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Levels, constraints and heads

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1. Introduction

The organization and content of this article is as follows. In Section 2, we offer a general outline of a two-level (i.e. lexical, post-lexical), principles-and-parameters approach to phonology. Though derivational in the sense of having two levels,[1] the model is constraint-based at each level (for us constraints are 'principles', i.e., universal constraints, and 'parameters' are constraints that languages choose from a limited pool). Since the constraints are not extrinsically ranked, the model only uses 'hard' (i.e. unviolable) constraints. Having discussed the derivational side of our approach in Section 2, Section 3 presents our commitment to a theory of phonological representations that attributes a fundamental role to the asymmetrical relation of head-dependency. This section contains an example of the type of analysis that our approach makes available. In Section 4, we turn to a proposed refinement of parameter theory that, in fact, extends the role of the head-dependency asymmetry into the domain of parameter setting. While this proposal is primarily made in the spirit of developing our own approach to phonology, it can, at the same time, be seen as an answer to certain objections that have been raised against parameter theory by proponents of Optimality Theory (OT). Implicit in this latter remark is the point that we ourselves have not embraced the ideas of OT (especially in rejecting the notion of constraint ranking). In comparing our own constraint-based approach to OT, we will take the opportunity to examine and criticize the OT-device of language-specific (parochial) constraint ranking. Section 5 summarizes our main conclusions and indicates areas for further research.

2. The organization of phonology

Our goal in this section is to argue in favor of a two-level (lexical/post-lexical) constraint-based approach to phonology that incorporates the so-called principles-and-parameters framework. As we present our views, we argue against the use of parochial constraint ordering (as advocated in Optimality Theory, OT; Prince & Smolensky 1993).[2]

2.1 Phonological constraints

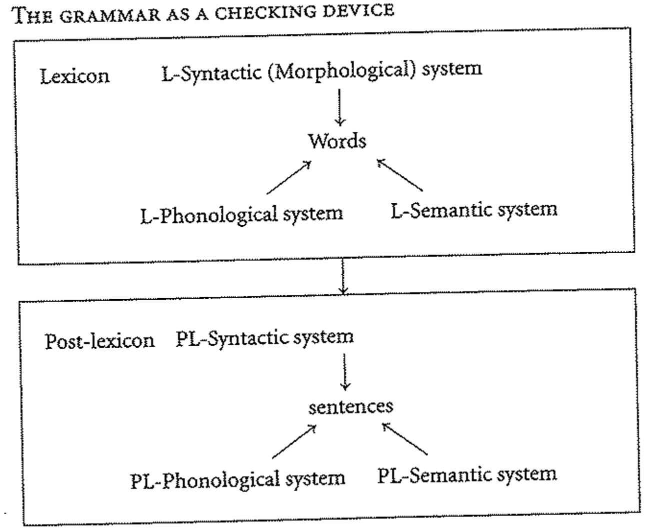
In our view, the heart of the phonological component of a language consists of a set of constraints that evaluate the well-formedness of the phonological representation of linguistic expressions in that language. Constraints can be universal (in which case we could call them principles) or they can be language-specific in the sense that they represent choices from a small set of universal options (in which case we speak of parameters, or parametric constraints). Effectively, this implies that we take phonology to be a constraint-based system, as opposed to the kind of rule-based system that was advocated in Chomsky and Halle (1968). As pointed out in Mohanan (2000), the important distinction here is not the use of terminology ('rule' versus 'constraint'), or the format for expressing phonological propositions (using or not using 'arrows'[3]). The important distinction is between a procedural and non-procedural (declarative) conception of grammar. We take the defining characteristic of a procedural conception to be the use of more than one level of representation.

Non-procedural phonologies (or proposals moving in that direction[4]) have been around in phonology (and linguistics) for a long time (for an historical perspective in phonology see Paradis & Prunet 1993; Scobbie 1997; Bird 1990, 1995). OT instantiates a particular version of this kind of approach with the specific property that, in OT, constraints are violable (or 'soft').

Our own approach is not strictly non-procedural, however, in that we adopt the central claim of Lexical Phonology (which is, in fact, a classical claim, going back to the very beginning of phonology[5]) namely, that phonology is sensitive to a fundamental difference between two types of linguistic expressions: words and sentences (Kiparsky 1982, 1985, 2000). In accordance with that division, there are, then, two sets of well-formedness constraints: a lexical (word-level[6]) set and a 'post-lexical' (sentence-level) set. This, of course, introduces a procedural element in the theory. We do maintain that within each of these two levels, the phonological system is non-procedural and declarative.

In general, we accept the view, defended in Jackendoff (2002), and his earlier work, that the grammar consists of three autonomous (generative) components and sets of interface relations (associations) between the outputs of these components (and grammar external components). We recognize these three components both at the word and the sentence level. An expression (word or sentence) is well-formed if its syntactic, phonological and semantic structures are well-formed and the interface conditions allow the three to be associated. The diagram in (1) shows the organization of the grammar; the interface relations that hold between all subcomponents are not indicated:[7]

(1) The grammar as a checking device



One question that might come up at this point is: where do the words and sentences come from in the first place, such that they can be checked for well-formedness? In generative grammar, the usual answer is that, in each major module, the syntactic system generates the structures. In this view, syntactic 'checking' is implied such that the generative system only produces syntactically well-formed expressions. In this syntactic-centric view, the other two systems (phonology and semantics) have a checking (sometimes called 'interpretative') role only.

In the spirit of Jackendoff (2002), we reject this syntactic-centric view, replacing it by the idea that the expressions that are checked are *all the possible combinations*[8] of L-primes and PL-primes, respectively. The L-primes are morphemes, packages of a chunk of phonological structure, a chunk of semantic structure and a syntactic category label.[9] The PL-primes are **words** as allowed by the L-module (the Lexicon).

Each of the six subcomponents in (1) characterizes a finite compositional system, i.e. a system comprising a finite set of primitives and a finite set of constraints on modes of combination, together defining an infinite set of expressions:[10]

(2) All grammatical systems have the same macro design

$$\begin{array}{lcl} \text{finite set of PRIMITIVES} & \searrow & \\ & & \text{well-formed EXPRESSIONS} \\ \text{finite set of COMBINATORIAL CONSTRAINTS} & \nearrow & \uparrow \\ & & \text{Adjustment} \end{array}$$

In (2), we have added one extra step: *adjustment*. Adjustment may seem a necessary step if basic primitives may vary in terms of their 'surface' appearance, depending on the environment that they appear in. Think, for example, of the phenomenon of allophony (with or without allophonic overlap[11]). Traditionally, phonological primitives are subsegmental (subphonemic) units called *features*. The combinatorial constraints ("segment structure conditions") define an inventory of phonemes, abstracting away from what is called allophonic variation. Hence, once phonemes occur in sequential combinations, allowed by the next layer of combinatorial constraints ("syllable structure conditions"), an extra step is required that accounts for the allophonic appearance of phonemes:

(3) L(exical)-phonology

$$\begin{array}{lcl} \text{finite set of primes}^{12} & \searrow & \\ & & \text{well-formed L-phonological expressions} \\ \text{finite set of constraints} & \nearrow & \uparrow \\ & & \text{allophony rules} \end{array}$$

We follow the lead of Government Phonology (GP) in assuming that all allophonic variation is due to the fact that phonological elements may not be licensed in all positions, assuming that non-licensed elements are not phonetically interpreted.[13] In other words, there are no adjustment rules in this model. In the diagram in (3), one might replace 'allophonic rules' by 'phonetic interpretation'. Let us discuss an example. It is well-known that, in English, there is an allophonic alternation between voiceless unaspirated stops and voiceless aspirated stops. Our analysis would go as follows. Firstly, the combinatory constraints dictate that the element 'stop' must co-occur with either the element

'aspiration' or the element 'voice'. This defines /p^h/ and /b/ as possible expressions, while it disallows /p/. Then, a second constraint indicates that the aspiration element is not licensed in certain contexts, allowing it in the onset of stressed syllables (unless preceded by /s/) only. Thus /p^hIt^h/ will be interpreted as [p^hIt]. We are not saying that the aspiration element is deleted; it is just not interpreted. (A 'traditional' analysis takes the underlying phoneme to be unaspirated /p/, thus requiring an aspiration rule.)

At this point, one might ask how we account for 'allomorphy', i.e. the fact that morphemes can be manifested in different ways depending on the context that they appear in. Our position is that allomorphy is also the result of 'phonetic interpretation', and thus is always due to the fact that certain elements of (segments or) morphemes are not interpreted because they cannot be licensed. After all, allomorphy simply results from allophony if the conditions for one variant happen to be created in a morphologically derived context.[14]

It will be obvious that the approach taken here places severe restrictions on the kinds of allomorphy that the phonology can account for. Indeed, certain types of alternations cannot be accounted for. An example involves 'velar softening' in English (*electric* - *electri*[*s*]*ity*). It has, of course, long been argued for (most forcefully in Natural Generative Phonology; Hooper 1976) that such cases of allomorphy are completely random from a synchronic phonological point of view. We propose that such random allomorphy, in as far as it necessitates a "rule" that substitutes [s] for /k/ in case of *-ity*, is a part of the morphological rule that introduces the relevant affix (cf. Strauss 1982). Another case in point is the rule of 'learned backing' in French (Dell & Selkirk 1978).[15]

In (3), we refer to the set of L-phonological expressions. What type of expressions do we envisage here? Firstly, let us say that expressions occur in a hierarchy of types:

(4) elements (finite set)
|
X-type expressions ('segments')
|
Syllabic expressions (onsets and rhymes)
|
L-phonological words[16]

Thus, elements can be combined forming an expression type that comes close to the traditional notion of 'phoneme'. We call these expressions *segments*, because, indeed, elements are the real 'phonemes' (in the sense of being phonological primes), whereas segments are not necessarily traditional phonemes (cf.

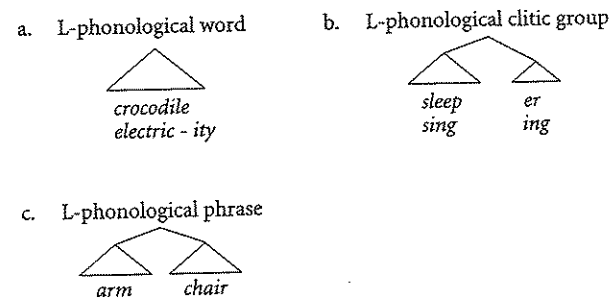
our example of aspiration above).[17] The term 'X-type expression', furthermore, refers to the fact that segments are linearly organized in terms of an X-skeleton. X-slots are organized into the syllabic constituents onset and rhyme, where each constituent is maximally binary in GP. Again, following GP, we do not assume that onsets and rhymes are organized into 'syllables', even though onsets and rhymes occur in packages, in which the onset is a dependent of the rhyme.[18]

Both onsets and rhymes enter into relationships among themselves, called inter-onset relations and inter-nuclear relations, which, as in the case of onset-rhyme relations, are not regarded as establishing constituents.[19]

The expression 'L-word' warrants a more detailed discussion. This is a type of unit within which onsets and rhymes form a close-knit organization that is totally independent from 'outside structure' (i.e. L-syntactic ('morphological') structure). Corresponding terminology for this domain would be the notion 'non-analytic domain' (as introduced in Kaye 1995), 'word level' (as used in Borowsky 1993), or the 'α-domain' (as discussed in Inkelas 1989).

In many, perhaps all, languages, morphological products fall into two classes as far as their phonological behavior is concerned. An 'inner class' (formed by affixes that attach to non-derived stems, or stems derived by members of this same class), where the morphological products behave just like underived words, and an 'outer class'. The idea is that words that are derived by affixes of this inner class and words that are underived form L-phonological words (i.e., *L-words*). Then, there is an 'outer class' of affixes, forming L-syntactic ('morphological') expressions that the phonology treats as consisting of an L-phonological word contained within a larger domain. Outer class affixes, in our view, include inflectional affixes, which, perhaps, constitute the most typical members in this class.[20] Finally, compounding appears to deliver combinations of L-phonological words. To capture these three cases, we propose to extend the terminology for L-phonological expressions in the following way:

(5)



The notion 'L-phonological clitic group' corresponds to Kaye's (1995) 'analytic domain' ([[X] Y]) and Inkelas' (1989) 'β–domain'. It is possible that the 'L-phonological phrase' also applies to words that are derived with certain types of 'heavy' prefixes and suffixes, in English and other languages. Evidence in favor of the L-phrase domain would require the identification of phonological generalizations that pertain to this domain exclusively. As far as we can see, the only reason for postulating the L-phrase domain lies in the fact that compounds have a characteristic stress pattern. Stress, being the exponent of phonological constituency, indicates that the members of compounds form a constituent.

These different types of phonological expressions, notably (5b) and (5c), are, effectively, projections from L-syntactic (morphological) structure. On the whole, this proposal is of course very similar to the classical SPE-treatment of the relationship between phonology and morphology, and its later development in Kiparsky's Lexical Phonology (Kiparsky 1982, 1985), based on Siegel's (1984) and Allen's (1978) models of the interleaving of morphology and phonology. Kaye (1995), however, points out that the distinctions in (5) cannot always be predicted from affix classes, or affixation versus compounding. For a specific word-formation process, some complex forms may be analytic, whole others (due to 'lexicalization') may behave as non-analytic. We return to the issue of mismatches between L-syntactic and L-phonological structure below.

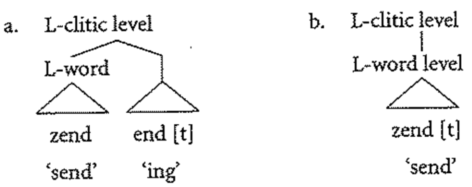
Assuming, then, that the higher levels in the L-phonology, involve at least L-words and L-clitic groups, we need to establish phonological constraints for each such domain. It is clear that the L-words form the domain of what are usually referred to as *phonotactic constraints*, i.e. constraints on combinations of consonants and vowels into onsets, rhymes and feet. In addition, this domain is relevant for phonological constraints that are responsible for 'allophonic (automatic) alternations'. For aspiration in English, we cannot establish whether its domain is the L-word or the L-clitic group simply because L-clitics (being many of the so-called 'Level II' suffixes such as *-er, -ing, -s, -ly* and inflectional suffixes) do not contain unaspirated voiceless stop consonants. However, Borowsky (1993) discusses a host of generalizations from English and other languages that involve automatic generalizations that are bound to the L-word domain.[21] Consider the following words:

(6)	a.	cycle	b.	cycling	c.	cycl-ic
		meter		metering		metr-ic
		center		centering		centr-al

In *cycle* we find a final 'syllabic liquid', which also occurs (in some dialects) in *cycling*. *Cyclic*, however, has a non-syllabic liquid. The constraint that enforces a final, post-consonantal liquid to be syllabic, can apparently apply in the case of *cycling*, which, Borowsky argues, indicates that *cycling* properly contains the phonological domain (in her terms: the word level) that is relevant for this constraint. In *cyclic*, the /l/ is not domain final, which indicates that this word does not properly contain a word level, but rather constitutes a word-level unit.

A complication in this case with respect to non-derived words ending in *-er* (such as *meter* in (6) above) is that the final /r/ of the agentive suffix *-er* (part of the L-clitic domain) can also be pronounced as syllabic, for example in *eat-er*. This indicates that the L-clitic domain is also subject to the same constraint regarding post-consonantal liquids as found in the L-word domain.[22] If this pattern is typical, it may indicate that the L-clitic group is a recursive version of the L-word, and that constraints that are relevant to the deepest L-word may apply to recursive L-words as well. It remains to be seen whether certain constraints are relevant to the deepest L-word or the recursive L-word only. Borowsky, in any event, concludes that, in English, there are no specific phonological generalizations that belong to the latter domain (what we here call the L-clitic group). However, we believe that this conclusion does not hold in general. Consider 'final devoicing' in Dutch.[23] We take this phenomenon to involve an L-phonological constraint that holds at the L-clitic group level and not at the L-word level. We propose that the relevant constraint states that the voice element is not licensed at the right edge of the L-clitic domain. If, for example, we assume that, in Dutch, the present participle suffix *-end* is an L-clitic, we clearly see that 'final devoicing' is relevant at not only the L-word domain:

(7) a. b.



As (7a) shows, voicing is licensed at the right edge of the L-word, as long as this right edge is not also at the same time the right edge of the L-clitic group.[24]

Thus, we believe that the L-clitic group (or: recursive L-word) *can* form a domain for phonological constraints that are specific to this domain.[25] Another set of examples for constraints that specifically bear on the L-clitic group is the set of *vowel harmony constraints* that apply in all languages where the domain of harmony subsumes inflectional affixes.

A final point with reference to the L-clitic group is the following. In the majority of cases, this domain will be morphologically complex. However, morphological complexity is not a requirement. It has been known for a long time that words may end in consonant coronal clusters that do not seem to 'fit' in the L-word domain in as far as the cluster represents an unusual kind of 'coda' that, apparently cannot occur word-medially, for example as in the word *first*. Traditional analyses (e.g. Fudge 1969, 1987) represent these coronal clusters as 'appendices'. We suggest that these 'appendices' are L-clitics, even though they do not correspond to synchronic suffixes. Possibly, initial /s/, especially in combination with branching onsets (as in /spl/, /spr/) can be analyzed as an L-preclitic. In other cases, monomorphemic words contain internal 'superheavy syllables', which are severely limited in their distribution, mainly occurring in 'word-final' position (for example, words like *mountain*). Also, monomorphemic words may have the appearance of compounds without being synchronically analyzable as such. Mismatches of this sort are expected given that the distinction between L-words and L-clitic groups is a purely phonological one, even though there are obvious generalizations with respect to the alignment of these domains and L-syntactic (morphological) structure.

2.2 Repairs?

Our approach bears a certain resemblance to so-called *constraints-and-repairs* models. The idea of a constraints-and-repairs (CR) approach has been put forward in, among others, Stewart (1983); Singh (1987); Calabrese (1986, 1995, to appear) and Paradis (1988).[26] In comparison to the rule-based approach advanced in Chomsky and Halle (1968, SPE), one might say that the CR-approach breaks up the 'rules' that were used in classical generative phonology, into two parts:

(8) Classical SPE rule

$$\begin{array}{c} \text{Classical SPE rule} \\ | \\ A \rightarrow B \,/\, C - D \\ \swarrow \qquad \searrow \\ \text{Repair} \qquad \text{Constraint} \\ | \qquad\qquad | \\ A \rightarrow B \qquad {*}CAD \end{array}$$

Once these two ingredients are teased apart, it becomes possible that one constraint may be 'served' by a variety of repairs that act on different kinds of violations of that constraint. A situation like that cannot be dealt with in a satisfactory manner in a rule-based approach without the loss of generalization, since several rules would necessarily repeat the statement of the relevant constraint, a situation referred to by Kisseberth (1970) as a 'conspiracy'.

Repairs are said to come into action when a combination of morphemes, which is well-formed from the viewpoint of the L-syntactic system and the L-semantic system, violates a constraint of the L-phonological system, either holding at the L-word domain, or at the L-clitic group domain. One might ask whether, analogous to L-phonological repairs, there are also L-morphological or L-semantic repairs? If this is not the case, then it follows that morpheme combinations that violate L-syntactic or L-semantic constraints are apparently **rejected**, rather than repaired. This lack of analogy between L-phonology and the other two L-components is unexpected in a view of grammar that attributes the same role to all subsystems, viz. that of a checking system.

In our approach to phonology, the lack of analogy does not exist. Our claim is that there are no phonological repairs. Phonological representations are interpreted in accordance with the constraints that hold for each domain. It is not relevant whether or not the domain is morphologically complex or not. L-words can be simplex or complex and, as argued above, the same holds for L-clitic groups.

Let us consider an example that involves an alleged conspiracy in some languages:[27]

(9) $*[V\{V,C\}C]_{rhyme}$ "no superheavy syllables"

A constraint of this type is relevant in Yawelmani, where it seems to motivate two rules (in traditional rule-based analyses): vowel shortening in case the violation is VVC (=> VC), and epenthesis in case the violation is VCC (=> VCVC). In a rule-based analysis, the constraint is encapsulated (and thus repeated) in two rules:[28]

(10) a. VVC => VC (shortening)
b. VCC => VCVC (epenthesis)

In a constraints-and-repairs model, the constraint is stated once (as in 9), while the repairs just say:

(11) a. delete V
b. insert V

The different violations will uniquely select the appropriate repair, assuming that the output of repairs must be well-formed structures (or at least, must not be worse than their input). The approaches of Paradis and Calabrese (cf. references above) offer analyses in this type of framework, addressing many issues of detail.

Another argument for separating constraints ands repairs can be based on *cross-linguistic* conspiracy effects, i.e. cases where different languages choose different repairs for what appears to be the same constraint. Thus, the idea is that for a specific violation of the constraint in (9), say VVC, different repairs are possible in different languages, for example:

(12) a. delete V (VVC => VC)
b. insert C (VVC => VCVC)
c. delete C (VVC => VV)

Steriade (2000) has recently pointed out that it is, in fact, not at all common to find that different languages select different repair solutions for what seems to be the same constraint violation. One of her examples involves the following constraint:[29]

(13) *[obstruent, voice] #

Of all the conceivable repairs (insert a vowel word-finally, delete the entire consonant, change the consonant into a sonorant and so on), the one that is always found is:

(14) Delete voice

Our own approach concurs with Steriade's findings. Indeed, since our model has no repair rules to begin with, languages could not possibly differ in having different repair rules. In our model, "repair" is embodied in the way in which phonological structure is interpreted. Following the original proposals in Government Phonology, we pursue the ideal that the interpretation of phonological constellations is entirely universal. Differences between languages cannot result from different 'repairs' of the same constraint. Rather, the well-formedness of phonological representations is dependent on universal constraints ('principles'), as well as parametric constraints. The latter lie behind differences among languages.

How does OT handle 'repairs' if it only has constraints? It is assumed by OT-proponents that the situation in (12) is a realistic one: different languages *can* respond differently to one and the same constraint. OT handles repairs by incorporating 'faithfulness constraints' that penalize discrepancies between the input and the output, for example:[30]

(15) a. *delete C (read as 'do not delete C')
b. *insert C (read as 'do not insert C')

By confronting the constraint set with all logical alternative 'repairs' (the candidate set) for a given input, and by postulating an extrinsic ordering on the faithfulness constraints, OT achieves the result of selecting a unique output for any given input. The lowest ranked 'anti-repair constraint' specifies the repair that a language will allow, assuming that there is a higher ranked well-formedness constraint that enforces the violation of this repair constraint:

(16) a. $*[\text{VVC}]_{\text{rhyme}} \gg$ *insert C $\gg$ *delete (VVC and VCVC lose, VC wins)
b. $*[\text{VVC}]_{\text{rhyme}} \gg$ *delete V $\gg$ *insert C (VVC and VC lose, VCVC wins)

Van der Hulst and Ritter (2000b) point out that the adoption of 'anti-repair constraints' forms one of the two important reasons for introducing parochial ordering into the set of constraints.[31] It should be clear at this point that parochial ranking is what separates our approach from OT, nothing else.[32]

2.3 On the lexical/post-lexical distinction

With reference to the post-lexical component, (2) is instantiated in the following way:

(17) PL-PHONOLOGY

finite set of L-phonological expressions[33] → well-formed PL-phonological expressions
finite set of constraints → well-formed PL-phonological expressions
↑
phonetic interpretation

When words are combined, all sorts of 'processes' seem to apply that cause variation in their phonological shape, dependent on neighboring words or position in the phonological hierarchical structure. Analogous to what we proposed for the L-phonology, we postulate that in this case too variation is due to phonetic interpretation.[34]

Now, whereas the L-phonological system characterizes exactly one L-representation (for a given idealized speaker), every such speaker is capable of pronouncing utterances in many different ways, depending on factors that relate to tempo and style of speech, and other sociolinguistic factors, which must be built into the constraint system.[35] A PL-model that incorporates some kind of gradient parameterization of constraints in order to account for stylistic variation has not been designed, as far as we know. In addition to needing gradient parameterization, it seems likely that the 'combinatorial syntax' of the PL-phonology is different from that of the L-phonology. It may be the same to a large extent, but we believe that certain differences must be assumed. For example, the notion of 'ambisyllabic consonant', and perhaps in general the idea of overlapping constituents and improper bracketing seems to belong exclusively to the post-lexical level.[36] In short, the PL-system is largely a terra incognita.

Let us now briefly address the question as to why we wish to adopt the lexical/post-lexical distinction. After all, this move introduces a procedural element in the theory. There are several reasons, but we focus here on Kiparsky's proposal that the lexical/post-lexical distinction is necessary to account for certain cases of 'legitimate' opacity. The separation of a word and sentence constraint set implies the possibility of the latter obscuring the former, creating opacity effects. Thus a lexical constraint barring initial clusters may be overridden by a post-lexical constraint that allows such clusters. We follow Kiparsky (2000) in adopting the hypothesis that many 'legitimate' opacity effects arise in this way. Why is this crucial? It seems that constraint-based approaches (including OT) are fundamentally unable to deal with opacity effects, without allowing some kind of procedural ordering into the system. Kiparsky's approach limits extrinsic ordering to ordering between entire constraint sets. We believe that this is the most principled way of accounting for certain (but not all[37]) opacity effects. In addition, differences between lexical structure and post-lexical constituent structure may produce what van der Hulst (to appear a) has called *Structure Paradoxes*. Note that such paradoxes are simply one instance of the broader phenomenon of opacity.

We might note that the ordering of constraints implies some kind of opacity as well. After all, if a constraint A outranks another constraint B (and A and B describe incompatible well-formedness properties), A *obscures* the presence of B. For example, if a constraint that describes that stress is initial (B) is outranked by a constraint describing that heavy syllables must be stressed (A), any word that starts with a light - heavy sequence will cause the initial stress constraint (B) to be opaque. The fact that constraints (if outranked) can be violated in the output makes them sőft constraints. Recall that declarative constraint-based systems (such as Scobbie 1997; Bird 1990, 1995) disallow this kind of opacity. To give it a name, let us refer to the opacity of constraints, due to ranking, as *non-procedural opacity*.[38] The kind of opacity that Kiparsky tries to avoid (and that motivated extrinsic ordering in SPE) is of a different kind that we will call *procedural opacity*.[39] Proponents of OT find it hard to accept, but constraint ordering *cannot* produce procedural opacity effects.[40]

So why, one might wonder, does Kiparsky (2000) adopt the extrinsic ordering of constraints, if it doesn't help to account for procedural opacity? The answer, we believe, has been partly given above. By introducing competing 'repair' constraints into the constraint set, ordering has to be imposed to select the correct output. There is, moreover, a second reason for why OT adopts ordering, resulting from the rejection of parameters. We will discuss this in Section 4.

We conclude this section, by recapitulating our position on the use of procedural mechanisms.[41] We make a three-way distinction:

a. We have adopted a two-level (lexical/post-lexical) approach to phonology. Since both levels are ordered (as a consequence of the organization of the grammar), our approach to phonology is procedural in the sense that the constraints on sentences take precedence over (i.e. come after) the constraints on words. This kind of ordering is totally universal in that it follows from the organization of the grammar as a whole.
b. Secondly, our model does not make use of extrinsically ordered rules that create intermediate steps (within the lexical or post-lexical level).
c. Thirdly, our model does not appeal to parochial ordering of constraints as used in OT. This ordering does not create intermediate levels.[42] However, specific constraint pairs may be ordered in terms of an 'elsewhere relation' in our model, as discussed in our analysis in Section 3.3 below (also cf. Ritter 1995 for such a discussion with respect to resolving parameter conflicts).

Thus, the approach that we explore is procedural in the sense of (a), but it rejects (b) and (c). Proponents of Government Phonology usually do not like to make the lexical/post-lexical distinction (Kaye 1995). This is largely a 'pro-

grammatic' claim since little work on sentence level expressions has been done in this model.[43] Dependency Phonology, however, incorporates the distinction explicitly. Standard OT (Prince & Smolensky 1993) rejects all three procedural elements, although it has something else that looks a lot like (b): the evaluation procedure is based on an input/output distinction. OT, in Kiparsky's approach, adopts (a). Declarative Phonology (Scobbie 1997; Bird 1990, 1995) rigidly rejects all three procedural elements, although one can conceive of a declarative phonology that adopts the lexical/post-lexical distinction (Coleman 1995a).

3. Head-driven Phonology

The preceding section presented the general outlines of a two-level (lexical/post-lexical), (declarative) constraint-based phonological model. In this section, we will discuss a specific theory that is compatible with these outlines.

3.1 The parallelism between phonology and syntax

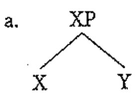
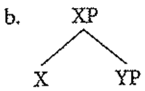
A model that, in our mind, comes close to incorporating all the hypotheses that we have adopted above is Government Phonology (Kaye, Lowenstamm & Vergnaud 1985, 1990). This model is constraint-based (incorporating principles and parameters). There is no extrinsic ordering of any kind.

In most other constraint-based approaches, the rejection of intermediate levels has lead to extremely 'surface-oriented' and 'construction-specific' constraints that shy away from anything that is not 'phonetically present' in the speech signal (cf. Natural Generative Phonology, Declarative Phonology). Even in OT, where constraints can be obscured in the output, there is a tendency to stick to the "phonetic facts". Government phonology is different from these surface-oriented approaches. Its presupposition is that phonology characterizes a cognitive system (cf. Kaye 1989). As such there is not even the possibility of referring to 'phonetic events'. On the contrary, the kinds of constraints that one finds in Government Phonology are general and refer to rather abstract properties of phonological representations. In doing so, Government Phonology has taken the explicit view that phonology is *not different* from syntax in allowing its expressions to contain abstract units that are essential in accounting for the well-formedness of expressions without necessarily receiving a phonetic interpretation.[44]

A second extremely attractive feature of this model involves its reliance on *head-dependency relations* at all levels of the phonological representation.[45] In adopting this feature, Government Phonology has been preceded (and influenced) by the model of Dependency Phonology (Anderson & Ewen 1987).

The parallelism between syntax and phonology that we signaled above, goes much further than simply allowing 'abstract units'. The fundamental hypothesis of the government/dependency program is what Anderson and Ewen (1987:283ff.) refer to as the *Structural Analogy Hypothesis*. According to this hypothesis, we expect, all things being equal, that the cognitive systems of syntax and phonology are organized in identical ways.[46] This view is in contrast with that of Bromberger and Halle (1989) (and many others) according to which 'phonology is different'. For Bromberger and Halle this means that phonology can have extrinsically ordered rules, while syntax does without such a mechanism. We do not subscribe to this extreme version of modularity. Maintaining that phonology and syntax are different modules, we pursue a highly parallel organization, subject to general principles of UG, for both modules.[47]

There is also a terminological consequence to the parallelism between phonology and syntax. Firstly, the term 'syntax' just means 'putting things together'. The modules of phonology and syntax both rely on a finite set of primitives and a finite set of rules in order to characterize their expressions. Thus, both modules are 'syntactic'. We claim that the 'syntax' of phonology and the 'syntax' of syntax share interesting properties such as binarity of structure and headedness.[48] Do the parallels extend further? They do, perhaps, in the more general claims of UG, for example, in that the projection of underlying structures cannot be tampered with in an ad-hoc fashion and that units (be they syntactic or phonological) must be licensed in their positions (especially those positions that are empty). It might also be asked whether there are phonological parallels to transformations. In the old days of generative grammar, the answer was simply affirmative: phonological rules were the analogues to syntactic transformations. The phonological model that we support does not have transformational rules. But then again, syntax can be done without transformations as well. In any event, the hypothesized parallelism does not imply that phonologists must blindly 'copy' the theories of their syntactic colleagues, or vice versa. Both phonologists and syntacticians pursue the best possible theory for their domain. They can look at each other's results in an heuristic spirit and import concepts back and forth, but the structural analogy hypothesis is ultimately an empirical claim. Moreover, it does not predict that both components are fully identical. A common set of principles and parameters may result in different structures in response to the fact that both domains start out with different sets of primitives (cf. van der Hulst 2000 for extensive discussion). Lastly, we should not be reluctant to see significant differences between the 'syntax' of phonology and the 'syntax' of syntax. One such difference might involve the notion of recursion. It seems to be a typical property of phonological constituency that different constituent types are arranged in 'strict layers', where each unit dominates one or two units at the lower layer, as in (18a). Syntactic structures are quite different and this is due to the fact that constituents can contain a constituent of the same type as a dependent of the head, as in (18b):

(18) a.  b. 

Dresher and van der Hulst (1998) refer to the relationship in (18a) as αα–dependency, and that in (18b) as αβ–dependency, simply to indicate that in the former case, head and dependent are of the same type (i.e. X-slot, syllable, foot and so), whereas in the latter case head and dependent are of different types. The lack of recursion in phonology seems to imply that the set of phonological expressions is finite.

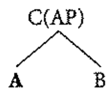
3.2 The expression of asymmetry in phonology

The Head-dependency Principle (HD) is the fundamental expression of *asymmetry* in phonology. The central claim is that phonological representations are driven by an asymmetrical relationship between the units. In fact, we believe that the idea of headedness is so fundamental that we have chosen to refer to our own views, which strongly build on Government and Dependency phonology, as *Head-Driven Phonology* (HDP).[49] The fundamental principle can be stated as follows:

(19) The Head-dependency Principle (HD)
All phonological relations involve one head and at most one dependent

In our earlier work (van der Hulst & Ritter 1999), we also formulated a Binarity Principle, which stated that phonological units are maximally binary. One might argue that binarity is implied by the above HD-principle. Note that (19) does not say that all phonological units are necessarily binary. An onset, for example, may contain one consonant.[50] A phonological representation is a network of binary relationships, and it will be necessary to distinguish a few different types of relationships. Some of these relationships correspond to structural notions such as sisterhood and dominance:

(20)

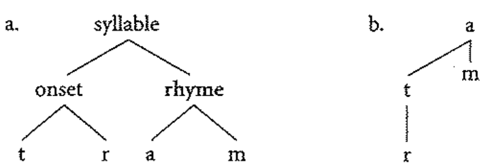


Assuming that the bold-face A is the head, a constituent implies a HD-relationship between C and A (A is the head of C; C is an A-phrase or AP). At the same time there is a HD-relationship between A and B (A is the head of B; A governs, or licenses B). One might, in fact, conflate these two head roles of A by replacing (20) by (21)

(21)

This assumes that the linear relationship between A and B (if present) is accounted for separately, in terms of 'linearization rules'. In Dependency Phonology, representations such as (21) have always been used for subsegmental structures since subsegmental relationships between phonological primes (features or elements) clearly do not involve linear order. But, even in domains where linear order is apparently relevant, such as syllable structure, it can be maintained that the phonological structures do not express linear order (which is left to separate linearization rules). Consider an English syllable like *tram*. Assuming that this syllable consists of an onset (tr) and a rhyme (am), we could adopt a traditional representation as in (22a), or a different representation as in (22b):

(22)



Given that (22b) is one constituent, it is predictable, because onsets universally precede Rhymes, that the (a,m) unit follows the (t, r) unit in order to constitute a well-formed syllable. Thus, (22b) should not be taken to express linear order. We should also note that in the case of syllabic constituents (onset, rhyme), the location (in terms of linear order) of the head is universally fixed: onsets and rhymes are left-headed.[51] Thus, the structure in (22a) can be taken as a linearization of the structure in (22b). At the foot and word layer, however, it appears that the orientation of the head is not fixed (i.e., it is parameterized).

The relevance of the head – dependent relation as part of constituent structure goes beyond determining the *syntagmatic* relation of linear precedence. In addition, heads and dependents differ in what they can dominate; we can call this the *paradigmatic* side of constituent structure. Here we mention an important principle that constrains the nature of structural paradigmatic relationships (cf. Harris 1990; Dresher & van der Hulst 1998):

(23) The Asymmetry-Complexity Principle[52]
Dependents cannot be more complex than their heads

This principle captures a fundamental property of representations. It states that in cases where head and dependent positions allow different units, head positions allow a greater array of contrasts than dependents. This has obvious distributional consequences. For example, head syllables allow a greater array of vowels than dependent syllables, or head syllables allow branching onsets, whereas dependent syllables do not. Another example is that heads of onsets allow a greater array of consonants than dependents of onsets do.

Government phonology has also made a case for head-dependent relations that do not refer to units that form a constituent in the traditional sense. We already saw this in the claim that the relationship between onsets and rhymes is not one of constituency. Another case in point is the Coda Licensing Principle (Kaye 1990):

(24) Coda Licensing
A coda must be followed by an onset that can license it

According to this principle, no word can end in a coda, and even word-medial codas are restricted in that the coda - onset sequence (called the interlude) must be such that the onset consonant can license the coda. Roughly, in order to have this potential, the onset consonant cannot be more sonorant than the coda. This principle accounts for the fact that whereas the sequence *n-t* is generally a well-formed 'interlude' (in languages that allow codas in the first place), *t-n* is not. Coda licensing is a head - dependent relationship in which the onset is the head, despite the fact that interludes do not form constituents in the traditional sense.

So far, head - dependency relations have been made 'responsible' for licensing units in the phonological structure. In particular, the claim is that dependent units must be licensed to occur by a head. In addition, we may need constraints that refer to structural positions such as 'edge of' a domain. It remains to be seen whether such *edge constraints* can be reduced to constituent or interconstituent head-dependency relations.[53]

We conclude that phonological representations are constellations of head-dependency relations that are subject to universal constraints (principles) and more specific constraints (parameters).

3.3 The role of interpretation in accounting for alternations

In our approach, 'phonetic interpretation' plays an important role. The result of interpretation at the L-level is, in our view, a *phonological* representation that forms the starting point for the post-lexical phonology. We assume that L-units that are not licensed, and thus not phonetically interpreted, are invisible to the PL-system, where combinations of L-words are subject to a (gradient) constraint system that characterizes the PL-level. PL-representations are also subject to 'phonetic interpretation'. The result of that can be phonetically implemented.

In this section, our goal is to show the important role of interpretation (at the L-level) in apparent cases of 'insertion' (producing vowel – zero alternations) in the lexical phonology. We also refer to van der Hulst and Ritter (2000a) for a discussion of the role of phonetic interpretation in accounting for alternations that involve apparent 'deletion' and resulting opacity effects.

Here we present a sample analysis of some phonological patterns in Yawelmani, involving the kind of data that motivated extrinsic rule ordering in SPE. We will show how the data can be accounted for in Head-driven Phonology. The analysis relies heavily on the original proposals made in the context of Government Phonology, but differs in various important respects from the analysis put forward in Kaye, Lowenstamm and Vergnaud (1990).[54] The focus will be on aspects of the data that have led prior researchers to postulate a rule of vowel epenthesis and a rule of vowel shortening, to be applied in that order.

3.3.1 *The relevant data*

Vowel shortening is motivated by the following paradigms (cited from Kenstowicz and Kisseberth (1979: 83 ff.):

(25)	Nonfuture	Imperative	Dubitative	Future	gloss
	dos - hin	dos - k'o	do:s- ol	do:s - en	report
	lan - hin	lan - k'a	la:n - al	la:n - en	hear

Roots that invariably have short vowels show that the above roots have underlying long vowels that apparently shorten before two consonants (which amounts to closed syllable shortening in some models).

Epenthesis is illustrated by the following data:

(26)	logw- ol	'might pulverize'	logiw - hin	'pulverizes'
	lihm - al	'might run'	lihim - hin	'runs'

An epenthesis analysis is more likely than a deletion analysis since there are otherwise no CVCVC roots in the language. This is explained if one assumes that there are, in fact, no such roots in the language and that the surface pattern CVCiC is derived through epenthesis. The rule of epenthesis breaks up a cluster of three consonants.

The two rules are extrinsically ordered as shown by the following data:

(27)	sonl - ol	'might put on the back'
	so:nil - mi	'having packed on the back'

The underlying form for these roots must be CV:CC. A standard derivation of both forms shows that epenthesis must precede shortening:

(28)	(a)	so:nl - ol	so:nl - mi	(b)	so:nl - ol	so:nl - mi
	Ep.	—	so:nil - mi	Short.	sonl-ol	sonl - mi
	Short.	sonl - ol	—	Ep.	—	*sonil - mi

By standard reasoning both rules must be extrinsically ordered.

3.3.2 *An HDP analysis*

In our model, there are no deletion or insertion operations. Following the ground-breaking idea of Government Phonology, vowel – zero alternations are handled by assuming that the input forms contain empty vowel positions that can be interpreted as silent or audible depending on the environment.[55] The crucial generalization is stated in (29):[56]

(29) An empty nucleus can be silent only

a. if it is governed by a following non-empty nucleus (*Proper Government*)
b. if it is final in its L-phonological domain (*Final Licensing*)

The implication of (29) is that a nucleus that is phonologically empty may be silent (if it meets 29a or 29b) or audible (if it does not meet 29a or 29b).[57] In practice, (29) makes it impossible for two adjacent empty nuclei to both be silent.

Let us first consider a form in which empty nuclei are silent:

```
(30)  ONONON-ONON     /logw - ol/ → logwol
      |||  |    ||
      log  w    ol
          ←———— √
```

The second nucleus from the left is the locus of the vowel - zero alternation, while the final empty nucleus is 'forced upon us' by the Coda Licensing Principle which disallows final codas. We have argued earlier that in GP, each onset co-occurs with a nucleus, and vice versa; in these packages, onsets are dependents while nuclei are heads. There are no sequences of N's or O's. This, in fact, necessitates postulating both empty nuclei and empty onsets (even when no alternations are present). In addition, a general convention seems needed that allows us to 'ignore' a sequence of an empty nucleus followed by an empty onset (i.e. the italicized sequence NO) (as proposed in Gussmann & Kaye 1993; and Yoshida 1993). We adopt an alternative, suggested by John Harris, which assumes that the morphological concatenation 'overlays' the empty suffix onset over the stem-final onset and the suffix vowel over the empty stem-final vowel such that the resulting representations will not contain the vacuous NO sequence. Thus, (31) replaces (30), showing suppression of the empty NO-sequence:

```
(31)  ONONO-NON     /logw - ol/ → logwol
      |||   | ||
      log   w ol
           ←——— √
```

The representation in (31) is well-formed. The left-pointing arrow represents Proper Government (PG), the HD-relation that licenses empty nuclei to remain silent. Hence, in this form, no empty nucleus is interpreted as audible; in other words: there is no 'insertion'. The '√' indicates Final Licensing (FL).

The question might be raised as to whether PG constitutes a constituent. The relationship between an empty nucleus and a following full nucleus is clearly 'foot-like' (as suggested in van der Hulst & Rowicka 1997). Here, we will leave this issue open. Clearly, the foot-like relationships are not responsible for the familiar rhythmic patterns in stress systems which, in our view, result from post-lexical foot structure (cf. van der Hulst, to appear a, b). In this sample analysis we do not discuss word stress in Yawelmani.

Now consider the next form:

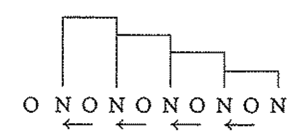

```
(32)  ONONONONON     /logw - hin/ → logiwhin
      |||  |  | |
      log[i]w  hin
             ←— √
```

As before, the final empty nucleus is licensed by FL.[58] The penultimate vowel properly governs the empty nucleus to its left. Hence, the empty nucleus *preceding* this properly governed empty one cannot remain silent; consequently, it is phonetically interpreted as the vowel sound [i].[59] The form in (32) tells us that PG 'operates' in a leftward fashion. We must assume this because otherwise the representation in (33) would be a possible candidate:

```
(33)  ONONONONON     /logw - hin/ → *logwihin
      |||  |  | |
      log  w[i]hin
          ←——— √
```

More needs to be said about this right-to-left directional property of PG. We suggest that the directionality of the binary government relationship and the unbounded right-to-left propagation of this relationship form part-and-parcel of the right-headed, right-branching constituency that organizes all nuclei into the L-word domain:

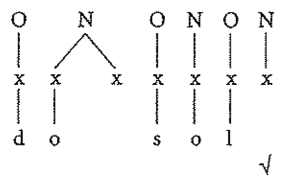
(34)



Next we turn to vowel shortening. Long vowels, in general, can result from two different structures, involving either a branching nucleus, or a sequence of two non-branching nuclei (with an intervening empty onset):[60]

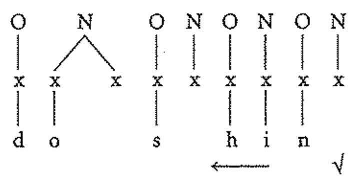
```
(35)  a.    N          b.  NON
           / \              |
          x   x             x
          |                 |
          o                 o
```

In both cases, the long vowels result from the fact that the second empty position is interpreted with the content of the first position. In the case of Yawelmani, we will show that (35a) allows us to provide an explanatory account of 'vowel shortening', i.e. the failure of the second position to be interpreted as involving the element that is associated to the first position.

(36)  /do:s/ - ol/ → do:sol

Example (36) is a representation of a stem with a long vowel where the second position of the branching nucleus is interpreted with the element associated with the head or first position of that nucleus.

Now consider the form that shows 'vowel shortening'. Here we have a sequence of two empty nuclei and we might therefore expect a lexical foot between them that would force audibility on the right-hand side of the long vowel, an undesirable result:

(37)  /do:s - hin/ → doshin

We now have to explain why the second position of the 'long' vowel cannot be phonetically interpreted in (37), though it is in (36). At first sight, one might argue that the interpretation of the second position of the branching nucleus in (37) is expected because that nucleus cannot be properly governed by the following nucleus that is itself properly governed to remain empty. We must assume that something overrides PG in this case. The GP literature contains a few different proposals. Here we propose our own, leaving the comparison and discussion for another occasion. Recall the principle of Coda Licensing, which demanded that a coda position be licensed by a following onset. We propose that the 'second half' of a long vowel must likewise be licensed. The candidate licensor for the second half of the long vowel is /s/, the immediately following consonant, both in (36) and in (37). The difference between both cases is that in (36) /s/ forms the onset of a non-empty nucleus, whereas this is not so in (37). We propose that onsets of empty nuclei cannot 'coda' license because, so to speak, the empty nucleus that follows the onset (which itself governs the onset) is incapable of giving the onset 'licensing power'. In other words, we propose that the constraint 'Coda Licensing' embodies the constraint that a licensor must be governed by a non-empty nucleus. We will refer to this new formulation of Coda Licensing as 'Revised Coda Licensing'. The idea of governors needing 'licensing power' is not new and there are several GP analyses that appeal to this notion (e.g. Charette 1990). Here its use is extended to a new situation. Thus in (36) the onset that licenses the second position of the branching nucleus is governed by a non-empty nucleus, resulting in the interpretation of that branching structure as a 'long vowel'. In (37), however, the nucleus governing the onset-licensor is empty, resulting in the onset's inability to license the preceding 'coda-like' nucleic position thus yielding the effect of 'vowel shortening'.

The analysis proposed here reveals that a nucleus dependent position is subject to a constraint (Revised Coda Licensing) which takes precedence over Proper Government. We assume that this precedence relationship follows from the Elsewhere Condition because whereas PG makes reference to empty nuclei in general, Revised Coda Licensing refers to *dependent* empty nuclei. Thus, we see here another instance of the relevance of head-dependent asymmetries.

4. Problems with parameters?

In this section, we will propose (or rather make explicit) how the setting of parameters is dependent on head-dependency relations. Our proposal will be that the setting of a parameter can differ for heads and dependents. Thus, a language *can* show evidence for opposite settings of a parameter. In the OT literature, it has been argued that the all-or-nothing approach of parameter theory fails to explain 'emergence of the unmarked', which is evidence for the unmarked setting, in a system that also shows evidence for the marked setting of a parameter. Our proposal embodies an answer to this kind of criticism.

Let us start this section, by recapitulating why we refer to our approach as 'constraint-based' if it is using principles and parameters. Firstly, we take principles to be constraints that hold true for all languages. Then, there are statements that specify choices that languages make from a small set options; these are the (set) parameters. Effectively, then, both principles and parameters (once provided with a value) *are* constraints in that these statements specify the well-formedness of phonological representations without any procedural elements.

Parameters, then, can be thought of as binary constraints. Fixing a parameter's value, turns a parameter into a (unary) constraint. This does not mean that languages differ in having 'positive' constraints or 'negative' constraints, corresponding to the positive or negative settings of the parameters. Both settings produce the same kind of constraint (which often can be formulated in a positive or negative way). Take, for example, foot formation, assuming that feet can be left-headed or right-headed, we see this as a parameter. A language that has LH feet can be said to have LH feet (a positive statement) or we can say that it disallows RH feet (a negative statement). Either way, the language has a simple unary constraint.

Optimality theory has no parameters. This means that it only allows unary constraints from the start.[61] Since all constraints are universal,[62] and since languages may have LH or RH feet, differences between languages necessitate extrinsic ordering of the constraints, which, then, is the second reason for why OT needs extrinsic ordering, the first one being the need to rank the anti-repair faithfulness constraints (discussed in Section 2.2). The two alternative approaches are summarized in (38). PPT stands for 'principles and parameters' theory:

(38)

	Language A	Language B
PPT	FootHead (left)	FootHead (right)
OT	FootHead (left) » FootHead (right)	FootHead (right) » FootHead (left)

Cases where the two values of a parameter correspond to two truly independent constraints (i.e. constraints that are not each other's opposite) are difficult to find and we should not be misled by the fact that the two opposite constraints sometimes have unrelated names. The difference between languages that have quantity-sensitive (QS) and quantity-insensitive (QI) feet would be made as follows in the two theories:

(39)

	Language A	Language B
HDP	QS (yes)	QS (no)
OT	Weight-to-Stress » Uniformity	Uniformity » Weight-to-Stress

The constraint Uniformity says that syllables must be grouped in a uniform way, forming regular groupings of two syllables. Weight-to-Stress requires that every heavy syllable is stressed, i.e. the head of a foot. The constraint *Uniformity* is violated when syllables are not grouped in a regular alternating fashion, which, of course, happens when Weight-to-Stress interrupts a regular grouping, demanding for example that two adjacent heavy syllables each forms its own foot. Now, it may seem as if the OT account has the advantage of appealing to independent forces, but it is really not obvious why 'uniformity' couldn't be called 'weight-not-to-stress', or why 'weight-to-stress' could go under the heading of 'non-uniformity'.

It seems hard to believe that OT has gained its popularity because of the difference outlined here. In fact, given the exponential power of constraint ranking, one would always adopt the PPT model as the more restricted one. The basic calculation is that adding a parameter to your model multiplies the set of possible grammars by 2. Adding a constraint multiplies the number of grammars by whatever the number of constraints was (plus 1).

Proponents of OT have argued that OT is *conceptually simpler* than a principles-and-parameters approach, especially if this latter approach is combined with repair mechanisms. OT uses only one type of mechanism: constraints. This is possible because parametric choices have been 'translated' into pairs of opposing constraints and the repair rules have also been 'disguised' as anti-repair constraints. We have argued that the 'conceptual argument' comes with a price: parochial ordering. It seems obvious that the conceptual argument of simplicity loses much of its force, if the gain in simplicity is counterbalanced by adding the complexity of ranking.[63]

In this section, we will focus on another, more interesting line of argumentation that OT-proponents have followed in dismissing a PPT-approach. The general point is, according to OT, that a principles-and-parameters theory (PPT) is forced into the position that any parameter, once it is set, must hold for the whole language. This position, the argument goes, cannot be correct because there are situations in which a language shows signs of both values of the parameter. It seems to us that we are dealing here with at least two types of cases, which we will discuss in the next two subsections.

4.1 Emergence of the unmarked

In OT, the grammar consists of constraints only, i.e. statements that specify "unmarked" properties of language (well-formedness or 'markedness constraints') and statements that bear on the relationship between input and output (faithfulness constraints). In order to express cross-linguistic diversity, it is claimed that the constraints are ranked differently in different languages. In each language, the specific ranking determines which candidate for some input is optimal. This works as follows. Each candidate will violate one or more constraints, i.e. no candidate is perfect. Since the constraints are ranked, each candidate has 'a highest violation'. Now we only need to compare the highest violations of all candidates and pick out the candidate whose highest violation is lower than the highest violation of all other candidates. That candidate is said to be the optimal candidate.

Constraints whose 'demands' are overruled by a higher-ranked constraint, need not be totally invisible in a grammar. Their relevance may be seen in cases for which the higher-ranked constraint is not relevant. This is called *emergence of the unmarked.*

With these points in mind, McCarthy (1995) claims that, in a PPT-approach, the setting of a coda-parameter to the marked option YES (i.e. allowing closed syllables) and the onset-parameter to the marked option NO (i.e. allowing onsetless syllables) fails to explain why a VCV string is always parsed V.CV. Given that a language allows codas and onsetless syllables, why isn't the parsing VC.V also possible? To address this 'problem' it might seem that the parameter allowing a coda must be made *context-sensitive* in the sense that it is 'no' in the context 'V-V' and 'yes' elsewhere. (Of course, if a language has no coda whatsoever, it is simply 'no' in all contexts.) This looks like a cumbersome and uncontrolled enrichment of the theory of parameter setting. OT does not have a comparable problem because even if a language allows onsetless syllables, the constraint Onset (penalizing onsetless syllables) is still part of the grammar and no matter what the ranking of NoCoda and Onset, the CV.CV candidate will always be optimal:

(40)

CVCV	NoCoda	Onset	Onset	NoCoda
CV.CV				
CVC.V	*	*	*	*

However, we submit that this case is not problematic in a PPT approach at all. There is no need to make the coda-parameter context-sensitive in some ad hoc fashion. To explain the universal emergence of the V.CV parsing we only need an inviolable and dominating constraint (a principle), that rules out the VC.V parsing universally. That constraint, as it turns out, is already in the grammar for independent reasons: *Coda Licensing*, proposed in Kaye (1990) and discussed above. Coda licensing disallows VC.V parsings. At the same time it also ensures that onsets are maximized (cf. the so-called Maximal Onset Principle) because, as pointed out in Kaye, Lowenstamm and Vergnaud (1990) and Kaye (1990), an onset can only license a preceding coda if the onset consonant is 'less sonorous' than the preceding coda (cf. Harris 1990 for a formalization of the notion 'sonorant' in terms of complexity). A string VbrV can thus never be parsed as Vb.rV because an /r/ can never coda-license a /b/. Such a string will be parsed as V.brV in a language that permits branching onsets.

We now turn to a second, similar objection to parameter theory that has been made in OT-work (cf. Rosenthall & van der Hulst 1999).

4.2 Head-sensitive parameter setting

The type of case that we investigate here has been discussed extensively in Rosenthall and van der Hulst (1999). These authors looked at a variety of cases where 'weight-by-position' (WBP) seems to be context-sensitive. WBP states that codas contribute to weight for the purpose of stress assignment. In a PPT approach, we can see WBP as a parameter (as proposed in Hayes 1989). If coda consonants contribute to weight, the value is positive; otherwise, it is negative. In the simple case, all coda consonants behave the same in a given language. Rosenthall and van der Hulst call attention, however, to languages in which the weight of codas seems to depend on the position of the syllable in the word. Hence they refer to this as 'weight-by-position-by-position'.

A typical language in point is Chugach. In this language, closed syllables count as heavy in word-initial position, whereas they count as light elsewhere. (Syllables with long vowels are heavy in all positions in the word.)

The authors claim that a PPT model has difficulty with expressing this state of affairs without 'fragmenting' the weight-by-position parameter. Essentially, they argue, two separate parameters have to be formulated, one that is context-sensitive (41a iii) and one that states the 'elsewhere' case, as in (41a iv). In OT, on the other hand, the situation can be neatly accounted for in terms of a constraint ranking such that a constraint 'Stress-Edge-left', requiring a stress on the left edge of the word, outranks the constraint that prohibits codas from being weightful (*WBP):

(41) a. HDP:
   i. Foot (left-headed)
   ii. Word (left-headed)
   iii. WBP-initial (yes)
   iv. WBP-elsewhere (no)

b. OT:
   i. Foot: left-headed » Foot: right-headed
   ii. Word: left-headed » Word: right-headed
   iii. Stress-Edge-left» *WBP

Thus, in contexts where both constraints are relevant, Stress-Edge-left will obscure *WBP, but in word-medial context, where Stress-Edge-left has no relevance, *WBP emerges.[64] The effect is that an initial CVC will count as heavy, while a non-initial CVC will count as light.

The OT-account seems to capture the conflict between a coda 'wishing to be weightless' and stress wishing to be on the edge (requiring the left-edge syllable to be heavy). The PPT account, on the other hand, seems clumsy. In particular, it does not seem to make a connection between the 'initial' part of (41aiii) and the fact that (41ai) and (41aii) together specify initial stress. Can we improve the PPT account in a principled way such that it no longer misses a generalization? It seems to us that we can.

In van der Hulst (1984), the idea was put forward that primary and secondary stress should not be collapsed into one algorithm for accent assignment. The reasons for that view were independent from the kinds of facts that we find in Chugach, but these facts can be taken to support the separation of primary and secondary stress, simply because in this case, the weight sensitivity of the primary stress foot (the left-hand foot) and secondary stress feet appear to be different.[65]

Now, given that the stressed initial syllable, being the syllable with primary stress, is the head of the word, it is not uncommon (given the Asymmetry-Complexity Principle) for such heads to allow greater complexity and/or more marked structures than dependents in the same domain. Thus, assuming that for the parameter WBP the value 'yes' (i.e. codas are weightful) is the marked option, we are not surprised to find that in head syllables, the value of the parameter is yes (marked), while in dependent syllables it is no (unmarked).

If head-dependent asymmetries are a general and pervasive characteristic of languages, it should not greatly surprise us to find that the setting of parameters can be sensitive to the distinction between head and dependent positions. In fact, this is precisely what we expect, given that head/dependent asymmetries are generally present, and given that, in general, heads show greater complexity or markedness. Thus, we propose then that parameter settings *can*, if not typically *are*, relative to head positions, setting the marked value for the head.

A small point is that we do not, in fact, have to specify both values if we adopt, as a general convention, that the activation of the head option in (42c) implies that elsewhere the unmarked value obtains:

(42)	HDP:	a.	Foot (left-headed)
	(revised)	b.	Word (left-headed)
		c.	WBP-head (yes)

We stress that this kind of context-sensitivity is far from arbitrary and this revision of the PPT (if indeed this is a revision rather than a clarification) is by no means an ad hoc move. We have, in fact, improved the theory by generalizing the impact of the *asymmetrical* nature of representations to the parameters that co-characterize these representations.

4.3 Explaining positional faithfulness

Appealing to differences between head and non-head positions has become rather common in OT. Implicit reference to the head – non-head distinction is seen, for example, in Beckman (1998) as an instantiation of *Positional Faithfulness*. Beckman states that there "is a small inventory of privileged linguistic positions which play a central role in the phonology of the world's languages" and she gives the following examples:

(43)	a. *Privileged positions*	b.	*Non-privileged positions*
	-root-initial syllables		-non-initial syllables
	-stressed syllables		-unstressed syllables
	-syllable onsets		-syllable codas
	-roots		-affixes, clitics, function words
	-long vowels		-short vowels

However, since proponents of OT make no commitments to any carefully formulated theory of representations, no attempt is made to explain *why* certain positions are more privileged. Noting this failure, Dresher and van der Hulst (1998) claim that the explanation lies in the fact that heads allow greater complexity (greater markedness) than dependents, and they suggest that an effort be made to analyze all instances of privileged positions as head positions. We believe that this is an interesting way to go, more interesting for sure than appealing to a notion of 'privilege' or 'salience' in the context of (unformulated) theories about production, perception and acquisition.

In the context of this article, we can only make suggestions as to how we can analyze the above-mentioned privileged positions as heads:

(44)	a. *Privileged positions as heads*	
	-root-initial syllables	Domain edge syllables are typical heads
	-stressed syllables	Stressed syllables are heads
	-syllable onsets	Onset consonants are heads (of onsets) and are heads of preceding codas in Coda Licensing

-roots	Roots typically form the head foot of prosodic words
-long vowels	Long vowels are headed domains (cf. Section 3.3.)[66]

The greater faithfulness of 'privileged' positions is, in our view, due to the fact that heads allow the maximum complexity allowed by the grammar, which is formally accounted for by having the marked setting of the relevant parameter. Even though the faithfulness/complexity asymmetries can be expressed in an OT-analysis, we claim that our approach accounts for them in a principled manner that relies on the most fundamental structural assumption of our theory: the asymmetrical head-dependency relation.

5. Conclusions

In this article, we have motivated, explained, exemplified and improved a two-level, declarative constraint-based approach to phonology. As inevitable in this day and age, we have compared this approach to that of Optimality Theory, taking issue with the mechanism of ranking, and, more implicitly with the lack of commitment to any specific theory of representations.

A second important objective was to discuss the central role of head-dependency relations in phonology. Following the lead of Dependency and Government Phonology, we have advocated that HD-relations form the foundation of phonological representations at all layers (segmental, syllabic, and so on).

Even though claims have been made about the post-lexical system, our focus has been on the lexical system. Our main argument against OT is directed at the treatment of lexical phonology, since we consistently find more restrictive analyses that do not invoke superficial, construction-specific constraints and parochial constraint ranking. A logical possibility is that whereas the lexical system is best handled within the more restricted approach of the principles-and-parameters model that we advocate here, the post-lexical system (that is obviously closer to the everlasting battle between ease of articulation and ease of perception) is best handled by the much more powerful OT-style model. It is perhaps not a coincidence that, in certain quarters, OT-phonology has moved into the treatment of low-level phonetic detail, operating with constraints that refer to gradient properties involving formant frequencies and the like (cf. Boersma 1998).[67]

Notes

1. The derivationality, in this case, forms part of the architecture of the grammar, rather than resulting from ad-hoc rule ordering.

2. This article pursues some of the points in van der Hulst and Ritter (2000b) regarding these same issues.

3. The proposition *[+nasal, +voice] is logically equivalent to propositions [+nasal] -> [-voice], and [+voice] -> [-nasal].

4. Shibatani (1973), Sommerstein (1974) and Clayton (1976) offer early proposals to use 'output constraints'. In general, all proposals to abandon extrinsic ordering, going back to Koutsoudas, Sanders and Noll (1974); Vennemann (1984); Ringen (1977); and Hooper (1976) lead to non-procedural phonologies. Strictly declarative frameworks are offered in Scobbie (1997); Bird (1990, 1995); and Coleman (1992, 1995a, b). Goldsmith (1993); Lakoff (1993); Karttunen (1993) and Orgun (1995), among others, present constraint-based systems that use more than one level. Prince and Smolensky (1993) also mention a long list of researchers that have anticipated their OT constraint-based approach.

5. cf. Trubetzkoy (2001:11): "The description of a phonological system of a language comprises *word phonology*, divided into lexical and morphological phonology, and *sentence phonology*."

6. Within lexical phonology, a distinction is usually made between two or more lexical levels, which correspond to blocks of morphological rules. We assume that the lexical constraint system is sensitive to a distinction between analytic and non-analytic domains (as proposed in Kaye 1995), a proposal that we discuss below.

7. Of course, our view of the lexicon here is simplified to the extent that the lexicon is seen as the collection of stored words. Obviously, both smaller (morphemes) and larger (phrases) units than words are stored. Cf. Jackendoff (2002) for extensive discussion.

8. Technically, this means that there is a system that produces the set of all possible combinations, a 'generator' of some kind. This system, of course, has no interesting linguistic properties or 'psychological reality' as it stands. As usual, viewing grammar as a checking system forces one to remain neutral with respect to the 'psychological' question as to what drives people to utter a certain combination of morphemes and words. The standard syntactic-centric view is not meant to be anymore 'psychologically 'real'. The pursuit of psychological reality drives Seuren (2001) to take the semantic structure as 'basic'. Perhaps, however, the pursuit of psychological reality should focus on the 'generator' and specify how speakers select combinations that they wish to submit to evaluation by the three checking systems.

9. In our view, there are no well-formedness requirements on morphemes as such. In reality (due to 'Lexicon Optimization'; cf. Prince & Smolensky 1993), morphemes tend to be largely well-formed. However, they can be potentially incomplete, either phonologically (or

semantically). We, therefore, do not envisage a set of phonological 'morpheme structure constraints'; cf. Paradis & Prunet (1993) and Booij (1999) for discussion.

10. Later we suggest that the set of phonological expressions may not be infinite, because there is no recursion.

11. Thus, we take allophonic in a broad sense of automatic alternations, which could be neutralizing or not.

12. In the model that we follow there are no features. Rather 'phonemes' are truly indivisible elements that can occur alone or in combination to form 'segments' (i.e. units that occupy syllabic positions); cf. van der Hulst and Ritter (in prep.) for discussion. This idea is taken from such approaches as Government Phonology (Kaye, Lowenstamm & Vergnaud 1985, 1990) and Dependency Phonology (Anderson & Ewen 1987). The universal set of elements is so small, that all languages use all of them. Languages differ only in their constraints on element combinations (called *licensing constraints* in the GP literature); cf. Ritter 1995, 1999 for discussion of this topic.

13. In Section 3.3, we will comment on the meaning of the term 'phonetic interpretation' in this context.

14. So far, we seem to claim that all phonological alternation involves some sort of 'deletion', here understood as the failure of an element to be phonetically interpreted. In Section 3.3, we show how the role of 'phonetic interpretation' can also be held responsible for phenomena that, traditionally, call for 'insertion'.

15. Such crazy morphologized rules have been called *morpho-lexical rules* (in Anderson 1976), and *allomorphy rules* (in Aronoff 1976) and *distributional rules* (in Hudson 1974 and Hooper 1976). Cf. Dressler (1985) for a broad discussion of relevant phenomena.

16. We will avoid the term 'prosodic word' since we wish to distinguish between a phonological notion of word at the lexical and the post-lexical level, which we will refer to as phonological L-words and phonological PL-words, respectively.

17. The term 'phoneme' for segment-sized units turned inadequate when phonologists started arguing that phonemes consist of smaller parts, i.e. features. In our approach, the smallest phonological units are elements; this is why we say that these elements could be regarded as the true phonemes. This being said, we do not use the term 'phoneme' in order to avoid confusion due to its traditional usage.

18. This is not just a terminological point, involving replacing 'syllable' by 'package'. The relationship between onsets and rhymes is not regarded as establishing a constituent. Cf. van der Hulst and Ritter (1999) for discussion.

19. Inter-nuclear relationships are discussed in Section 3.3. Van der Hulst (to appear a) and van der Hulst & Rowicka (1997) argue that these relationships have a 'foot-like' appearance. We will not pursue this terminology here, however, pending a more thorough discussion of the notion foot in the L-phonology.

20. The distinction between 'inner' and 'outer' does not necessarily correlate with unproductive and productive word formation, although there certainly seems to be a tendency for the latter class to be highly productive.

21. Since many of her examples involve non-neutralizing alternations, the idea that lexical rules must be 'structure preserving' (as originally assumed by Kiparsky 1982, 1985) cannot be maintained.

22. For similar reasons, Borowsky assumes that level II suffixes go through the word-level phonology.

23. Cf. Brockhaus (1995) for an analysis of final devoicing in German within the GP framework.

24. In Kiparsky (1985) rules of this type are acknowledged as 'post-cyclic lexical rules', also referred to as 'word level' rules. Clearly these 'word-level' rules are distinct from the class of rules that Borowsky calls word-level rules. Cf. Booij and Rubach (199x) who specifically address the place of final devoicing in a lexical model.

25. It is, in addition, likely that the L-clitics, are subject to specific phonotactic constraints due to the fact that phonological constraints discriminate between strong (i.e. head) positions and weak (i.e. dependent) positions.

26. Repair (considered a potentially destructive type of operation) has also been explicitly barred from frameworks such as Declarative Phonology (Scobbie 1997; Bird 1990, 1995; Coleman 1995a, b). To account for apparent alternations in the form of morphemes and words, such models must rely rather heavily on underspecification or, in many cases, on denial of phonological generalizations and must appeal to lexical listing. Declarative Phonology, then, is very similar in spirit to GP.

27. In the model that we will discuss in Section 3.3, such rhymes are ruled out universally.

28. In Section 3.3, we discuss this example, including relevant data, in some detail.

29. The specific formulation of the constraint is not at issue here. As mentioned above, we would assume a constraint that specifies that the voice element is not licensed in the relevant context. Consequently it is not phonetically interpreted (rather than being deleted).

30. The original 'parse-and-fill' approach (Prince & Smolensky 1993), or the more recent proposals in Goldrick & Smolensky (1999) resemble our own views on 'repair' more closely than the latter versions of OT.

31. Apart from having to rank the 'anti-repair constraints', a second reason for ranking lies in replacing parameters by binary sets of constraints such that a parameter setting must be encoded by ranking the two 'choices'. We discuss this point in Section 4.

32. In practice, OT-analyses differ enormously from our type of analysis in terms of the kinds of well-formedness constraints that are used. Our approach, in fact, focuses on the form and substance of the actual constraints (principles and parameters). We address this issue briefly in Section 3.1.

33. The primitives of PL-phonology are, we assume, segments (skeletal positions plus all elements that are phonetically interpreted, i.e. licensed at the L-level). Thus, the PL-structure is built 'from scratch', and independent of the lexical structure, rather than taking up where the L-phonology has left off. PL-phonological words are aligned with L-words, irrespective of their L-syntactic (morphological) or L-phonological structure; cf. van der Hulst (to appear a) for discussion of these points.

34. Our notion of phonetic interpretation should not be confused with what is often called *phonetic implementation.* Since Pierrehumbert (1980), more attention has been paid to the relationship between phonological representations and their corresponding phonetic realizations. Pierrehumbert referred to the relationship as 'phonetic implementation', having in mind a system that converts a phonological representation into an actual phonetic event, an acoustic signal or articulatory movement(s). Subsequently, it has been proposed by some writers that post-lexical phonological processes *are* (part of) this implementation system. In our view, the post-lexical system is a *phonological* system that characterizes a set of well-formed representations. Phonetic implementation (i.e. the mapping of PL-phonological structure into a physical phonetic event) affects all phonological units that are licensed (i.e. phonetically interpreted) in this structure.

35. Cf. Anderson and Ewen (1987:122): "...any sequences of word structures may be associated with several distinct utterance structures." The latter one-to-many relation is due to "information structure or considerations of rythm and tempo".

36. Anderson and Ewen (1987:279) suggest that post-lexical structure may allow one head to have more than one dependent.

37. In van der Hulst and Ritter (2000a) we discuss a number of opacity effects within the framework of Head-driven Phonology, which we analyze without appeal to a lexical/post lexical distinction. Rather we show that opacity effects can also result from interpretation effects at the lexical level. More specifically, a rule in a traditional generative account that 'deletes' a unit that conditions another process will create a counterbleeding opacity effect. In our account, the unit that is said to be deleted would always still be there, but it would not be licensed and thus remain silent. The proposals in Goldrick & Smolensky (1999) go in a very similar direction.

38. Thus each constraint in Declarative Phonology expresses a 'true generalization' (cf. Hooper 1976). In general, it is believed that a ranking relationship between constraint pairs that stand in an 'elsewhere' (general - specific) relationship does not pose a threat to the declarative approach; cf. Scobbie (1997). Thus, our own approach allows the same kind of ranking.

39. It is usually said that opacity results from counterfeeding and counterbleeding relationships. Andrea Calabrese pointed out to us that feeding relations may also introduce opacity. If, in a string VCC, a vowel is inserted between the two consonants, the presence of the penultimate consonant might trigger a rule of intervocalic deletion. The resulting VVC string is opaque vis-à-vis the insertion rule, yet the ordering is feeding.

40. Cf. McCarthy (1999). This is, in a sense, ironic because at an abstract level, OT shares with SPE (Chomsky & Halle 1968) its need for extrinsic ordering, which in SPE was introduced precisely to deal with procedural opacity.

41. We use 'procedural' here in the way others use 'derivational' or 'serial' (cf. Clements 2000 for discussion).

42. OT uses an input - output distinction, but this is in itself not an automatic consequence of constraint ranking. Rather, this distinction is necessary in order to deal with repair in terms of anti-repair constraints.

43. Our own position in this article is no less programmatic of course.

44. Contrary to the position of Bromberger and Halle (1989), it is also assumed that phonology is not different from syntax in that neither have ordered rules. Cf. Ritter (1995) for a discussion of the role of general UG principles in both syntax and phonology.

45. The term 'level' is used in two different ways, here and in the literature at large. Sometimes it stands for the distinction between word and sentence phonology, while in other cases it refers to different 'layers' or 'domains' in the hierarchical organization of representations.

46. Following Jackendoff (2002), we extend this point, and all following points about the parallelism between grammatical systems; to the semantic system.

47. It follows, we think, that adopting a non-OT approach to syntax, entails a similar stance for phonology, and vice versa.

48. It is sometimes remarked that the notion head is differently used in phonology and syntax. This may be so. We believe that there are also deep and significant resemblances. The 'definition' of what constitutes a head may be too narrow and too domain-specific on both sides, and it may be too early to come to a full understanding of the relevant concept that is shared by both modules.

49. New names are always dangerous. We do not wish to imply here that our work is the phonological counterpart of what is known as 'Head-Driven Phrase Structure Grammar'(HPSG). Such a parallelism would require embracing the specific approach of Declarative Phonology and combining it with the structural ideas of Government and Dependency Phonology. This, of course, is possible; cf. Coleman (1992). However, on the other hand it is probably true that HPSG and HDP share a concern with on-procedural grammars in which head - dependent relations play a pivotal role.

50. At the level of foot structure, it has been proposed that all feet are binary. In most theories, however, this binarity may involve a non-branching foot if the only syllable is itself branching (i.e. bimoraic, however moraicity is expressed).

51. In Government phonology, and in HDP, the relationship between the onset and the rhyme is not seen as a constituent relationship. The 'syllable' is not understood as a constituent in the traditional sense. Given this, the relationship in (22b) between onset and rhyme is not one of constituency, although it is a head-dependent relationship. GP proponents usually do not abstract away from the linear order of onset and rhyme. Hence, the HD-relationship in that case is right-headed.

52. As Dresher and van der Hulst (1998) point out, this principle is relevant for αα–relationships only.

53. The division into constituent, interconstituent and edge constraints bears an abstract relationship to the typology of rules proposed in Selkirk (1980) that involves: domain-span rules, juncture rules and edge rules.

54. Neither HDP nor Government Phonology are, at this point, restricted enough to lead to unique analyses. There are alternatives and the discussion is ongoing, just like in any other framework that we are aware of. For discussion of different analyses of the Yawelmani data, cf. Rowicka (1999).

55. There may be crosslinguistic variation in the phonetic properties of the realization of ungoverned empty nuclei. This may suggest a parameterized aspect to interpretation.

56. In this section, following Kaye, Lowenstamm and Vergnaud (1990), we propose an analysis that uses a right-headed relationship. Van der Hulst and Rowicka (1997) propose a left-headed relationship. For a discussion of the two analyses, cf. Rowicka (1999). In this article, we do not wish to get involved in a discussion of various alternative analyses that are consistent with the basic ideas of Government Phonology.

57. A complete discussion of the theory would include a more subtle discussion of the circumstances that determine the choice between 'silent' and 'audible' empty nuclei.

58. Even though the suffix vowel is /i/, we do not assume that it corresponds to an empty nucleus; there is no alternation to warrant such an analysis. But even if we assumed it was empty, it would have to be realized because the suffixal nucleus would have to be audible because it does not meet the conditions in (29).

59. This fact does not necessitate the insertion of a phonological element.

60. At this point, we include the X-positions (which we assumed all along) in our notation.

61. It is unfortunately the case that there has been a tendency, especially in OT, to think of constraints as specifying very concrete, almost 'phonetic' properties of words and utterances. Our constraints typically make reference to more abstract phonological properties. This difference (to the extent that it exists), however, has no bearing on the use of the term constraint. Even in OT there is no need for constraints to be literally superficial and, indeed, the more interesting constraints are not superficial, but simply mimic traditional principles and parameters.

62. This claim is notoriously unfalsifiable, since constraints need not have an effect in languages in which their demands are totally superceded by higher-ranked constraints. It is also implausible in view of the ad hoc constraints that appear in the OT-literature.

63. We are ignoring here that OT has substantially enriched the theory of constraint interaction with all sorts of additional mechanisms, such as *extrinsic ordering, universally top-ranked constraints* and more recently: *constraint conjunction, sympathy theory et alia.* This further weakens the claim of being 'conceptually simple'.

64. In their actual analysis, Rosenthall & van der Hulst show that WBP itself interacts with a constraint '*Append' which rules out the adjunction of a non-moraic coda consonant to the syllable node. We suppress that complication here. Note, by the way, that NotAppend is virtually the opposite of No-WBP.

65. The phonetic evidence for taking the leftmost stress as primary is controversial, but we see no reason to demand, in general, that primary stresses are phonetically more salient than secondary stresses. The notion 'stress' refers to the phonetic exponents of a metrical structure. General principles of well-formedness demand that all structures must have a head, and that this head must be on the edge of the constituent domain.

66. Short vowels are heads of their nucleus/rhyme, but long vowels govern a sister; this is the relevant difference.

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Obstruent neutrality in nasal harmony*

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1. Introduction

In long distance nasalization or nasal harmony, segments are either targets of the process or remain neutral. Cross-linguistically, vowels and laryngeals are consistently targets, while sonorant consonants (i.e., glides, liquids) vary between neutral and target status. In contrast, the behaviour of obstruents is less uniform. While fricatives may also be either neutral or target segments, stops as a class may be neutral but are never targets. Among stops, the voiced subset may be targeted but the voiceless set is resolutely neutral. When voiced stops are targeted, other voiced segments must be also. The neutrality of sonorants and fricatives takes the form of opacity to nasal harmony. Neutral stops, by comparison, are either opaque as a class, or the voiceless subset is transparent. When the latter situation arises, voiceless fricatives are (generally) also transparent. Consequently, the robust generalization is that transparency is restricted to the class of voiceless obstruents. No voiced consonant (sonorant or obstruent) is ever transparent to nasal harmony. The following generalizations about segment neutrality must, therefore, be explained by any explanatory analysis of nasal harmony.

(1) Segment neutrality
  a. Sonorant consonants and fricatives may be either targets or neutral segments.
  b. Neutral sonorants are always opaque to nasal harmony.
  c. The class of obstruent stops is never targeted.
  d. Voiceless stops are always neutral.
  e. If voiceless stops are transparent, then voiceless fricatives must be also.
  f. Only voiceless obstruents are transparent to nasal harmony.