third, when a secondary derivational suffix is added (table 10c), the resulting secondary nominal stem may possess accent on the suffix (e.g., ***á**śva* → *aśv**í**n*; *m**á**nas* → *manasm**á**ya*) or may retain accent on the same syllable as the primary nominal stem **(***bh**á**ga* → *bh**á**gavant*; *prīy**á*** → *prīy**á**tara*). Also, affixation of secondary suffix, *-tā*, results in accentuation of the penultimate syllable (syllable immediately preceding *-tā*) regardless of where the accent fell on the primary nominal stem.

These observations may be framed as questions:

1. Why do root words, and only root words, display accent shift?
2. How is accent placement determined for primary derived nominal stems?
3. How is accent placement determined for secondary derived nominal stems?

I will attempt to answer these questions by expanding the Stratal OT framework proposed in Section 4.

5.3 Strata of inflectional and derivational word building

As discussed in section 3.1, Kiparsky proposes three strata under the Stratal OT model: stem, word, and phrase level. In section 4, I demonstrated how constraints operating at the word level can explain the alternation between fixed and shifting accent in the inflectional paradigms of two representative words, *marut* and *pad*. Although *marut* is a "root word", the system yields the correct output for derived nominals, all of which display fixed accent, assuming that the input reflects stem level accent. The constraint tableaux given in table 11 demonstrate operation of word level constraints for the primary derived nominal stem *bala*.

Table 11. Constraint tableaux – *bala* strong and weak case

bála
'strength'

Strong Case: Nominative Plural, *-as*

WORD LEVEL

Input: bála -as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. balās		*!	*	*	*
b. bálā́s		*!		*	
c. ☞ bálās					
d. balā́s			*!	*	*

Weak Case: Inst/Dat/Abl Dual, *-bhyā́m*

WORD LEVEL

Input: bála -bhyā́m	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. balābhyām		*!	*	*	*
b. bálā́bhyā́m		*!		*	
c. balā́bhyā́m		*!	*	*	*
d. bálā́bhyām		*!		*	
e. bálābhyā́m		*!			
f. ☞ bálābhyām				*	
g. balā́bhyām			*!	*	*
h. balābhyā́m			*!	*	*

Just as with *marut*, the constraint MAX-IO(Accent)$_{STEM}$ ensures that the correct form surfaces in both the strong and weak cases. This is true for all "fixed accent" words because the input (stem) is underlyingly accented.

Now I will turn attention to the stem level, which is the key to derivational word building. In Sanskrit, as in other Indo-European languages, derivational suffixes combine with nominal stems to form derived stems which are then subject to inflection. This is analogous to the English

derivational suffix –er combining with a word such as "work" to form "work-er", which is then subject to inflection by the addition of the plural to form "worker-s." In a highly inflected language such as Sanskrit, the derived form is not a complete word until it is declined; addition of the derivational suffix forms a new stem with predictable or unpredictable (due to lexical drift) meaning, which must then be inflected appropriately to form a finished word. Thus, we can conclude that addition of derivational suffixes occurs at the stem level, whereas inflectional suffixes are subsequently added at the word level.

5.4 Proposed stem level constraint system

Accentual constraints operating at the word level (input stem + input inflectional suffix) were given in section 4.4. Now I will propose a constraint system for the stem level (input root/stem + input derivational suffix). The constraints are listed in table 12 below; explanation of, and justification for, these constraints follow the table.

Table 12. Proposed constraints – Stem level

Constraint	*Description*	*Constraint Type*
STEM LEVEL		
• Stem = PrWd >>	A stem equals a prosodic word	*Prosodic Constraint*
• MAX-IO(Accent)$_{SUFFIX}$ >>	Suffix input accent must have output correspondent	*Identity Constraint*
• IDENT-IO(Accent) >>	Output accent is the same as input accent	*Identity Constraint*
• ALIGN-LEFT(Accent)	Align accent leftmost in stem	*Alignment Constraint*

The first thing to notice is that the constraint system at this level is almost identical to the word level (table 3). The first constraint, Stem = PrWd, requires a stem to possess just one *udatta* accent; this is the same prosodic constraint operating at the word and phrase levels (GrWd =

PrWd and Phrase Initial Word = PrWd). Cross-linguistic data supporting Stem = PrWd is given in Kager (1999:220, 264). The final constraint, ALIGN-LEFT(Accent), is the familiar alignment constraint found at all three levels.

The second and third constraints, MAX-IO(Accent)$_{SUFFIX}$ and IDENT-IO(Accent) are identity constraints; the first requires underlying accent, if any, on the stem-level suffix (i.e., primary or secondary derivational suffix) to surface in the output stem, while the second requires correspondence between the accent of the overall input form, whether accented or unaccented, and the output. The ranking of these two constraints (MAX-IO(Accent)$_{SUFFIX}$ >> IDENT-IO(Accent)) results in a grammar that "prefers" suffixal accent to root accent.

There is independent evidence for the proposed ranking of this constraint pair. In her important dissertation "Headmost Accent Wins", Revithiadou (1999:1) proposes a "theory of head dominance" where "the faithfulness [identity] constraint that refers to the lexical accent of the morphological head is ranked above the faithfulness constraint that refers to any lexical accent that is present in the word". She states, "In lexical accent systems, primary stress shows a high degree of dependence on morphological structure…stress in systems like Greek (and Russian) is sensitive to morphological headedness. The accent that prevails belongs to the 'head of the word'…In languages with fusional morphology like Greek and Russian [and Sanskrit], the notion 'head of the word' must be read as the element that determines the categorical status of the word. **Derivational suffixes are almost always heads** because they define the lexical category, class or gender of the derived form [emphasis mine]" (18, 20). Revithiadou provides convincing evidence for the universality of headmost accent. Extending this line of thought to the present analysis, I could restate the constraint MAX-IO(Accent)$_{SUFFIX}$ as **MAX-IO(Accent)$_{HEAD}$**.

At the stem level (i.e., derivation), the grammar "prefers" to maintain accent on the derivational suffix, i.e., the head of the stem. Therefore, if the suffix is underlyingly accented, it will surface in the output stem because MAX-IO(Accent)$_{SUFFIX}$ is the highest ranked constraint. If it is underlyingly unaccented, the next constraint, IDENT-IO(Accent), will ensure that underlying accent on the input root or stem will surface.

Note that this pair of identity constraints is similar to those operating at the word (inflectional) level: MAX-IO(Accent)$_{STEM}$ >> IDENT-IO(Accent). Returning to Revithiadou's argument for headmost accent, she states the following with regard to inflection: "We infer from the above discussion that inflectional suffixes cannot determine the distributional properties, argument structure, etc. of the word. For this reason, I assume that inflectional suffixes can never be heads in the intended sense. The 'morphological determinant', that is, the element that carries information about its combination with other elements and, moreover, determines the category of a construction, its class and gender, constitutes the 'head of the word'. All the theories presented in the above paragraphs converge to the conclusion that the morphological determinant in inflectional constructions is the root" (1999:187). I can therefore restate the word level constraint MAX-IO(Accent)$_{STEM}$ as **MAX-IO(Accent)$_{HEAD}$**, just as I did for stem level constraint MAX-IO(Accent)$_{SUFFIX}$. In other words, from the perspective of headedness, the identity constraints and their ranking pattern are identical at the stem and word levels.

5.5 Stratal ranking patterns

The discussion above indicates that the relevant constraints and ranking patterns at the various levels are similar or identical. The constraints in this analysis demonstrate the following ranking pattern:

> Morphological Constraint >>
> Prosodic Constraint >>
> Identity Constraints >>
> Alignment Constraint

The identity constraints themselves display a ranking pattern, which is deemed significant by Revithiadou (1999), as discussed above:

> $\text{MAX-IO(Accent)}_{\textbf{HEAD}}$ >>
> IDENT-IO(Accent)

Thus, constraints exhibit consistency in ranking pattern between the three levels, while remaining relevant to the prosodic and morphological requirements of the specific level. Such consistency between strata may be expected, as the ranking patterns determine the language's overall prosodic and morphological system, which should be largely harmonious.

I will demonstrate how these stem level constraints interact in the following three sections. I will first examine primary and derived stems in sections 5.6 and 5.7, then I will return to root stems, such as *marut* and *pad*, in section 5.8.

5.6 Stem level constraint interaction: Primary derived stems

A review of nominal derivative suffixes in Whitney (1924:ch. XVII) reveals definite patterns of accentuation. A few primary suffixes, such as *–ra* and *–ma*, are almost always accented on the suffixal ending. I propose that these suffixes are underlyingly accented. An accented suffix will always result in a stem with accented suffixal ending because MAX-

IO(Accent)$_{SUFFIX}$ is the highest ranked constraint. This is demonstrated for *śak-rá* in table 13 below. Note that the root can be either underlyingly accented or unaccented; the result (accent on the suffixal ending) will be the same. Thus, we do not need to construct a hypothesis regarding underlying accent on the root √*śak* and, importantly, neither does the language learner.

Table 13. Stem level constraint tableaux – *śakrá* (comparison with accented & unaccented root)

śakrá
('mighty')

Proposed underlying representation:
- ***Accented root: śák***
- ***Accented suffix: -rá***

STEM LEVEL

Input: śák -rá	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. śakra	*!	*	*	*
b. śákrá	*!			
c. śákra		*!		
d. ☞ śakrá			*	*

Proposed underlying representation:
- ***Unaccented root: śak***
- ***Accented suffix: -rá***

STEM LEVEL

Input: śak -rá	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. śakra	*!	*		*
b. śákrá	*!		*	
c. śákra		*!	*	
d. ☞ śakrá				*

In contrast, the stems formed from most of the other primary suffixes show accentual variation. The best example is the primary suffix *–a*, which forms the largest number of nominals

in the language. As shown in Table 10c, the accent may fall on either the root or the suffix, for example, *kā́ma devá*, *áśva*, *prīyá*. At first glance, such data suggests that accent may be arbitrary (i.e., lexical) at this level. On the other hand, if we consider the data with regard to the proposed stem level constraint system, we might assume that the primary suffix "-a" is unaccented (because an accented suffix would ensure accent on the suffixal ending). However, I would like to suggest an alternative explanation that allows for more predictability of accentuation of the primary stems which display "variable" accent.

Whitney notes that the primary suffixes "fall in general into two great classes, the one indicating the action expressed by the verbal root ["action nouns"], the other the person or thing in which the action appears, the agent or actor – the latter, either substantively or adjectively ["agent nouns"]. The one class is more abstract, infinitival; the other is more concrete, participial. Other meanings may in the main be viewed as modifications or specializations of these two" (Whitney 1924:421).

There are numerous examples demonstrating this broad division for the primary suffixes, including some in which accent is contrastive. Table 14 lists some of these formed with the primary suffixes *–a* and *–as* (Whitney 1924:423-4, 428).

Table 14. Accentual patterns of "action nouns" versus "agent nouns"

"Action nouns"	**"Agent nouns"**
śr**á**m-a *'weariness'*	kṣam-**á** *'patient'*
gr**á**h-a *'seizure'*	jīv-**á** *'living'*
v**é**d-a *'knowledge'*	megh-**á** *'cloud'*
kr**ó**dh-a *'wrath'*	plav-**á** *'boat'*
j**ó**ṣ-a *'enjoyment'*	sarp-**á** *'serpent'*
t**á**p-as *'warmth'*	toś-**á**s *'bestowing'*
t**é**j-as *'splendor'*	yaj-**á**s *'offering'*
cr**á**v-as *'fame'*	vedh-**á**s *'pious'*
m**á**n-as *'mind'*	āhan-**á**s 'heady'
v**á**c-as *'speech'*	veś-**á**s *'settler; neighbor'*
Contrastive Forms	
éṣ-a *'haste'*	eṣ-**á** *'hasting'*
ś**ā́**s-a *'order*	śās-**á** *'orderer'*
áp-as *'work'*	ap-**á**s *'active'*
y**á**ś-as *'beauty'*	yaś-**á**s *'active'*
t**á**r-as *'quickness'*	tar-**á**s *'quick'*
t**á**v-as *'strength'*	tav-**á**s *'strong'*
m**á**h-as *'greatness'*	mah-**á**s *'great'*

These and other examples show that, in general, the so-called "action nouns" are accented on the root, while the "agent nouns" are accented on the suffix. I propose that there are two underlying forms for primary suffixes which form stems with variable accent. An underlyingly unaccented

primary suffix (-*a*) combines with roots to form so-called "action nouns", while an underlyingly accented suffix (-*á*) is marked to indicate agency and combines with roots to form "agent nouns".

Tables 15 and 16 give constraint tableaux for two of the contrastive forms we saw in table 14, *máh-as* and *mah-ás*. I am again presenting tableaux with both accented and unaccented roots to demonstrate that the result is the same regardless of root accentuation; underlying accentuation of the output stem is only dependent on the suffix. Thus, the burden on the language learner is reduced, as it is unnecessary to deduce the underlying accent of roots.

Table 15. Stem level constraint tableaux – *máh-as* (comparison with accented & unaccented root)

máhas *('greatness')*

Proposed underlying representation:

- ***Accented root: máh***
- ***Unaccented suffix ("Action noun"): -as***

STEM LEVEL

Input: máh -as	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. mahas	*!		*	*
b. máhás	*!		*	
c. ☞ máhas				
d. mahás			*!	*

máhas *('greatness')*

Proposed underlying representation:

- ***Unaccented root: mah***
- ***Unccented suffix ("Action noun"): -as***

STEM LEVEL

Input: mah -as	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. mahas	*!			*
b. máhás	*!		*	
c. ☞ máhas			*	
d. mahás			*	*!

The constraint tableaux in table 15 show that an unaccented suffix will always yield a stem that is accented on the root, either because the root is underlyingly accented and the winning form is selected by IDENT-IO(Accent) or because the root is underlyingly unaccented and the winning form is selected by ALIGN-LEFT(Accent).

Table 16. Stem level constraint tableaux – *mah-ás* (comparison with accented & unaccented root)

mahás *('great')*

Proposed underlying representation:

- ***Accented root: máh***
- ***Accented suffix ("Agent noun"): -ás***

STEM LEVEL

Input: máh -ás	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. mahas	*!	*	*	*
b. máhás	*!			
c. máhas		*!	*	
d. ☞ mahás			*	*

mahás *('great')*

Proposed underlying representation:

- ***Unaccented root: mah***
- ***Accented suffix ("Agent noun"): -ás***

STEM LEVEL

Input: mah -ás	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. mahas	*!	*		*
b. máhás	*!			
c. máhas		*!		
d. ☞ mahás			*	*

As expected, the tableaux in table 16 show that an accented suffix will always yield a stem with accented suffixal ending, regardless of underlying accent of the root, due to the high rank of MAX-IO(Accent)$_{SUFFIX}$.

I will present two additional constraint tableaux to demonstrate the operation of stem level constraints on primary stems. In accordance with the discussion above, I propose that

kā́ma, ‘love’, has an underlyingly unaccented suffix (*-a*), while *devá*, ‘god’, has an underlyingly accented suffix (*-á*). As the underlying accent of the root does not affect the outcome, I will use an accented root for both tableaux.

Table 17. Stem level constraint tableaux – *kā́ma* and *devá*

***kā́ma** (‘love’)*
Proposed underlying representation:

- ***Accented root: kám***
- ***Unaccented suffix: -a***

STEM LEVEL

Input: kám -a	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. kama	*!		*	*
b. kā́má	*!		*	
c. ☞ kā́ma				
d. kamá			*!	*

***devá** (‘god’)*
Proposed underlying representation:

- **Accented root: dív**
- **Accented suffix: *-á***

STEM LEVEL

Input: dív -á	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. deva	*!	*	*	*
b. dévá	*!			
c. déva		*!	*	
d. ☞ devá			*	*

It should be noted that not all nouns fall neatly into an “agent noun” / “action noun” category with the accentuation expected from the above analysis. Some exceptions may be due to differing underlying estimations of “agency” between ourselves and Vedic Sanskrit speakers. Others may be due to lexical drift and other diachronic semantic processes. Nonetheless, I

believe that the present analysis is valid and that the stem level constraint system is crucially dependent on underlying suffixal (head) accent.

5.7 Stem level constraint interaction: Secondary derived stems

In this analysis, I assume that the output stem of a primary nominal derivation will become input to word level inflection or will be input to stem level secondary derivation. That is, stem level constraints are applied to both primary and secondary derivations, with the appropriate primary stem being input to the latter. This could be viewed as an argument for another level within stratal OT (two stem levels). I prefer to view this theory as inherently word-building; stem level constraints will be applied as needed to construct legitimate stems. The parallel with the derivational cycle is clear, however, I believe that this analysis does not compromise the basic tenets of OT. I will compare the analysis to a pre-OT lexical phonology analysis in section 6.1 below.

Secondary derivative suffixes generally form adjectives, many with the sense of "having a relation with or connection to" or "possessing or comprised of". In general, there is less variation connected with agency than we saw with the primary suffixes and most secondary suffixes have accent either fixed on the same syllable as the input stem (remember that all stems possess accent after primary derivation) or on the secondary suffix. For example, stems formed with the secondary suffixes *–in*, *-maya*, and *tva* (reference table 10c above) are all accented on the suffix, virtually without exception. I therefore hypothesize that these suffixes are underlyingly accented. Table 18 gives the constraint tableau for *balín* ('strong'), which is derived from the stem *bála* ('strength').

Table 18. Stem level (secondary derivation) constraint tableau – *balín*

balín *('strong')*
Proposed underlying representation:

- ***Accented primary stem: bála*** *('strength')*
- ***Accented suffix: -ín*** *('possessing')*

STEM LEVEL

Input: bála -ín	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. balin	*!	*	*	*
b. bálín	*!		*	
c. bálin		*!		
d. ☞ balín			*	*

This tableau is straightforward. As expected, an accented suffix will always surface, due to the high ranking constraint MAX-IO(Accent)$_{\text{SUFFIX}}$.

Some secondary suffixes, such as –*vant*, -*tara*, and –*tama* always maintain accent on the same syllable as the input primary stem. We can therefore conclude that these suffixes are underlyingly unaccented. Table 19 gives the constraint tableau for *priyátama* ('dearest'), the superlative of *priyá* ('dear').

Table 19. Stem level (secondary derivation) constraint tableau – *priyátama*

priyátama *('dearest')*
Proposed underlying representation:
- ***Accented primary stem: priyá*** *('dear')*
- ***Unaccented suffix: -tama*** *('most')*

STEM LEVEL

Input: priyá -tama	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. priyatama	*!		*	*
b. príyátámá	*!		*	
c. príyátáma	*!		*	
d. príyatámá	*!		*	
…	*!		*	
l. príyatama			*!	
m. ☞ priyátama				*
n. priyatáma			*!	*
o. priyatamá			*!	*

When the secondary suffix is unaccented, the accent on the input primary stem will surface.

As noted in section 5.2, there is an exceptional secondary suffix, *-tā* (reference table 10c) that results in accentuation of the penultimate syllable, regardless of where the accent fell on the primary nominal stem. I propose that this is a feature that is actually contained in the underlying representation of –tā, perhaps as follows: –V́*tā*. There would then be no difference in the constraint tableaux for stems derived from this suffix from what we have seen previously, as shown in Table 20.

Table 20. Stem level (secondary derivation) constraint tableau – *puruṣátā*

puruṣátā *('divinity')*
Proposed underlying representation:

- ***Accented primary stem: púruṣa***
- ***Accented suffix: -V́tā***

STEM LEVEL

Input: púruṣa -V́tā	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. puruṣatā	*!		*	*
b. púrúṣátā́	*!		*	
c. púrúṣátā	*!		*	
d. púruṣátā́	*!		*	
…	*!			
l. púruṣatā		*!	*	
m. purúṣatā		*!	*	*
n. ☞ puruṣátā			*	*
o. puruṣatā́		*!	*	*

Finally, note that a word may contain more than one secondary stem, as seen in examples 11 and 12 in table 10c above: *balíntama*, "strongest", and *devatāmáya*, "containing all deities". I assume that the second suffix is attached (at the stem level) to the input stem, which here means the root + primary suffix + (1st) secondary suffix. These cases are straightforwardly handled by the proposed constraint system, as shown in table 21 below.

Table 21. Stem level constraint tableaux for affixation of 2nd secondary suffix – *balíntama* and *devatāmáya*

balíntama *('strongest')*
Proposed underlying representation:

- ***Accented secondary stem: balín***
- ***Unaccented suffix: -tama***

STEM LEVEL

Input: balín -tama	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. balintama	*!		*	*
b. bálíntámá	*!		*	
…	*!		*	
l. bálintama			*!	
m. ☞ balíntama				*
n. balintáma			*!	*
o. balintamá			*!	*

devatāmáya *('containing all deities')*
Proposed underlying representation:

- ***Accented secondary stem: devátā***
- ***Accented suffix: -máya***

STEM LEVEL

Input: devátā -máya	**Stem = PrWd**	**MAX-IO (Suffix Accent)**	**IDENT-IO (Accent)**	**ALIGN-LEFT (Accent)**
a. devatāmaya	*!		*	*
b. dévátā́máyá	*!		*	
…	*!			
v. dévatāmaya		*!	*	
w. devátāmaya		*!	*	*
*x. devatā́maya		*!	*	*
y. ☞ devatāmáya			*	*
z. devatāmayá		*!	*	*

Addition of a second secondary suffix that is unaccented, such as *–tama*, will leave accent on the same syllable that was accented on the input stem, whereas addition of an accented secondary suffix, such as *–máya*, will result in accent "moving" to the suffixal ending. Thus,

accentual patterns of "stacked" secondary stems are entirely consistent with the proposed constraint system.

To sum up, the stem level constraint system proposed generates the correct surface forms for primary and secondary derived nominal stems. The system is critically dependent on underlying accentuation of the derivational suffix, which is the head of the stem, as claimed by Revithiadou (1999) and discussed in section 5.4 above. That is, underlyingly accented suffixes will always generate stems that are accented on the suffixal ending, regardless of underlying root accentuation, due to the highest ranked identity constraint MAX-IO(Accent)$_{SUFFIX}$. Underlyingly unaccented suffixes will always generate stems that are accented on the root/primary stem, either because IDENT-IO(Accent) selects the winner in the case of an underlyingly accented root/primary stem, or because ALIGN-LEFT(Accent) selects the winner in the case of an underlyingly unaccented root/primary stem.

I have now addressed two of the three questions posed in section 5.2 above: "How is accent placement determined for primary derived nominal stems?" and "How is accent placement determined for secondary derived nominal stems?" In the next section, I will answer the first question, "Why do root words, and only root words, display accent shift?"

5.8 Stem level constraint interaction: Root stems

I will now argue that "root stems" (see table 10a) are not in fact generated at the stem level. Rather, inflectional endings are added directly to the root, therefore, the root is the input to the word/inflectional level.

At the stem level, the highest ranked identity constraint (MAX-IO(Accent)$_{SUFFIX}$) refers to the derivational suffix, that is, the head of the stem. At the word level, on the other hand, the

highest ranked identity constraint (MAX-IO(Accent)$_{STEM}$) refers to the input stem (or, as I argue here, input root), that is, the head of the word (see the discussion in section 5.4 regarding derivational and inflectional heads). Therefore, if the root is the input to the word level, its underlying accent is the key determinant of word accent. This is in contrast to the situation at the stem level, where the key determinant of stem accent is the underlying accent of the derivational suffix. Table 22 summarizes the differences between the two levels.

Table 22. Comparison of Stem and Word Levels

	STEM LEVEL	**WORD LEVEL**
Word-building process	Derivation	Inflection
Head	Derivational Suffix	Root or Stem
Highest ranked identity constraint	MAX-IO(Accent)$_{SUFFIX}$	MAX-IO(Accent)$_{STEM/ROOT}$
Ranking pattern	MAX-IO(Accent)$_{SUFFIX}$ >> IDENT-IO(Accent)	MAX-IO(Accent)$_{STEM/ROOT}$ >> IDENT-IO(Accent)
Consequence of ranking pattern	• Underlyingly accented derivational suffix always wins regardless of underlying accentuation of root/primary stem. • Underlyingly unaccented derivational suffix ○ + accented root/stem → accented root/stem due to IDENT-IO(Accent) ○ + unaccented root/stem → accented root/stem due to ALIGN-LEFT (Accent)	• Underlyingly accented root/stem always wins regardless of underlying accentuation of inflectional suffix. • Underlyingly unaccented root/stem ○ + accented inflectional suffix (“weak case”) → accented ending due to IDENT-IO(Accent) ○ + unaccented inflectional suffix (“strong case”) → accented root/stem due to ALIGN-LEFT(Accent)

The behavior of roots at the word level is exactly the same as that of derived stems at word level, strongly indicating that the root is the input to the word level for this class of words.

The fact that this is a distinctive class of words is supported by Whitney (1924:143):

> Root-stems, having in them no demonstrable element added to a root: thus, **ṛ́c** *verse*, **gír** *song*, **pád** *foot*, **díś** *direction*, **máh** *great*. Words of this division in uncompounded use are tolerably frequent in the older language: thus, in RV. [Rig Veda, ~1500 b.c.] are found more than a hundred of them; in AV. [Atharva Veda, ~1000 b.c.], about sixty; but in the classical Sanskrit [~500 b.c.] the power of using any root at will in this way is lost, and the examples are comparatively few.

It seems likely that the formation of words by adding inflectional endings directly to roots (at the word level) was productive in Proto-Indo-European, perhaps becoming unproductive in Vedic or proto-Vedic, with root words gradually being lost in Sanskrit over time. The competitive process of forming stems prior to inflection may have become dominant and then exclusive in the language through the diachronic processes of reanalysis and extension. The fact that *máh,* "great" is noted by Whitney as being a "root stem" in the above quote (i.e., subject to direct inflection), but is also attested as being affixed to a primary suffix to form "*máhas*", "greatness", and *"mahás*", "great", as we saw in tables 15 and16 above, is compelling evidence for the operation of two distinct word formation processes.

It should be noted that Sanskrit grammarians mark (textually) an *udatta* accent on "root-stems"; I have therefore included the accent in table 10a in order to faithfully represent the texts of the grammarians. However, while this may indicate that Vedic speakers pronounced *udatta* accent on these stems when uttered <u>in isolation</u>, I argue that this does not reflect the <u>underlying</u> accent. In fact, the stems pronounced in isolation could be reflecting a phrase level prosodic constraint.

The behavior of the root words is persuasive evidence that they are comprised of underived roots (i.e., roots that have not been produced at the stem level) which are direct inputs

to the word level and provides additional evidence for the operation of distinct stem and word levels. This answers the question posed above as to why root words, and only root words, display accent shift.

6.0 Comparison with pre-OT and Parallel OT solutions

6.1 A pre-OT solution

Kiparsky proposed a pre-OT, rule-based, Lexical Phonology analysis of the Vedic accentual paradigm in his 1984 article, 'A Compositional Approach to Vedic Word Accent.' In the opening paragraph, he notes that "inflectional and derivational accent patterns are customarily treated in separate ways". He attempts to "develop a more unified analysis, based on associating accentual properties with morphemes in such a way that the accent of words is derivable compositionally by general phonological rules that do not refer to specific morphemes or classes of morphemes" (1984:201). Kiparsky includes both nominals and verbs in his analysis; my discussion here is limited solely to nominals.

Kiparsky posits that there are two types of stems, fixed and movable; fixed stems have underlying accent while movable stems are underlyingly unaccented. Both inflectional and derivational suffixes may be underlyingly accented or pre-accenting (i.e., assign accent to the last syllable of the stem); additionally, derivational (but not inflectional) suffixes may be underlyingly unaccented. Suffixes may also be distinguished as "dominant" or "recessive", regardless of whether they are accented or not; dominant suffixes deaccent stems to which they are attached, while recessive suffixes do not. All inflectional suffixes are recessive, whereas the majority of derivational suffixes are dominant.

These stem and suffix types interact in accordance with the "Basic Accentuation Principle" ("BAP", Kiparsky 1984:202):

> (i) If there is no accented syllable, the first syllable receives the ictus [word accent];
> (ii) The first accented syllable receives the ictus.

The two rules of the BAP apply at distinct levels of the grammar, in line with the principles of Lexical Phonology. Dominant/derivational suffixes are added at level 1; deaccentuation of the stem takes place along with application of BAP (i) at this level. Recessive/inflectional suffixes are added at level 2; BAP (ii) applies at this level. In this manner, Kiparsky successfully generates the correct accentual patterns for nominal and verbal inflected and derived forms.

Of course, the key point of agreement between Kiparsky's pre-OT analysis and the present analysis lies in the assumption of multiple levels within the grammar. Under the Stratal OT model, the derivational ("dominant") suffixes are attached at the stem level, while inflectional ("recessive") suffixes are attached at the word level. The present analysis is also essentially a compositional approach to the problem and certainly meets Kiparsky's goal of treating inflectional and derivational accent patterns in a unified manner.

I contend that the Stratal OT analysis is superior to a rule-based account because it provides a principled account of the differences seen at the stem and word level, namely the difference in headedness of stems and words. The rule-based account differentiates between recessive and dominant suffixes, however, there is no external motivation for this division. Additionally, this pre-OT analysis does not address the vocative, as does the present analysis.

6.2 Inadequacy of the original OT model

I contend that no solution to the Vedic nominal accentual paradigm can be formulated under the original OT model, due to one of its central tenets, "richness of the base". Summarizing this aspect of the original model, Kager states (1999:19):

> The Lexicon contains all contrastive properties of morphemes (roots, stems, and affixes) of a language, including phonological, morphological, syntactic, and semantic properties. The Lexicon provides the input specifications which are to be submitted to the Generator. In this connection, perhaps the most striking property of the Lexicon, as conceived of in OT, is that no specific property can be stated at the level of underlying representations:
>
> **Richness of the Base**: no constraints hold at the level of underlying forms.
>
> In OT grammatical generalizations are expressed as interactions of constraints *at the level of the output*, never at the input level.

Under this stipulation, we are unable to generate the correct forms for entire classes of words. For example, if we assume that the word level constraints given in section 4 are correct, we are able to generate the correct inflectional paradigms for root words such as *marut* and *pad*. However, we will be unable to generate the correct surface forms of many derived words. Table 23 shows how the incorrect inflected forms for *balín*, 'strong', will be selected if we assume richness of the base and only one level of constraint evaluation.

Table 23. Incorrect winner under Parallel OT and richness of the base

Strong Case: Nominative Plural, *-as*

WORD LEVEL

Input: bá́la –ín -as	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. balinas		*!	*	*	
b. bálínás		*!		*	*
c. bálínas		*!			*
…		*!		*	
f. ☞ bálinas				*	*
g. 💣 balínas			*!	*	
h. balínás			*!	*	

Weak Case: Inst/Dat/Abl Dual, *-bhyā́m*

WORD LEVEL

Input: bá́la –ín -bhyā́m	*CA	GrWd= PrWd	MAX-IO (Stem Accent)	IDENT-IO (Accent)	ALIGN-LEFT (Accent)
a. balibhyām		*!			
b. bálíbhyā́m		*!			
c. bálíbhyām		*!			
…		*!			
f. ☞ bálibhyām					
g. 💣 balíbhyām			*!		
h. balibhyā́m			*!		

We see that the winning forms have the stem (initial "a") accented, due to the high-ranking MAX-IO(Accent)$_{STEM}$ constraint at this level. The actually observed form, *balíbhyām*, (shown with the 💣 next to it) cannot emerge as the winner. If we try to "add" the constraint for suffixal accent predominance to this level, MAX-IO(Accent)$_{SUFFIX}$, no differentiation can be made between the derivational suffix *–in* and the inflectional suffix *–bhyām*, and *balibhyā́m* would incorrectly emerge as the winner. No matter how the constraints are manipulated, there is no way

to select the correct forms for all the alternations in the paradigms given in the present analysis in a traditional OT framework.

Additionally, in the present analysis, there is motivation for the constraints MAX-IO(Accent)$_{STEM}$ and MAX-IO(Accent)$_{SUFFIX}$ to be high ranked in the word and stem levels respectively, as the stem and suffix are the heads of those domains. This principled explanation is lost in any parallel OT solution.

Thus, Parallel OT as originally conceived is inadequate to explain the Sanskrit nominal accentual paradigm. The only recourse Parallel OT has is to introduce exotic constraints or other devices into the constraint system.

6.3 A Parallel OT solution

One such Parallel OT explanation for the basic Sanskrit nominal paradigm is given by Frazier (2006). Frazier proposes an "anti-OP" constraint, a hybrid of Alderete's Anti-faithfulness constraints and McCarthy's Optimal Paradigm constraints (see sections 2.3.3 and 2.3.4 above). The proposed system of constraints appears to be quite stipulative. For example, the description of two constraints are (2006:3):

- ¬OP-DEP(ACCENT): realize a dominant ending by inserting accent into the stem (as compared to the same stem when inflected with a recessive ending)
- ALIGN(post-accenting morpheme, R, accented morpheme, L) = POSTACCENT: accent occurs on the morpheme following a post-accenting morpheme

The outcome is that these constraints in fact appear to be capturing the accentuation and deaccentuation rules posited by Kiparsky in his pre-OT rule-based solution.

Additionally, the constraint system is only applied to inflection of "athematic" nouns. This is another way to refer to the "root words" such as *marut* and *pad*, discussed in detail in section 5.8 above; it does not address derived nominals as does the present analysis.

7.0 Suggestions for further research

Stratal OT promises to be a productive area of investigation within the field of Optimality Theory due to its theoretical advantages and the supportive empirical data that has been generated to date. A significant amount of further research is required to demonstrate that Stratal OT is universally applicable and is preferable to rival OT models. My analysis indicates that research is called for in the following three areas:

7.1 Cross-linguistic and diachronic data

Obviously, the theory will gain strength and prominence if a significant amount of cross-linguistic data supporting the Stratal OT approach can be accumulated. The analyses should focus on problems involving opacity, derived environment effects and paradigmatic effects in various languages. Data which has previously been analyzed using the parallel OT approaches mentioned above should be reanalyzed under the Stratal OT model to determine if Stratal OT offers increased economy and explanatory power.

My analysis of the Vedic Sanskrit nominal paradigm indicates that the following accentual paradigms may be fruitfully analyzed by the Stratal OT model:

- *Complete accentual analysis of Vedic, including verbal paradigms and compounds*. Kiparsky's rule-based account (1984; see section 6.1 above) handles verbal accentual paradigms in the same manner as the nominal paradigms, indicating that verbal and nominal accentuation are subject to similar constraint systems. I am confident that the entire accentual system of Vedic can be analyzed using a Stratal OT approach.

- *Cross-linguistic accentual data: Japanese and Lithuanian*. Alderete (2001) applies his anti-faithfulness approach (section 2.3.4 above) to the Japanese accentual

paradigm (Japanese is also a pitch accent language). Review of this data indicates that it functions in a similar fashion to Sanskrit and would therefore be a good subject for a Stratal OT analysis. The same is true for Lithuanian (which Alderete mentions but does not specifically analyze). Review of Lithuanian pitch accent data in Illich-Svitych (1979) indicates that it may be successfully analyzed using Stratal OT.

- *Diachronic analysis: PIE → Vedic Sanskrit/Balto-Slavic/Ancient Greek*. Frazier (2006; see section 6.3 above) performs a diachronic analysis of constraint changes between Proto-Indo-European and Vedic Sanskrit accentual nominal paradigms using the "anti-OP" constraint approach. The success of the present analysis of the Sanskrit nominal paradigm indicates that a similar diachronic analysis of Sanskrit, as well as of other pitch accent Indo-European languages (Balto-Slavic languages and Ancient Greek), could be performed using the Stratal OT approach.

7.2 Architecture of Stratal OT

In addition to specific language analyses, certain aspects of Stratal OT need to be developed as the body of empirical data grows. My analysis leads me to believe that these include:

- *Morphological constraints*. As mentioned in section 4.5.3, the nature and justification of morphological constraints requires theoretical elucidation and empirical support.

- *Ranking Patterns*. As mentioned in section 5.5, the present analysis indicates that the ranking of the constraints at each level follows a consistent pattern while remaining

relevant to the requirements of the particular stratum. Empirical data is needed to establish if this is a universal phenomenon.

7.3 Response to criticisms of Stratal OT

As mentioned in section 3.2, McCarthy raises some serious criticisms of Stratal OT in his 2007 book. He states (41):

> There are two main problems with Stratal OT as a theory of opacity. First, Stratal OT is not powerful enough to deal with the full range of observed opaque interactions. Second, Stratal OT is also too powerful, since it massively overpredicts phonological systems that are never observed and seem impossible.

He gives specific examples illustrating Stratal OT's failure in these two areas. It is critical that Stratal OT theorists address these criticisms and provide solutions to the specific examples he has given.

8.0 Conclusion

This analysis of the Sanskrit nominal accent paradigm demonstrates that Stratal OT is able to capture accentual placement within inflectional and derivational paradigms using a small number of well-grounded constraints. The proposed constraint system, comprised of stem, word and phrase levels, is able to generate correct surface forms for inflectional paradigms that are "fixed" or display "accent shift", word level and phrase level accentuation of the vocative, and accentual variation of primary and secondary derived stems and words.

At the stem and word levels, the highest ranked identity constraint is consistent with the head of the domain. This provides a principled explanation for the various accentual phenomena, as well as powerful evidence for distinct stem and word levels. Parallel OT is unable to provide a solution to the paradigms, much less a principled explanation, without the introduction of exotic, less well-grounded constraints.

All Parallel OT approaches that have been proposed to strengthen the original OT model deal with only one or two of the three problematic areas discussed in this paper (opacity, derived environment effects and paradigmatic effects), whereas Stratal OT addresses all three in a uniform manner. Due to its inherent word-building nature, Stratal OT may provide an explanation of derivational and inflectional phonology and morphophonology that is superior to Parallel OT alternatives. Kiparsky concisely sums up the situation: "At the root of this problem is the fact that parallel OT attempts to deal with the morphology/phonology interface without a theory of morphology" (2000:9).

Stratal OT brings a comprehensive theory of morphology and morphophonology to Optimality Theory; it is certainly a leading candidate to strengthen the OT framework.

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