Morphemes and candidates in Optimality Theory

— draft, comments welcome —

Kevin Russell*
University of Manitoba
krussll@ccu.umanitoba.ca

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This paper is about the nature of morphemes and, more specifically, the proper relationship between morphemes and candidate sets within the framework of Optimality Theory. I shall argue that the phonological information of morphemes is best encoded in constraints rather than in representations.

Optimality Theory has rejected the rule-based derivations that characterized generative phonology, yet it has kept another central tenet, the idea of underlying representations (URs), even at the cost of significant complications in the overall architecture of the theory. But, given the other machinery available to OT, URs are no longer necessary. Inkelas (1994) observes that "[g]rammar multiplication reduces need for underlying phonological contrasts; taken to the logical extreme, it makes underlying phonological representation unnecessary altogether", though she assumes that the problem must be with the idea of multiple grammars rather than the idea of underlying representations. URs are not necessary to encode the phonological information of morphemes. Nor are they sufficient—we still need morpheme-specific constraints, most obviously constraints using the Align schema of McCarthy and Prince (1993b).

But representational coding of morphemes is not the only option that has been explored. There have been three broad approaches within linguistics to the nature of morphemes and to the phonological information associated with morphemes, which we can summarize as:

(1) i) morphemes are representations
 ii) morphemes are rules
 iii) morphemes are constraints

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Explicit recognition of the first two as distinct and viable approaches goes at least as far back as Hockett's (1954) distinction between the Item-and-Arrangement and the Item-and-Process models of grammar.

The morphemes-as-representations (or Item-and-Arrangement) approach has been and continues to be the dominant approach within phonology, and many phonologists subscribe to its fundamental assumptions often without examining their consequences or acknowledging that things could be any other way. This approach holds that the most appropriate method of encoding the phonological content of morphemes is as actual phonological representations, i.e., underlying representations. In derivational frameworks, these representational building blocks are laid end to end (or in more complex arrangements in autosegmental phonology) and the resulting concatenated string is then subjected to phonological rules to produce the surface representation. Although it has rejected a derivational framework, Optimality Theory remains firmly wedded to the morphemes-as-representations approach: even though the constraint hierarchy takes the set of all possible candidates as its starting point, it is still assumed that the phonological information of morphemes can only be encoded in underlying representations. This necessitates a translation procedure, known as Gen, to mediate between the underlying representations and the candidate sets that the constraint hierarchy deals with.

The morphemes-as-rules (or Item-and-Process) approach, on the other hand, holds that the phonological content of some or all morphemes is best encoded in phonological rules that effect changes in a representation. Some researchers who have adopted this approach to some extent are Hockett (1955), Kiparsky (1982), Hoeksema and Janda (1987), Steriade (1988) on reduplication, and most recently and forcefully, Anderson (1992).

A third approach has been developed more recently. It holds that the phonological information of morphemes is best encoded, not in a representation or in rules that change a representation, but in constraints. These constraints specify what properties a phonological representation would have to have in order for it to be associated with certain types of syntactic and semantic content. This approach has been developed most fully within the frameworks often known as Declarative Phonology (e.g., Bird 1990, Scobbie 1991, Russell 1993), but it has also made inroads into Optimality Theory with the notion of generalized alignment (McCarthy and Prince 1993b). Hammond (1995) also argues within an OT framework that underlying representations are unnecessary and that their work can be taken over by the constraint hierarchy.

It is the purpose of this paper to argue that OT would be theoretically simpler and empirically more adequate if this move towards treating morphemes as constraints were taken to its logical conclusion. As well as handling morpheme-specific requirements on alignment, constraints should also handle morpheme-specific requirements on segmental content, weight, and so on. In such a framework, there will be no need for Gen, as there will be no need to translate underlying representations into a candidate set. Instead, a universal candidate set of all conceivable representations will be taken as the starting point and the job of morphemic constraints will be to rule out those that fail to live up to their morphological requirements. Morphemic constraints will, for example, assess violation marks against a string /kæt/ that attempts to be associated with the semantic and syntactic information appropriate for 'dog'.

In the first section of this paper, we shall review the overall architecture of OT as it is currently understood. This is an important thing to do in its own right, since the overall architecture is seldom discussed in one place in the OT literature. Specific attention will be paid to those pieces and aspects of the architecture that are made necessary by the underlying assumption that morphemes are encoded as representations.

We shall then examine two cases where it seems as if the same piece of a representation "belongs" simultaneously to more than one morpheme. These cases are problematic for the standard theory that uses URs and Gen, but are completely natural in a framework that uses morphemic constraints.

Section 2 contains an extended discussion of a coalescence phenomenon in Nisgha, indicating why this phenomenon would be a problem for standard OT and giving an analysis of it using morphemic constraints. In section 2.1 we look more closely at a particular aspect of how Gen works under the interpretation of its principles given by McCarthy and Prince, namely the inability of Gen to perform the kind of fusion or coalescence that Autosegmental Phonology often analyzed as the automatic result of the Obligatory Contour Principle when identical specifications become adjacent through the concatenation of morphemes. We shall see why it is necessary for McCarthy and Prince's (1993a) account of Axininca Campa epenthesis for this kind of fusion to be impossible.

Section 2.2 describes a case of coalescence in Nisgha that bears some similarities to the type of fusion outlawed by McCarthy and Prince. It will be argued that Nisgha coalescence cannot be handled within OT under the current assumptions. It will be suggested that the most illuminating explanation of what is going on in the language will rely on the possibility that a single piece of a phonological representation can "belong to" (or satisfy the requirements of) more than one morpheme. Section 2.3 begins to sketch some of the key points of a morphemic constraints theory, retaining the hallmarks of the current OT model — the harmonic application of ranked constraints to a set of candidates — but having no need for URs, for Gen, or for the other vaguely defined processes of OT outlined in section 1. Section 2.4 analyzes the Nisgha coalescence phenomenon in these terms.

Section 3 contains a similar analysis of verbal ablaut in Hua. Vowels in Hua verbs are determined by a complicated interaction of factors such as the person and number of the verb's subject, the verb's class, and the identity of the following morpheme. It will be argued that Hua verbal ablaut, like Nisgha coronal coalescence, is best analyzed as a case of the same piece of a representation "belonging to" more than one morpheme, or more precisely, the same piece of a representation trying, and often failing, to satisfy the demands of more than one morphemic constraint.

In section 4, I discuss a number of implications of an OT framework without URs. I look at the work performed by Gen in standard OT and show how the same work is accomplished in a framework without Gen. It will also be suggested that morphemic constraints can allow us to do without other features of standard OT, such as faithfulness constraints (e.g., PARSE, MSEG), and multiple grammars triggered by lexical idiosyncracies.

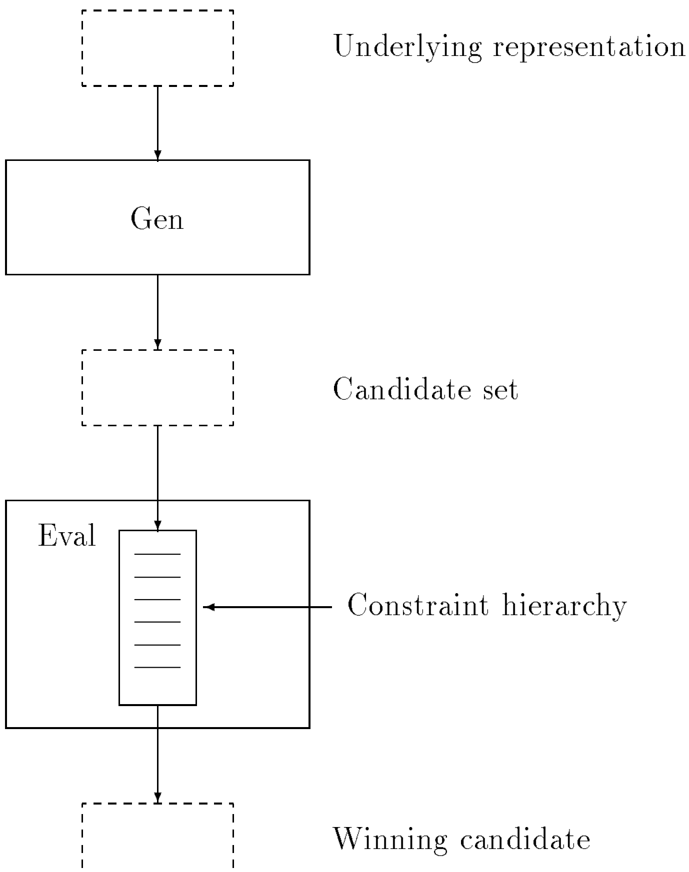
1 An overview of OT architecture

McCarthy and Prince (1993a) characterize the overall architecture of OT as a pair of functions, Gen and Eval:

(2) $\text{Gen}(\text{in}_i) = \{\text{cand}_1, \text{cand}_2, ...\}$
$\text{Eval}(\{\text{cand}_1, \text{cand}_2, ...\}) = \text{out}_{real}$

This deceptively simple pair of equations suggests a two-step process: an underlying representation (in_i) is fed into the function Gen, which generates an infinite set of candidates. This candidate set is then fed into the function Eval, which chooses one (or under limited circumstances more) of them as the most harmonic. More graphically, a derivation can be seen as the following:

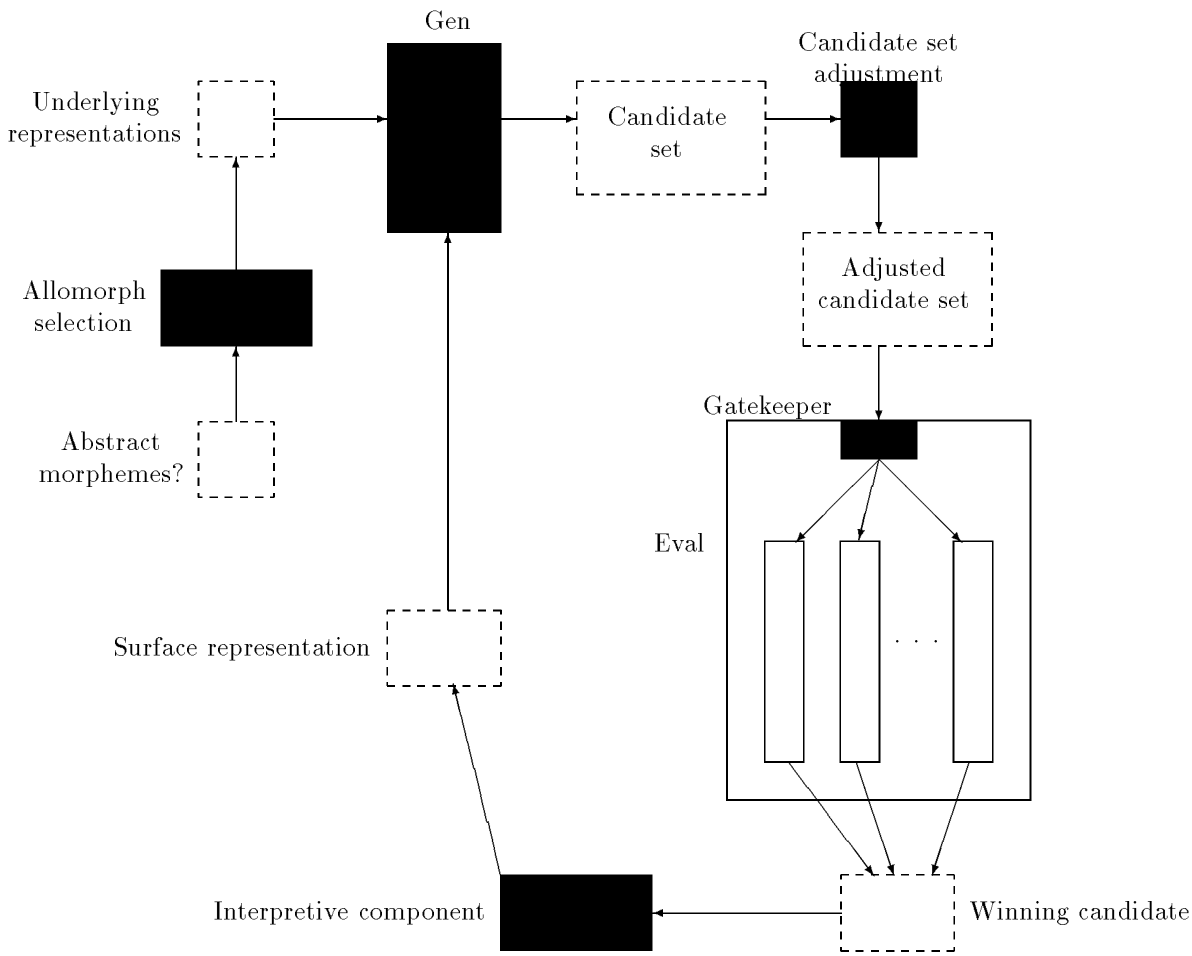
(3)



The operation of Gen is supposedly determined by universal principles, that of Eval by a language-particular constraint hierarchy. Of these two major functions, only Eval has been explored in any depth.

There are several additional aspects of Optimality Theory which fall outside the strict purview of candidate generation and evaluation. McCarthy and Prince (1993a) admit the possibility of a language having a multistratal phonological system, with each stratum potentially using a different constraint hierarchy. McCarthy (1993a) admits the need for some additional rules "outside the system of Optimality", whose purpose is to enlarge the set of candidates beyond what would normally be given by Gen operating under its universal principles. Some mechanism is needed to perform various adjustments on the candidate that emerges victorious from Eval: stray deletion of unparsed material, specification of epenthetic segments, etc. And there remain some unresolved issues involving the mechanisms by which the proper allomorph's underlying representation is chosen for each morpheme. Taking all these additional factors into consideration, the overall architecture for a phonological system in OT would look more like the diagram in (4):

(4)



Not all of these pieces will be necessary under every set of assumptions. For example, candidate set adjustment (as argued for by McCarthy 1993a) could be dispensed with under the assumption that Gen can freely insert the complete structure of entire segments (cf. Smolensky 1993, or even McCarthy 1993b).

1.1 Allomorph selection

The initial input into the system is presumably the output from the morphosyntactic component, a hierarchically organized set of abstract morphemes. These abstract morphemes must be spelt out as strings of phonemes, i.e., a string of root nodes and dependent segmental information,[1] perhaps with some prosodic information, such as underlying morae to mark long vowels. In (4), this stage of an OT derivation is represented by the black box labelled Allomorph Selection.

The spelt-out morphs that serve as the input into Gen are not simply strings of segments. They must also bear most, if not all, of the abstract morphological information that they carried into the allomorph selection process. In addition, each morph will need to carry some uniquely identifying index or diacritic feature. For want of a better term, we can call this collection of morphological information the "abstract signature" of the morph. Many constraints in the constraint hierarchy need to refer to information in the abstract signature. The most basic type of information referred to comes in the form of notions like "stem", "root", and "affix". Morphosyntactic features that define natural classes of morphemes can be referred to by constraints, e.g., the feature POSS appears in the constraint ALIGN-TO-FOOT (McCarthy and Prince 1993b), which requires all Ulwa possessive infixes to be aligned at the right edge of the head foot of the prosodic word:

(5) ALIGN-TO-FOOT (Ulwa)
Align ([POSS]$_{Af}$, L; Ft′, R)

A pressing case for the need for abstract signatures (especially the uniquely identifying feature for every morph) can be seen in the behaviour of reduplicative morphs in languages that use more than one pattern of reduplication. In Paamese, for example, the reduplicant can sometimes be a monosyllabic prefix, sometimes a disyllabic prefix, sometimes a disyllabic suffix (Crowley 1982). Stems must lexically specify which reduplicative patterns they can use:[2]

(6)	REdup:	sitali	si+sitali	'emerge'
		mesai	me+mesai	'sick'
	REDUp:	hiteali	hite=hiteali	'laugh'
		saani	saa=ni	'give'
	reDUP:	matou	matou=tou	'dry coconut'
		tupasu	tupasu=pasu	'smoky'

[1] For Prince and Smolensky (1993), this dependent segmental information does not come attached to root nodes in UR, rather UR is a string of sets of unassociated feature instances. At this stage in the derivation, feature instances must be distinguishable from each other, e.g., {COR, COR} is a different set of features from {COR}, despite the deceptively identical labelling of the two CORs.

[2] Crowley here abstracts away from some of the processes that may affect one of the copies without affecting the other, e.g., raising *a* to *e* before the word boundary. Semantically, reduplication can mark a change of transitivity of a verb, plurality of a noun, or an "out of control" action. There seems to be no correlation between semantic function and which reduplicative pattern is chosen. Some stems can select more than one pattern.

Stems must lexically specify which reduplicative patterns they can use.

If all reduplications were simply the result of the maximally unspecified morph, which McCarthy and Prince (1993a) label RED, we would not be able to derive all three types of Paamese reduplication. Constraints imposed on the prosody and alignment of RED would be able to produce at most one of the patterns. So there must clearly be three different morphs at work here, which we can call RED_1, RED_2, and RED_3. Alignment and weight constraints could then ensure that RED_1 was realized by a monosyllabic prefix, RED_3 by a disyllabic suffix, and so on. Reduplicative morphs are assumed to have absolutely no phonological content in OT, so the information needed to distinguish between RED_1, RED_2, and RED_3 cannot be part of the phonological representation of the morphs, since all three will be identical in their phonological emptiness. The sum of this extra, non-phonological information is what I mean by the term "abstract signature".

Another example of allomorph selection is found in McCarthy and Prince's (1993a: 110–2) discussion of the ergative suffix in Dyirbal. The suffix has two allomorphs: it takes the form *–ŋgu* after disyllabic V-final nouns and *–gu* elsewhere. McCarthy and Prince have an interesting discussion of how the marked suffix *–ŋgu* can be prevented by clever constraint conspiracies from occurring anywhere but after disyllabic V-final nouns. But they have no discussion at all about how the default *–gu* can be prevented from occurring where *it* shouldn't, i.e., in the marked environment after disyllabic V-final nouns. Furthermore, since *–gu* has less structure to it and will not cause a violation of any coda condition, we might expect it to be the preferred allomorph, even in those situations where *–ŋgu* is not prosodically forbidden. It may be that the only way to prevent candidates containing *–gu* from winning where they shouldn't is to prevent *–gu* from entering Gen in the first place, that is, by pre-selecting *–ŋgu* as the appropriate allomorph for disyllabic V-final nouns.

The job of the box labelled Allomorph Selection is to choose the appropriate morph to submit to Gen, appropriate both in the phonological string and in the abstract signature. For the Paamese reduplication patterns illustrated in (6), Allomorph Selection will have to choose the appropriate signature for RED_1, RED_2, or RED_3, based on the noun or verb stem that is its morphosyntactic sister. To my knowledge, the mechanics of this procedure have not been dealt with in the OT literature, nor are they entirely unproblematic. For example, it is not clear that Allomorph Selection can operate correctly at this point in the derivation without access to information that will not be available until after Eval has already selected the winning candidate.[3]

1.2 Gen

The output of Allomorph Selection is what is referred to in OT as the "underlying representation" of the morphemes. These underlying representations are submitted to Gen, which will create an infinite set of candidate representations that must each bear a certain relation to the phonological strings that were its input. Each candidate will continue to bear the

[3]For example, it is not clear that the information that a Dyirbal noun is disyllabic and V-final will be available to Allomorph Selection until after prosodic structure has been assigned by Gen and the winning candidate chosen by Eval.

abstract signatures of Gen's inputs.

McCarthy and Prince (1993a: 20) propose that the following three principles underlie the operation of the Gen procedure:

(7)
1. **Freedom of Analysis**. Any amount of structure may be posited.
2. **Containment.** No element may be literally removed from the input form. The input is thus contained in every candidate form.
3. **Consistency of Exponence.** No changes in the exponence of a phonologically-specified morpheme are permitted.

Some of the effects of the principles that have been proposed governing the operation of Gen will be discussed in more depth in the next section.

1.3 Candidate Set Adjustment

Unfortunately, these principles are not necessarily empirically correct in and of themselves. Gen, operating under the strictures of (7), might fail to produce a candidate set that contains the correct output form, the form that is empirically observed to exist in the language. McCarthy (1993a), for example, deals with the "linking r's" of an eastern Massachusetts dialect of English, which appear in phrases such as *Wandar arrived*. Given only the underlying representations of *Wanda* and *arrived*, McCarthy claims that Gen would not of its own free will produce candidates that contained the linking *r*, so he is forced to posit an ad hoc, language-particular "rule" that will increase the size of the candidate set to include the eventual winner and candidates similar to it.

McCarthy (1993a: 190) elaborates somewhat on this operation: "Let us suppose that the grammar contains a phonological rule of *r* insertion: $\emptyset \rightarrow$ r. By a 'rule' here I mean a phonologically arbitrary stipulation, one that is outside the system of Optimality. This rule is interpreted as defining a candidate set {Wanda, Wanda*r*}, and this candidate set is submitted to the constraint hierarchy." But many questions remain unanswered: How and by what is the rule "interpreted as defining" a new candidate set? How powerful is the interpreter? What kinds of rules can it understand? Can there be more than one such rule, and if so, how do they interact?

The stage of the derivation where these kinds of operations take place are represented in (4) by the black box labelled Candidate Set Adjustment.

1.4 Eval

The candidates of the adjusted candidate set are then submitted to the harmonic evaluation procedure to run the gauntlet of the constraint hierarchy. The operation of Eval is the most fully discussed aspect of OT, so I shall not concentrate on it here. But one property of Eval, which is usually not emphasized in the literature, deserves mention.

It is somewhat of an over-simplification to speak of "the" constraint hierarchy. The OT literature indicates that a single language can have many different constraint hierarchies, with different rankings of the same constraint. The choice of which hierarchy should be used is sensitive to such things as which stratum the forms are currently "in" and the lexical demands of individual morphs (e.g., Ulwa *gobament*, McCarthy and Prince 1993b: 32) or sets of morphs (e.g., vocabulary classes like [+Latinate] or neighborhoods of peripherality, cf. Itô and Mester 1993). We might assume, therefore, that Eval contains several parallel constraint hierarchies and a pre-processing step that selects the appropriate constraint hierarchy based on information in the candidates' abstract signatures. (It is unclear how the right ranking should be chosen at later strata higher prosodic levels, for example, in evaluating candidate representations for an entire phrase, some of whose constituent morphemes demand one ranking and while others demand another ranking.) For concreteness in figure (4), I have called this pre-processing step the "gatekeeper" and have illustrated it as if it were a part of Eval.

1.5 Interpretive component

At the end of each phonological stratum, the optimal candidates emerging from Gen have some adjustments performed on them. Unparsed material undergoes stray deletion. Epenthetic segments that survive despite Fill receive default specifications. Again, it is unclear exactly what the power of this interpretive component is. Since different languages (and different strata for that matter) have different default segments, the interpretive component is obviously not universally fixed, but how much can it vary?

1.6 Summary

This brief examination of the architecture of OT reveals that it is more complex than is usually implied in the overviews at the beginning of articles within the framework. The existence of the boxes in figure (4) has been proposed or hinted at by researchers in the field, but their exact operation and more importantly their limitations remain almost completely unexplored. This raises serious questions about the restrictiveness of OT: it may be a waste of time trying to restrict the power of Eval when a small change to Gen could more than make up for the loss of power; similarly, it may be a waste of time trying to restrict the power of Gen if it turns out that the Candidate Set Adjustment and Allomorph Selection procedures will need a vast amount of power in order to the jobs that have been given to them. In short, the uncertainty posed by the additional procedures outlined in this section may seriously compromise the theoretical advances that OT has made in its close examination of Eval.

Researchers within the OT framework continue to assume without examination that morphemes are literally things, that is, they are composed of pieces of phonological representation. Most of the boxes in figure (4) besides Eval are made necessary in order to deal with the negative side-effects of this assumption. One of the main points of this paper is that by abandoning the assumption that morphological information must be encoded in phonological representations, we can also do without the mysterious additional boxes of (4). The result will be a framework that consists of Eval and little else, and will also, I argue, have empirical advantages over the current framework.

2 Nisgha coronal coalescence

2.1 A consequence of the properties of Gen

The three underlying principles governing the operation of Gen that have been discussed in any depth, Freedom of Analysis, Containment, and Consistency of Exponence, were outlined in (7). Containment prevents Gen from deleting anything from the URs, but Freedom of Analysis allows it to add as much structure as it pleases. The effects of Consistency of Exponence are somewhat less obvious. McCarthy and Prince (1993a:20-21) explain that

> Consistency of Exponence means that the phonological specifications of a morpheme (segments, moras, or whatever) cannot be affected by Gen. In particular, epenthetic segments posited by Gen will have no morphological affiliation, even if they are bounded by morphemes or wholly contained within a morpheme. Similarly, underparsing will not change the make-up of a morpheme, though it will surely change how that morpheme is realized phonetically. Thus, any given morpheme's phonological exponents must be identical in underlying and surface form, unless the morpheme has no phonological specifications at all (as is the case with the reduplicative affix RED...). Something similar was first mooted by Pyle (1972:522), who noted that morphological boundary theory implausibly requires that epenthetic segments be assigned an arbitrary morphological affiliation.

Since we cannot rely on boundaries to determine morphological affiliation, implementing this idea would probably require some kind of accounting system where individual nodes of a representation are marked (diacritically?) as to which morphemes, if any, they belong to. Other researchers have relied on this overall idea to formulate constraints that measure the degree of divergence between URs and candidates.

Let us look in more detail at one consequence of the three principles in (7) for what happens at morpheme boundaries. It was a common assumption in autosegmental phonology that when two identical specifications become adjacent to each other as a result of morpheme concatenation, they are merged into a single specification in confomity with the Obligatory Contour Principle (cf. Mester 1986, McCarthy 1986, Myers 1987, Yip 1988, Schlindwein 1988):

(8)
$$\begin{array}{ccccccccc} \mathrm{x} & + & \mathrm{x} & & & \mathrm{x} & + & \mathrm{x} \\ | & & | & \Longrightarrow & & & \backslash\ / & \\ [+\mathrm{F}] & & [+\mathrm{F}] & & & & [+\mathrm{F}] & \end{array}$$

This is no longer a possibility in OT, at least under McCarthy and Prince's interpretation of the principles in (7). Given two morphemes whose edges have the shapes in the left hand side of (8), Gen could not produce a candidate like the right hand side. Doing so would violate Containment — one of the [+F]s has been literally removed from the input. The remaining [+F] would also have a problematic morphological affiliation, creating difficulties for Consistency of Exponence.

This revision of how heteromorphemic OCP violations are treated has empirical consequences. McCarthy and Prince (1993a: 29) use these properties of Gen to force epenthesis in Axininca Campa despite a conceivable candidate without epenthesis that obeys the phonotactic constraints of the language.

In Axininca Campa, the only permissible coda consonant is a nasal which is homorganic to a following stop or affricate. If a consonant cluster arises across a morpheme boundary, an epenthetic *a* is required. For example, between the morphs *č^{h}ik* and *wai*, the optimal candidate has an epenthetic *a*, since this violation of Fill is preferable to violations of the higher constraints Coda-Condition and Parse:

(9)

	Candidates	Parse	Coda-Cond	Fill
☞	~.č^{h}i.kA.wai.			*
	~.č^{h}ik.wai.		*!	
	~.č^{h}i.⟨k⟩wai.	*!		

But epenthesis is also required even when the consonant cluster is otherwise legal, such as the heteromorphemic *m* and *p* in the following form:

(10) /iN-kim - piro-i/ 'he will really hear'
   a. *iŋki**mp**iroti
   b. iŋki**map**iroti

Some conceivable candidates for this concatenation of morphemes would be:

```
(11)  a)  k  i   m     A   p   i  r  o
                 |         |
                 PL        PL

      b)  k  i   m    p    i  r  o
                 |    |
                 PL   PL

      c)  k  i   m    p    i  r  o
                     \ |
               ⟨PL⟩   PL

      d)  k  i   m    p    i  r  o
                  \  /
                   PL
```

In (11a), the potential problem with a coda *m* is resolved by making *m* an onset of a syllable with an epenthetic vowel. This will result in a violation of Fill. In (11b), we have simple concatenation, with both morphemes keeping the place features they had in UR. This will result in a violation of CODA-COND, since *m* is in a coda but has place features that aren't linked to the following onset. In (11c), both place features are still present in the candidate, but the one belonging to the first morpheme has been left unparsed in favour of sharing the place features of the following onset. This conforms to CODA-COND, but will violate PARSE. Candidates (a), (b), and (c) can be put into the following constraint tableau (not actually given by McCarthy and Prince):

(12)

	PARSE	CODA-COND	FILL
☞ a. ki.mA.piro			*
b. kim.piro		*!	
c. kiN.piro	*		

With these three candidates, the constraint ranking proposed by McCarthy and Prince selects the candidate that is the one actually found in Axininca Campa, *kimapiro*. Representation (11d), however, would fare even better in the tableau in (12). There are no unparsed features, so it does not violate PARSE. The place features of the coda *m* are linked to the following onset, so it does not violate CODA-COND. In addition, there is no epenthetic segment between the *m* and the *p*, so it does not violate FILL either. At this point, representation (11d) is more harmonic than representation (11a), and we would expect it to be the winning candidate and that the Axininca Campa form would be [kimpiro] rather than [kimapiro].

The only way that McCarthy and Prince can prevent the winning candidate from being (11d) is to assume that (11d) was never one of the candidates in the first place, that it was never generated by Gen. They do this by interpreting the principles of Containment and Consistency of Exponence in such a way as to forbid Gen from performing the kind of "OCP" coalescence illustrated in (8).[4]

In effect, McCarthy and Prince have accounted for the absence of coalescence in a single language by banning coalescence universally. Many languages, however, do seem to show exactly this kind of coalescence. For McCarthy and Prince's interpretation, these languages must necessarily use a structure like (11c) rather than (11d), and PARSE must be dominated by CODA-COND or whatever other constraint enforces feature sharing.

In the rest of this paper, I would like to look at a somewhat different example of coalescence in Nisgha. I will argue for an analysis that violates McCarthy and Prince's interpretation of the principles of Gen. Although my proposed representations will not involve a doubly linked node, they will resemble (11d) more closely than (11c) in the sense that the same sub-segmental node must have more than one morphological affiliation. If this analysis is correct, it poses problems for the McCarthy and Prince interpretation of Gen: Either

[4]Another solution immediately suggests itself, one relying on the black box labelled Candidate Set Adjustment in (4), the procedure invoked by McCarthy (1993) to enlarge the candidate set for Massachusetts English. We can allow Gen to generate fused structures like (11d), and then have Candidate Set Adjustment delete them, shrinking the candidate set. The end result is the same — structures like (11d) never enter the competition — but the price is further weakening the constrainedness of the theory. The fact that the architecture in (4) makes such a solution even imaginable is not to be counted as one of its strengths.

their analysis of Axininca Campa epenthesis is wrong, Gen's behaviour with respect to coalescence is not universal but can be parametrized by different languages, or the Candidate Set Adjustment procedure has almost unlimited power to change the candidate set.

None of these alternatives is very attractive. I shall instead argue for a different conception of the overall architecture of OT, one which lacks Gen entirely and where the segmental properties of morphemes are as much the result of constraints as their alignment properties are.

2.2 Description of Nisgha coalescence

Nisgha is a Tsimshianic language spoken in northern British Columbia. Most of the data to be presented here are drawn from Tarpent's (1987) grammar and from the *Nisgha Phrase Dictionary*. As background, it should be pointed out that Nisgha divides nominals into two classes, which Tarpent (1987) calls determinate and indeterminate. Determinate nominal include all proper names and a couple of deictics. All other nominals, including all common nouns, are indeterminate.[5]

In a transitive sentence which has an overt third person subject, the order of morphemes between the verb stem and the noun of the subject is as follows:

(13) VerbStem–(Comp)–3sg =(Evidentials) =(Erg) =Det # Noun

Comp is a morpheme that appears in what Belvin (1990) calls "independent" clauses. ("Dependent" clauses are subordinate clauses and clauses that are clefted, have a fronted Wh-word, or are preceded by one of a set of modal or aspectual auxiliary verbs.) There can be a number of evidential postclitics following the 3sg agreement marker. The ergative marker =*s* marks determinate (i.e., proper noun) transitive subjects that remain in their normal VSO position; although it belongs syntactically with the following NP, phonologically it cliticizes onto the end of the verb word. The determiner marks the class of all nominals: =*t* for determinate, =*ɬ* for indeterminate. These are also post-verbal clitics.[6]

Within this stretch of a sentence, the coronal consonants *s*, *t*, and *ɬ* have a disturbing habit of disappearing in the presence of each other.[7] The four morphemes we shall be most concerned with consist of nothing but one of these coronal consonants, i.e., the determiners =*t* and =*ɬ*, the ergative marker =*s*, as well as the third person singular agreement marker −*t*. The phenomenon also affects those *s*s, *t*s, and *ɬ*s that occur at the end of a verb stem or at the end of an evidential postclitic.

[5]Except for using *ɬ* instead of the digraph *hl*, I have tried to keep the transcriptions as close as possible to the practical orthography used in Tarpent (1987) and the *Nisgha Phrase Dictionary*. An apostrophe indicates a glottal stop or that the preceeding consonant is glottalized. An underlined velar symbol indicates the corresponding uvular. Though marked in the orthography, voicing is not distinctive.

[6]The determiner does not cliticize to the verb if it belongs to the object of an "independent" (main-clause) transitive clause.

[7]The coalescence to be described does not apply if one of coronals is pre-glottalized or a sonorant, e.g., *n*, *l*, *y*.

For example, the 3sg marker *t* surfaces if it occurs after a verb ending in ny other consonant, e.g., *limx* 'sing', but fails to surface after a verb ending with *s*, *t*, or *ł*, e.g., *naks* 'marry':[8]

(14)	limx-t	s/he sings
	naks	s/he marries
	luutk̲'almił	s/he dies in the fire
	(?)g̲al'it	s/he drops

The 3sg *t* is equally vulnerable to obliteration from an *s* or *ł* occuring to its right. It will surface without problem if there is no following subject NP:

(15)	gin'am–i	–**t**	loo–y'	*gin'amit looy'*
	give	–COMP–3sg	to –me	She gave it to me

But the determiner of a subject will prevent the 3sg marker from surfacing:

(16)	gin'am–i	=(**t**)=ł	hanak̲'	loo–y'	*gin'amił hanak̲' looy'*
	give	–COMP=3sg=DET	woman	to –me	The woman gave it to me

That this disappearance is phonological rather than morphological is suggested by the fact that the 3sg *t* resurfaces if it is shielded from the determiner *ł* by an evidential post-clitic:

(17)	gin'am–i	–**t**	=a'a	=ł	hanak̲'	loo–y'	*gin'amita'ał hanak̲' looy'*
	give	–COMP–3sg	=ASSERT	=DET	woman	to –me	The woman *did* give it to me!

This behaviour affects more than just the 3sg marker. If an evidential post-clitic is unfortunate enough to end in one of the eligible coronals, this coronal too will be lost:

(18)	gin'am–i	–**t**	=g̲a(**t**)=ł	hanak̲'	loo–n	*gin'amitg̲ał hanak̲' loon*
	give	–COMP–3sg	=EVID =DET	woman	to –you	I hear the woman gave it to you.

The 3sg *t* can coalesce into the *s* of a following determinate ergative marker, as well as the *ł* of the indeterminate determiner.

(19)	gin'am–i	=(**t**)=s	=(**t**)	Mary	loo–y'	*gin'amis Mary looy'*
	give	–COMP=3sg=ERG	=DET		to –me	Mary gave it to me

[8] I have been unable to find an example of a *t*-final stem taking a 3sg agreement marker in isolation, without an intervening Comp morpheme and without a following argument NP (and therefore a following coalescencing determiner). In fact, *t*-final verbs seem to be extremely rare in Nisgha. One listed in the index of the *Nisgha Phrase Dictionary* is *g̲al'it* 'drop'. As expected, the *t* of this verb does show coalescence with a following =*ł* determiner, of the kind illustrated below, implying that it has also coalesced with the 3sg marker.

The final *t* of an evidential post-clitic suffers the same fate before the ergative =*s*:

(20)	gin'am–i	–**t**	=ga(**t**)=**s**	=(**t**)	Mary	loo–n	*gin'amitga***s** *Mary loon*
	give	–COMP–3sg	=EVID	=ERG=DET		to –you	I hear Mary gave it to you.

The most dramatic example is the following sentence, where the coronals of four different morphemes — the final *s* of the verb stem, the 3sg –*t*, the ergative =*s*, and the determiner =*t* — all coalesce into a single *s*:

(21)	ɬa	nak**s** –(**t**)=(**s**) =(**t**)	Peter	*ɬa naks Peter*
	now	marry–3sg=ERG=DET	Peter	Peter is married now.

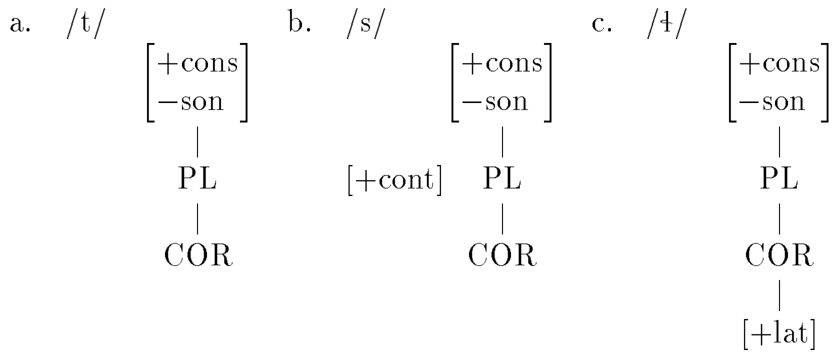
Using a brute-force deletion analysis, we would need to propose a number of rules, most of them with a mirror-image counterpart, to take care of the deletions illustrated above:

(22)
$$
\begin{array}{lcl}
t \rightarrow \emptyset \ / \ \_\_\ s & & t \rightarrow \emptyset \ / \ s\ \_\_ \\
t \rightarrow \emptyset \ / \ \_\_\ ɬ & & t \rightarrow \emptyset \ / \ ɬ\ \_\_ \\
ɬ \rightarrow \emptyset \ / \ \_\_\ ɬ & \text{or} & ɬ \rightarrow \emptyset \ / \ ɬ\ \_\_ \\
s \rightarrow \emptyset \ / \ \_\_\ s & \text{or} & s \rightarrow \emptyset \ / \ s\ \_\_ \\
t \rightarrow \emptyset \ / \ \_\_\ t & \text{or} & t \rightarrow \emptyset \ / \ t\ \_\_
\end{array}
$$

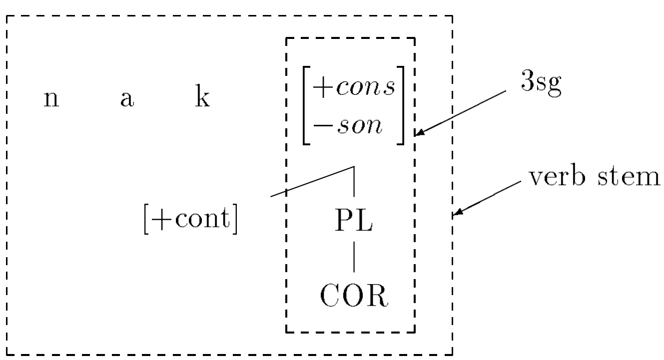
Put less formally, the situation is as if slots for consonants were a scarce commodity in Nisgha words, and consonants had to compete for them in order to be phonetically realized. In a competition between an *s* and a *t*, the *s* will win. In a competition between an *ɬ*, and a *t*, the *ɬ* will win. In a competition between two *s*s or two *ɬ*s, only one will survive (it is an arbitrary and empirically unprovable decision as to which one, but a decision that the classical deletion rule notation nonetheless forces the analyst to make).

But it is necessary to ask why there should be such a competition in the first place. Elsewhere in the language there is certainly no shortage of consonant clusters (cf. Shaw and Walsh 1991). Even in this environment, analogous forms like *limx–t* 's/he sings' make it clear that there is no overwhelming syllabic prohibition against a *t* surfacing, even after two other consonants. In fact, there does not seem to be any way to force the deletion by appealing to syllable structure constraints. In many cases, if the coalescence had not taken place, the result would still have been a perfectly legal syllable of Nisgha. It is hard to imagine some more subtle constraint that is low-ranking enough not to disallow legitimate occurrences of *kst* sequences, yet more highly ranked than PARSE (since the final $-t$ is left unparsed rather than resulting in *naks-t*), but would not also result in the $-t$ remaining unparsed in a form like *limx-t*.

The behaviour seems to be inherently bound up with the coronality that the three consonants share. One intriguing idea is this: the phonological information contributed by each morpheme has not really been destroyed, it has simply been redistributed in ways that we aren't used to seeing. If we assume that [−cont] is an underspecified feature in Nisgha, we would have structures something like the following for the three consonants in question:[9]

(23)


Given these representations, what is significant to note is that the structure for *t* is properly contained within the structures for *s* and *ɬ*. Looking at *naks-(t)* with this in mind, we do not need to assume that the phonological information contributed by the 3sg suffix has been destroyed. It is simply *inside* part of the phonological information contributed by the verb stem:

(24)


Somehow the two original structures have coalesced into a single structure that has more than one morphological affiliation. This kind of coalescence would not seem to be countenanced by McCarthy and Prince's (1993a) interpretation of the principles of Gen as illustrated by their analysis of Axininca Campa.

So Nisgha coronal coalescence poses a problem for the standard interpretation of OT. For reasons mentioned earlier, I do not believe it can be analyzed as underparsing forced by dominant (syllable structure or other) constraints. Nor can the coalescence be handled within Gen, without allowing the principles governing Gen to be parametrized, with one setting permitting coalescence (for languages like Nisgha) and another prohibiting it (for languages like Axininca Campa).

[9]The exact position of [lateral] is irrelevant for this discussion. For the future discussion we need a way of keeping *s* from being a substructure of *ɬ*, since *s* and *ɬ* do not coalesce with each other. To do this, I simply assume that *ɬ* in Nisgha is [−cont], though other ways are conceivable.

2.3 Morphemes as constraints

In the introduction, three approaches to the phonological information of morphemes were outlined: morphemes as represenations, morphemes as rules, and morphemes as constraints. It is only when one assumes the morphemes-as-represenations approach and believes that the *s* of *naks* and the *t* of the 3sg marker of Nisgha are real pieces of representation that one needs to come up with an explanation for why one of those pieces has disappeared in the output. The problem can be avoided by using one of the other approaches.[10]

In the morphemes-as-constraints approach, a morpheme is not itself a representation, but rather a set of requirements that a representation must satisfy in order for it to become the winning candidate. One of the main differences between the two approaches is this: in the underlying representation approach, a single piece of a representation cannot "belong" simultaneously to two different morphemes; in the morphemes-as-constraints approach, it is perfectly possible for the same piece of a candidate representation to satisfy the requirements of more than one morpheme.

To preview the analysis of Nisgha: the 3sg morpheme requires there to be a non-sonorant coronal immediately before the corresponding morphological boundary. The morpheme for the verb 'marry' requires, among other things, that there be a continuant non-sonorant coronal immediately before *its* associated boundary. If the two boundaries coincide, as in (25), exactly the same continuant non-sonorant coronal can satisfy both morphemes:

(25)
$$\begin{array}{cccccccccc} [& \mathrm{r}_1 & \mathrm{r}_2 & \mathrm{r}_3 & & [& \mathrm{r}_4 &]_{3sg} &]_V \\ & & & & & & | & & \\ & & & & [+\mathrm{cont}] & & \mathrm{PL} & & \\ & & & & & & | & & \\ & & & & & & \mathrm{COR} & & \end{array}$$

The fact that the segment in question has an extra piece, [+cont], that the 3sg morpheme is not looking for does not affect the outcome. (25) has everything that the morpheme *is* looking for, so (25) will be one of the candidates that the morpheme passes on to the next constraint.

It may not be immediately apparent how such an approach to the nature of morphemes could be incorporated into the framework of Optimality Theory. I would argue that significant parts of it already have been incorporated. In the earliest presentations of OT, it was often claimed that the constraint hierarchy used by some individual grammar was simply a language-particular ranking of universal constraints. It came to be realized that this pure conception of the constraint hierarchy could not be maintained, leading to McCarthy and Prince's (1993b) discussion of the universal constraint *schema* ALIGN, which allows individual grammars to construct any number of language-particular constraints. There seem to

[10] While the morphemes-as-rules approach can avoid just this problem — there is no second piece of representation there because in just these environments the morphemic rules have failed to insert it — this solution is still not satisfying. It misses a generalization by leaving us with several morphemes all having nearly identical environments in which they fail to insert material and it gives us no insight into why just these environments should be the ones that cause such a failure to insert.

be no differences between these language-particular constraints and the presumably universal constraints in terms of how they apply to candidates or how they can be ranked in the constraint hierarchy.

Alignment properties are one type of phonological information that morphemes must encode. Segmental properties are another. Despite the realization that alignment properties are best encoded as constraints that are equal citizens of the constraint hierarchy, it has continued to be assumed that the best way to encode segmental properties is in representations. These underlying representations must first be chosen appropriately and then require translation into the candidate sets that Eval can deal with, so an architecture that assumes URs must also have Gen, an allomorph selection procedure, and perhaps McCarthy's (1993) candidate set adjustment procedure, and so on. I do not believe that the limited conceptual simplicity gained by assuming URs is worth the proliferation of unexamined procedures and the resulting potential unconstrainedness of the theory. It is the purpose of this paper to argue that it is a better choice to handle the segmental properties of morphemes in the same way as their alignment properties, that is, as the subjects of constraints ranked on the constraint hierarchy.

In order to express the segmental properties of morphemes using constraints, it will likely be necessary to introduce at least one new universal constraint schema, along the lines of Align, to predicate properties of root nodes, e.g., their dependents and their linear ordering.[11] Most of the relevant inflectional morphs in Nisgha, however, consist of a single segment, and the interesting effects on larger stems occur next to morphological boundaries. In order to avoid unnecessarily complicating the following exposition, therefore, I shall only use the constraint schema Align.

2.4 Analyzing Nisgha with morphemic constraints

The analysis of Nisgha coalescence in terms of morphemic constraints relies on the insight illustrated in (24) and (25), namely that the same piece of a candidate representation can satisfy the requirements of more than one morpheme.

For concreteness, let us consider what the morphemic constraints for the 3sg marker would look like. The 3sg marker, when unaffected by surrounding coronals, consists of a single non-sonorant coronal, or *t*. To capture this, it is sufficient to have the following pair of constraints:

(26) Align (3sg, L; *t*, L)
Align (3sg, R; *t*, R)

This requires that a *t* occur next to the left boundary of the morph and that a *t* occur next to the right boundary of the morph. This would of course allow a number of candidates through that we don't really want: *tt*, *tat*, *tamoy'et*, etc. It is not necessary to formulate

[11] See Bird (1990), Scobbie (1991), Russell (1993) for various suggestions within Declarative Phonology for schemata that could be used. It should added that these additional schemata would almost certainly be necessary in any adequately formalized version of OT where constraints were written in a formal language rather than in English.

the 3sg morpheme to rule out these possibilities, since the excessively long candidates will be ruled out quite naturally by the general anti-structure constraints of OT. We can see this in the following tableau, which illustrates how the 3sg of 'sing', *limx-t*, is correctly chosen by a constraint hierarchy that orders the morphemic constraints higher than *STRUC. (For simplicity, *STRUC violations incurred by the stem have been ignored.)

(27)

	Align (3sg, L; *t*, L)	*STRUC
limx	*!	
☞ limx-t		*
limx-tat		**!*

Alternatively, as will be seen below, *limx-tat* and friends can be ruled out for having a right boundary for 3sg that is unwarrantedly far from the right boundary of the stem.

It is important to understand that the *t* in the constraints in (26) is an abbreviation for the segmental content consisting, minimally, of [−son] and COR. The constraints will be satisfied by *any* appropriately located segment that contains these specifications, including *s* and *ɬ*. We shall see shortly how this results in the coalescence behaviour we are interested in, but first we should reassure ourselves that it will not interefere with the picture we have already built up for *limx-t*. Specifically, (26) would let through a candidate that had [−son] and COR, but also a [+cont], that is, it would give *limx-s* no violation marks. Again, it is the anti-structure constraints of OT that will rule out the unnecessarily bulky representation. In the tableau below, the morphemic constraints outrank the anti-structure constraint *[+cont]:

(28)

	Align (3sg, L; *t*, L)	*[+cont]
limx	*!	
☞ limx-t		
limx-s		*!

The 3sg marker is a suffix on the verb stem, so we might expect to find the alignment constraint:

(29) Align (3sg, L; stem, R)

This constraint will in fact be necessary, as we shall see below, but it is not the full story. We want the right-hand boundaries of the stem and the suffix to coincide if at all possible. This can be accomplished by having the following constraint outrank (29):

(30) Align (3sg, R; stem, R)

For *limx-t*, this constraint is violated, the right boundary of the suffix being misaligned with the right boundary of the stem by one segment, but this violation is forced by the out-ranking segmental content constraints:

(31)

	Align (3sg, L; *t*, L)	Align (3sg, R; stem, R)
limx]]	*!	
☞ limx]-t]		*

But when the final segment of the stem is compatible with the non-sonorant coronal requirements of the morpheme, (30) will result in the kind of coalescence we saw in section 1. The winning candidate for the third person singular of 'marry', *naks*, will have the structure of (25), repeated here:

(32)
```
[ r1  r2  r3          [ r4 ]3sg   ]V
                         |
               [+cont]  PL
                         |
                        COR
```

Note that, unlike in the standard interpretation of OT, bracketing r_4 with $[\ ]_{3sg}$ does not prevent it from "belonging" to $[\ ]_V$ as well.

The most likely competitor to *naks* is the one where the suffix has a segment of its own, i.e., *naks-t*:

(33)
```
[ r1  r2  r3        r4    ]V  [    r5     ]3sg
                    |               |
           [+cont] PL              PL
                    |               |
                   COR             COR
```

Constraint (30) will rule in favour of (32) over (33):

(34)

	Align (3sg, L; *t*, L)	Align (3sg, R; stem, R)
☞ naks]]		
naks]-t]		*!

We can see that the normal suffixal constraint Align(3sg, L; stem, R), while low-ranking, is still active. A stem like *lip'ilsk*^{w} will have the 3sg form *lip'ilsk*^{w}*–t* rather than *lip'il[s]k*^{w}. That is, the non-sonorant coronal requirement of the 3sg morpheme will not be optimally satisfied by the non-sonorant coronal further inside the stem, which would have the structure:

(35)
```
[ l  i  p'  i  l       [    s    ]3sg  kw ]V
                            |
              [+cont]       |
                           PL
                            |
                           COR
```

Both candidates fare equally well in terms of the morphemic constraints of (26). Assuming that misaligning the right edges leftward by one segment is an equal violation to misaligning them rightward by one segment, *lip'ilsk*^{w} and *lip'ilsk*^{w}*–t* will tie with one violation apiece on constraint (30) and the decision will be passed on to the normal suffixal constraint (29):

(36)

		Align (3sg,R; stem,R)	Align (3sg,L; stem,R)
	[lip'il[s]k^w]	*	*!*
☞	[lip'ilsk^w]-[t]	*	

We have seen how the interaction of segmental content constraints and boundary alignment constraints can result in the coalescence of the 3sg marker *t* into a verb stem ending with *t*, *s*, or *ɬ*. The same explanation can be extended to all the other cases of coalescence discussed in section 1: the evidential post-clitics, the ergative marker =*s*, the determiners =*ɬ* and =*t*. For our most extreme example, *ɬa naks Peter*, where the *s* of *naks* is an exponent of four different morphemes (the verb stem, the 3sg marker, the ergative marker, and the determinate determiner), the structure of the winning candidate would be:

(37) $[\ \ r_1\ \ r_2\ \ r_3\ \ \ \ [\,[\,[\ r_4\ ]_{det}]_{erg}]_{3sg}\ \ ]_V$

$$\begin{array}{cc} & | \\ [+\mathrm{cont}] & \mathrm{PL} \\ & | \\ & \mathrm{COR} \end{array}$$

This structure will satisfy all the segmental content constraints imposed by the four morphemes:

(38)

Align ('marry', R; *s*, R)	
Align (3sg, L; *t*, L)	Align (3sg, R; *t*, R)
Align (erg, L; *s*, L)	Align (erg, R; *s*, R)
Align (det, L; *t*, L)	Align (det, R; *t*, R)

Alignment constraints like (30) that give preference to candidates where the right boundaries of these categories coincide will choose (37), *naks*, over a candidate where every morph has a segment of its own, *naks-t-s-t*, or any of the intermediate candidates.

3 Hua ablaut

Hua ablaut is the second case we shall look at where it appears as though phonological information from two different morphemes is sharing the same space in the representation. Hua is a Papuan language spoken in the eastern highlands of New Guinea. Hua phonology has been described in detail by Haiman (1980). The phenomena of verbal ablaut seem to lend themselves naturally to an account using ranked constraints, as shown by Dunstan

Brown's computer implementation of the paradigms using DATR, a specification language for default logic (Brown 1993).

Hua has clause-chaining serial verb constructions, where a sequence of medial verbs is terminated by a final verb. The final verbs we shall be looking at have the following general morphological structure:

(39) stem - (tense/aspect) - mood

where the suffixes of the mood position mark a variety of subordination types as well as modal categories (e.g., indicative, interrogative, concessive conditional, counterfactual relative clause). Suffixes in the tense/aspect slot are often homophonous with independent verbs, which led Haiman to analyze a number of them as auxiliary verbs.

Medial verbs that involve a different subject in the following clause have the following general structure:

(40) stem - (tense/aspect) - medial - anticipatory

The medial suffixes mark the person/number of the verb's subject. The anticipatory suffixes mark the person/number of the subject of the following clause.

Hua has a standard five-vowel system: *i, e, a, o, u*. It also has an excrescent schwa that breaks up consonant clusters, but this will play no role in the data and analysis below.

3.1 Description of Hua ablaut

Hua verbs undergo three kinds of ablaut, which Haiman calls *predesinential ablaut*, *presubjunctive ablaut*, and *general ablaut*.

3.1.1 Predesinential ablaut

Predesinential ablaut occurs in the vowel immediately preceding one of what Haiman calls the *threefold desinences*. These are a set of suffixes, each of which has three allomorphs whose selection depends on the person and number of the verb they are attached to. The threefold desinences include the suffixes in the mood position of the schema in (39) and those in the medial slot of (40).

As an example of the vowel alternations caused by predesinential ablaut, let us look at some paradigms for verbs with the interrogative mood suffix, which has the following three allomorphs:[12]

(41) Interrogative threefold desinence:

–pe	1pl and 2sg
–'ve	dual, all persons
–ve	all others

[12]In all threefold desinences, the dual allomorph is a glottal stop followed by the default allomorph, and could plausibly be treated as bimorphemic. The alternation between the 1pl/2sg allomorph and the default allomorph, while clearly not random, is not quite predictable.

There are three classes of verbs with different ablaut behaviour, which we shall illustrate using the stems for 'do', 'eat', and 'give'. For convenience, following Haiman, we shall refer to the stems using the imperative singular forms of the verbs.

(42) *hu–* 'do'

	sing	dual	plur
1	hu-ve	hu-'ve	hu-pe
2	ha-pe	ha-'ve	ha-ve
3	hi-ve	ha-'ve	ha-ve

(43) *do–* 'eat'

	sing	dual	plur
1	do-ve	do-'ve	do-pe
2	da-pe	da-'ve	da-ve
3	de-ve	da-'ve	da-ve

(44) *mi–* 'give'

	sing	dual	plur
1	mu-ve	mu-'ve	mu-pe
2	mi-pe	mi-'ve	mi-ve
3	mi-ve	mi-'ve	mi-ve

Some pretheoretical observations concerning the above paradigms: There is no distinction between second and third persons in the dual and plural. This is a perfectly general fact throughout the morphology of Hua, and indeed many Papuan languages: all non-singular third persons are treated as though they were the corresponding second persons.[13] All first person forms have a stem-final round vowel. All third person singulars have a stem-final front vowel. All "second" persons (including non-singular third persons) have a stem-final low vowel, except in the *mi*-class. All *mi*-class forms have high vowels; all *do*-class forms have non-high vowels. It may be noted that, except for the non-distinctness of second and third person non-singulars and except for the homophonous 3sg and 2pl forms of *mi*-class verbs, predesinential ablaut and the allomorphy of the threefold desinences are between them almost always sufficient to uniquely identify the person/number of a verb.

This kind of ablaut does not affect the verb stem per se, but any vowel immediately preceding one of the threefold desinences. This can be seen in the following paradigm (Haiman 1980: 60), which shows the conjugation of subjunctive final verbs. In these verbs, the threefold desinence is the unmarked ("indicative") mood suffix (*e∼'e∼ne*. This triggers

[13]This could be the result of a morphological rule/constraint that literally realizes a syntactic third person as a morphological second person. Below we shall develop an alternative solution where morphemes bear the expected person features and neutralization is the result of referring only to the feature [−me] or [−first], with the different behaviour of 3sg forms being the result of a constraint ranking.

predesinential ablaut not on the verb stem, but on the immediately preceding morph, the subjunctive auxiliary -*sV*-, which acts in this respect like a *hu*-class verb.

(45) Subjunctive *hu* 'do'

	sing	dual	plur
1	hi- su -e	hi- su -'e	hi- su -ne
2	hi- sa -ne	hi- sa -'e	hi- sa -e
3	hi- si -e	hi- sa -'e	hi- sa -e

3.1.2 Presubjunctive ablaut

The paradigm in (45) also illustrates the second kind of ablaut, which applies to the morph immediately preceding one of a set of "subjunctive" suffixes, of which -*sV*- is a member. Before any of these subjunctive suffixes, the vowel of the verb stem will be front. *hu*- and *mi*-class verbs will have a high front vowel, as *hu*- does in (45). *do*-class verbs will have a mid front vowel. The paradigm of (45) for *do*- 'eat' would have *de-su-e, de-sa-ne,* etc.

3.1.3 General ablaut

Given the two types of ablaut we have seen so far, we might expect no vowel changes to occur before suffixes that are neither threefold desinences nor subjunctive. One such suffix is progressive aspect *bau*, which itself takes predesinential ablaut like a *hu*-class verb, but triggers neither predesinential ablaut nor presubjunctive ablaut on the preceding verb stem. We might expect the stem vowel, subject to no ablaut conditioning, to surface in its true form before the progressive suffix. This does seem to be true in first person forms and in singular forms, where stems show the same vowel in the progressive as they do in their "bare" form, the imperative singular.

(46) hu-bau-e 'I am doing'
do-bau-e 'I am eating'
mi-bau-e 'I am giving'

But in second and third person dual and plural, the stem vowel is front — *hi, mi,* and *de.* The full paradigm for the progressive of *hu* 'do' is:

(47)

	sing	dual	plur
1	hu-bau-e	hu-bau-'e	hu-bau-ne
2	hu-bai-ne	hi-bai-'e	hi-bai-e
3	hu-bai-e	hi-bai-'e	hi-bai-e

This fronting of vowels in non-first non-singular forms is perfectly general and occurs in all environments where the other two kinds of ablaut do not apply. In OT terms, predesinential ablaut outranks general ablaut. Presubjunctive ablaut is consistent with general ablaut (both require a front vowel). Some of the environments where general ablaut occurs are in plural imperatives (48), before "auxiliaries" like *-bau-*, and before same-subject anticipatory suffixes of medial verbs (49).[14]

(48) Imperatives

	do	eat	give
singular	hu	do	mi
dual	hi-'o	de-'o	mi-'o
plural	hi-o	de-ho	mi-o

(49) Same subject medials

	sing	dual	plur
1	hu-da	hu-ta'a	hu-ta
2	hu-ka	hi-ta'a	hi-ta
3	hu-na	hi-ta'a	hi-ta

Since there is no consistent morphological environment in which general ablaut takes place (i.e., nothing the following morphemes have in common), general ablaut must be triggered by person/number features that are borne by the verb stem itself. Presumably, these were copied into the verb's morphosyntactic representation by the rules or principles of morphosyntax.

3.1.4 Identical vowel reduction

Hua has a general phonotactic prohibition on sequences of identical vowels. Whenever such sequences arise, they are reduced to a single vowel.

Across morpheme boundaries, this results in a situation that looks suspiciously like coronal coalescence in Nisgha. For example, the third person of the indicative mood uses the final mood suffix *–e*. Added to verb stems which have undergone fronting ablaut, this results in *hi–e* and *mi–e*. But when added to *do*, the result is not the expected *de–e*, but simply *de*.

Identical vowel reduction can also apply within a single morph, when ablaut causes two vowels of a stem to become identical. For example, we would expect the 2sg indicative of *hao* 'shoot' to be *haa-ne*, with the stem-final *o* being realized as a low vowel by second person predesinential ablaut. Instead, we find just one low vowel: *ha-ne*.

[14]Medial verbs whose subject is the same as the subject of the next clause have a structure like that given in (40), except without the (redundant) medial slot. The subject of both clauses is marked by the final anticipatory desinence, which is not threefold and does not trigger any kind of ablaut.

3.2 An analysis with morphemic constraints

Predesinential ablaut is triggered by the presence of one of the threefold desinences. I shall assume that the morpheme involved in the ablaut is not the threefold mood or medial agreement suffix itself, but rather a separate person/number morpheme which the morphology of Hua will place between the tense/affix suffix and the threefold desinence.

(50) Stem + (Tense/Aspect) + Person/Number + Threefold-Desinence

This person/number morpheme is a terminal node of morphosyntactic structure. Rules of morphosyntax will ensure that the person and number features borne by this morpheme are spread (perhaps by percolation through higher nodes) to the other morphemes in the verb—the stem, the threefold desinence (whose allomorphy depends on person/number information), and to the tense/aspect auxiliaries (which can also undergo general ablaut in non-singular non-first persons).

Before we begin our analysis using morphemic constraints, let us consider the kinds of difficulties that would be faced by the standard OT approach which assumes that the phonological information of morphemes is encoded in underlying representations. Let us assume that the stems *hu* and *mi* and the 1sg and 3sg suffixes have URs which contain (at least) the following features:

(51) *hu* $\begin{bmatrix}+\text{high}\\+\text{back}\end{bmatrix}$ *mi* $\begin{bmatrix}+\text{high}\\-\text{back}\end{bmatrix}$ 1sg $\begin{bmatrix}+\text{back}\end{bmatrix}$ 3sg $\begin{bmatrix}-\text{back}\end{bmatrix}$

Recall that the inflected forms of the verbs are:

(52)

	'do'	'give'
1sg	hu	mu
3sg	hi	mi

If the UR of the verb *mi* 'give' contains the feature [−back], this feature must remain unparsed in the 1sg form, giving way to the [+back] feature of the 1sg morpheme's UR. This could be accomplished by a giving a low ranking to a constraint like Parse[−back] relative to a constraint like Parse[+back]. But in 3sg *hi*, the situation is reversed. The [+back] feature of the verb stem's UR must remain unparsed, giving way to the [−back] feature of the 3sg's UR, implying a ranking of Parse[−back] over Parse[+back]. Another approach might be to say that the entire segmental position of the verb stem remains unparsed in favour of the segmental position of the suffix.[15] But even this does not hold in all cases. It would explain why second person /hu+a/ and /do+a/ are realized as [ha] and [da], but not why /mi+a/ is realized as [mi]. Furthermore, it is not always entire segments that are

[15]It is unclear why this should be so in just this environment. Except for the undominated constraint against adjacent identical vowels, discussed above, Hua has no aversion to adjacent vowels, accepting either hiatus or optional epenthetic glides.

kept: the vowel of 3sg *hi* seems to keep the [+high] of the verb stem and the [−back] of the suffix. The parallels with Nisgha coronal coalescence are clear: we have underparsing in morphologically determined environments, without a prosodic motivation and without a consistent choice of whether it is the first or second element that is unparsed.

Instead of trying to tweak parsing constraints and underspecification in the hope that ever more complicated accounts will eventually result in at least descriptive adequacy, a more promising way of dealing with the problem would take into account the way in which these behaviours are so intimately tied to the morphemes involved. The [a] in /hu+a/→[ha] is not there because it is a low vowel or because it is the vowel on the right, but because it belongs to the second person morpheme. The [i] in /mi+a/→[mi] is not there because it is a high vowel or because it is the vowel on the left, but because it belongs to the verb *mi*. Which vowels appear on the surface and which vowels do not is an unpredictable phonological property of the morphemes involved. One of the central principles of generative phonology, largely carried over into standard OT, is that the unpredictable phonological properties associated with a morpheme ought to be encoded in the UR of the morpheme. But URs are incapable of encoding the kinds of properties we find in Hua ablaut.

The kinds of things we find—e.g., in a competetion between the [+back] of '1sg' and the [−back] of 'give', the [−back] of 'give' wins—are the kinds of things that seem to be best handled by ranked constraints. I shall now outline an analysis of Hua ablaut based on the idea that the phonological properties of morphemes are not encoded in URs, but in constraints that are distributed through the constraint hierarchy.

3.2.1 Predesinential ablaut

Let us recall our initial pre-theoretical observations about the stem-final (or auxiliary-final) vowels that undergo predesinential ablaut:

(53) a. All first persons have a back round vowel.
b. All third person singulars have a front vowel.
c. "Second" persons (including non-singular third persons) have a low vowel, except in the *mi*-class.
d. All *mi*-class forms have high vowels.
e. All *do*-class forms have non-high vowels.

There must be a set of constraints sensitive to the featural make-up of the person/number morpheme's terminal node in the morphosyntactic tree. These constraints will demand certain phonological features in the morph that corresponds to that morphosyntactic terminal node. Using generalized alignment, we can simply align these required features at the right edge of the person/number morphs.

(54)	a.	BACK$]_1$	Align ($[+\text{first}]_{P/N}$,	R; [+back], R)
	b.	LOW$]_2$	Align ($[+\text{second}]_{P/N}$,	R; [+low], R)
	c.	FRONT$]_{3sg}$	Align ($[-\text{first},-\text{second},+\text{sing}]_{P/N}$,	R; [−back], R)

Each of these alignment constraints has been given a schematic abbreviation. Most of the abbreviations contain terms that look suspiciously like feature names, but I have placed them in small caps, following the convention for constraint names in OT, in order to reinforce the point that these "features" are not actual pieces of a representation, but constraints that look for certain kinds of pieces in candidate representations.

There will also be requirements imposed on the same vowel by the verb stem's morpheme. A *mi*-class verb, for example, always has a high vowel, even in second person forms where the other two verb classes have a low vowel. We may take this requirement for a high vowel as a (relatively highly ranked) constraint forming part of the morpheme for a *mi*-class verb. Furthermore, while a *mi*-class verb is forced to have a back round vowel in the first person, in all other environments, including those where the vowel does not undergo any of the three kinds of ablaut, it has a front vowel. We may take this too to be part of the morpheme for the verb stem.

As in Nisgha, the two morphemes are forced to try to express themselves on the same vowel by a constraint aligning their right edges with each other:

(55) ALIGN-P/N:
Align (Person/Number, R; Stem, R)

This will result in the same kind of overlapping structure we saw in Nisgha:

(56) $[\ \mathrm{m}\ [\ \mathrm{u}\ ]_{1sg}\ ]_{give}$

In Nisgha, the constraints forcing the alignment of the right edges could be dominated, that is, disalignment could be forced if the two segments being demanded were incompatible, as in [*lim*x][*t*]. The segmental demands of the two morphemes were met even at the expense of misaligned boundaries. In Hua, however, ALIGN-P/N is undominated by morphemic constraints. If the segmental demands of the two morphemes are incompatible, one of them must give way in order to preserve alignment.

We are ready to see how the 1sg and 2pl forms of *mi* can be derived in a constraint tableau. We may note that all first-person forms of every verb always have back round vowels, suggesting that the first person constraint (54a), which we can abbreviate schematically as $\text{BACK}]_1$, is undominated by any other morphemic constraint. The [−back] requirement of the verb stem is dominated by the [+back] requirement of the first person morpheme, but the [+high] requirement of the verb stem dominates the [+low] requirement of the second person morpheme. The tableaux for *mu-ve* and *mi-ve* are given below. In all the tableaux in the Hua analysis, I shall assume that Hua has undominated segmental structure constraints which ensure that the candidates that survive to the portion of the hierarchy we are interested in will contain only the five vowels *i, e, a, o,* and *u*, fully specified for at least [high], [back], and [low]. Although there is no evidence for ranking the $\text{HIGH}]_{mi}$ portion of the verb stem morpheme lower than $\text{BACK}]_1$, I shall assume for convenience that all the pieces of a single morpheme apply in one block. In the tableaux, candidates will incur one violation mark for each required feature that they lack.

(57)

	BACK$]_1$	HIGH,FRONT$]_{mi}$	LOW$]_2$
mi$]_{1sg}]_{mi}$-ve	*!		
me$]_{1sg}]_{mi}$-ve	*!	*	
ma$]_{1sg}]_{mi}$-ve		**!	
mo$]_{1sg}]_{mi}$-ve		**!	
☞ mu$]_{1sg}]_{mi}$-ve		*	

(58)

	BACK$]_1$	HIGH,FRONT$]_{mi}$	LOW$]_2$
☞ mi$]_{2pl}]_{mi}$-ve			*
me$]_{2pl}]_{mi}$-ve		*!	*
ma$]_{2pl}]_{mi}$-ve		*!*	
mo$]_{2pl}]_{mi}$-ve		*!*	*
mu$]_{2pl}]_{mi}$-ve		*!	*

In *mi*-class verbs, we do not get much of a chance to see the second person morphemic constraint in action, since its preferences are always overruled by the more highly ranked morphemic constraints of the verb stem. In the other two verb classes, though, the morphemic constraints of the verb stem are lower ranked and we can see the effects of LOW$]_2$. Assuming for the moment that *hu*-class verbs have morphemic constraints requiring the presence of a high back vowel, schematically HIGH,BACK$]_{hu}$, we can see that these constraints are overruled by LOW$]_2$. A preliminary tableau for 2pl *ha-ve* is:

(59)

	LOW$]_2$	HIGH,BACK$]_{hu}$
hi$]_{2pl}]_{hu}$-ve	*!	*
he$]_{2pl}]_{hu}$-ve	*!	**
☞ ha$]_{2pl}]_{hu}$-ve		*
ho$]_{2pl}]_{hu}$-ve	*!	*
hu$]_{2pl}]_{hu}$-ve	*!	

FRONT$]_{3sg}$ (54c) will require 3sg forms to have a front vowel. With *mi*-class verbs, this was trivial, since the verb stem also required front vowels. But with *hu*-class verbs, 3sg's requirement for [−back] and the verb's requirement for [+back] conflict, as as can be seen from the paradigm in (42) the [−back] of the 3sg wins. The fact that we will need a separate constraint anyway to handle 3sg forms suggests a way of dealing the third person dual and plural forms that seem to act like second persons. We can generalize constraint LOW$]_2$ to apply not just to second persons but to all non-first persons:

(60) LOW$]_2$ (revised):
Align ([−first]$_{P/N}$, R; [+low], R)

This constraint could in principle apply to 3sg forms as well, but it will be prevented from doing so by the specific 3sg constraint that outranks it and requires a [−back] that is inconsistent with [+low]. In other words, 3sg forms *are* subject to LOW$]_2$ and incur violation marks for not obeying it, but these violation marks are forced by a higher ranking constraint. The preliminary tableau for the 3sg *hi-ve* is:

(61)

	FRONT$]_{3sg}$	LOW$]_2$	HIGH,BACK$]_{hu}$
☞ hi$]_{3sg}]_{hu}$-ve		*	*
he$]_{3sg}]_{hu}$-ve		*	**!
ha$]_{3sg}]_{hu}$-va	*!		*
ho$]_{3sg}]_{hu}$-ve	*!	*	*
hu$]_{3sg}]_{hu}$-ve	*!	*	

We have captured the tendency of *hu*-class verbs to have a high back vowel in unmarked environments with morphemic constraints to that effect which are ranked below LOW$]_2$. We could similarly capture the tendency of *do*-class verbs to have mid back vowels, and the general fact that their vowels are never high, by having a similar set of morphemic constraints ranked at relatively the same place of the hierarchy as those of *hu*-class verbs. But, in fact, this is not necessary. We can instead generalize the rounding requirement of *hu*-class and *do*-class verbs and have it apply once to *all* verbs rather than individually in the lexical entires of most of the verbs. We can formulate this constraint as:

(62) BACK$]_V$:
Align (Verb, R; [+back], R)

If (62) is ranked in the same place of the hierarchy as we proposed for the morphemic constraints of *hu* (crucially below FRONT$]_{3sg}$), then this will apply as expected to *hu*-class and *do*-class verbs. It will also assess violation marks against non- first person *mi*-class verbs, but these violations will be forced by the higher-ranking [−back] morphemic constraints of the *mi*-class.

We also need a way of expressing the difference between *do*-class and *hu*-class verbs, whose paradigms are the same except for the height of non-low vowels, which are consistently mid in *do*-class verbs and high in *hu*-class verbs. This could be accomplished by specifying both classes for their height or by specifying one of the classes for height and leaving the other to more general constraints. For concreteness, and by analogy with the [+high] requirements of *mi*-class verbs, I shall assume that *hu*-class verbs have constraints requiring [+high], ranked as suggested earlier below LOW$]_2$, and that the mid vowels of *do*-class verbs are the result of general, very low- ranking anti-structure constraints against the features [+high] and [+low].

So far our morphemic constraints for the three verb classes look like this: *mi*-class verbs require [+high,−back] so strongly that only BACK$]_1$ outranks them; *hu*-class verbs require

[+high] relatively strongly, but lower-ranked than LOW]$_2$; *do*-class verbs impose no morphemic requirements at all on the final vowel of the verb stem.[16] The effect of these morphemic constraints in a non-ablaut environment, such as the imperative singular, is illustrated in the following tableaux:

(63) imperative singulars:

		HIGH,FRONT]$_{mi}$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
☞	mi		*		*	
	me	*!	*			
	ma	*!*				*
	mo	*!*				
	mu	*!			*	
	hi		*!		*	
	he		*!	*		
	ha			*!		*
	ho			*!		
☞	hu				*	
	di		*!		*	
	de		*!			
	da					*!
☞	do					
	du				*!	

The following list summarizes the constraints we have developed so far.[17] At the positions marked with ellipses will occur the morphemic constraints for the final vowels of the other *mi*-class and *hu*-class verbs.

(64) Segmental structure constraints, ALIGN-P/N
BACK]$_1$
HIGH,FRONT]$_{mi}$, ...
FRONT]$_{3sg}$
LOW]$_2$
BACK]$_V$
HIGH]$_{hu}$, ...
*[+high], *[+low]

[16]Another possiblity is that *every* verb requires exactly the same final vowel, namely [+high,−back], and that the only difference between verb classes is where in the constraint hierarchy these requirements sit. The constraints of *mi*-class verbs are very highly ranked; those of *hu*-class verbs are ranked moderately strongly, but not strongly enough for the [−back] requirement to outrank the general [+back] requirement imposed on all verb stems; the constraints of *do*-class verbs are ranked so low that they are never undominated.

[17]Not all the rankings suggested by the listing are necessary. There is no evidence for ranking Align (Person/Number, R; Stem, R) over BACK]$_1$ or BACK]$_V$ over HIGH]$_{hu}$. We shall see below evidence from ranking transitivity that LOW]$_2$ must outrank BACK]$_V$.

To verify that the above constraints will work, the following tableaux show the competition for the 1sg, 2pl, and 3sg forms of the verbs *mi*, *hu*, and *do*, illustrating the operation of the constraints for all three verb classes in all three ablaut environments.

1sg	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
mi	*!				*		*	
me	*!	*			*			
ma		**!						*
mo		**!						
☞ mu		*					*	

2pl	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
☞ mi				*	*		*	
me		*!		*	*			
ma		**!						*
mo		**!		*				
mu		*!		*			*	

3sg	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
☞ mi				*	*		*	
me		*		*	*			
ma		**!	*					*
mo		**!	*	*				
mu		*	*	*			*	

1sg	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
hi	*!				*		*	
he	*!				*	*		
ha						*!		*
ho						*!		
☞ hu							*	

2pl	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
hi				*!	*		*	
he				*!	*	*		
☞ ha						*		*
ho				*!		*		
hu				*!			*	

3sg	BACK]$_1$	HIGH,FRONT]$_{mi}$	FRONT]$_{3sg}$	LOW]$_2$	BACK]$_V$	HIGH]$_{hu}$	*[+high]	*[+low]
☞ hi				*	*		*	
he				*	*	*!		
ha			*!			*		*
ho			*!	*		*		
hu			*!	*			*	

1sg	BACK$]_1$	HIGH,FRONT$]_{mi}$	FRONT$]_{3sg}$	LOW$]_2$	BACK$]_V$	HIGH$]_{hu}$	*[+high]	*[+low]
di	*!				*		*	
de	*!				*			
da								*!
☞ do								
du							*!	

2pl	BACK$]_1$	HIGH,FRONT$]_{mi}$	FRONT$]_{3sg}$	LOW$]_2$	BACK$]_V$	HIGH$]_{hu}$	*[+high]	*[+low]
☞ di				*!	*		*	
de				*!	*			
da								*
do				*!				
du				*!			*	

3sg	BACK$]_1$	HIGH,FRONT$]_{mi}$	FRONT$]_{3sg}$	LOW$]_2$	BACK$]_V$	HIGH$]_{hu}$	*[+high]	*[+low]
di				*	*		*!	
☞ de				*	*			
da			*!					*
do			*!	*				
du			*!	*			*	

All of these vowel mutations are forced because in Hua, unlike Nisgha, the alignment constraint encouraging the two morphemes to share their right edges is undominated by morphemic constraints. In case of conflict between the stem morphemic constraints and the person/number morphemic constraint, the undominated ALIGN-P/N constraint forces one of the two morphemes to go unsatisfied rather than letting both be satisfied by simple concatenation:

(65)

	ALIGN-P/N	BACK$]_1$	HIGH,FRONT$]_{mi}$
[mi][u]	*!		
☞ [m[u]]			*
[m[i]]		*!	

3.2.2 Presubjunctive ablaut

Stem-final vowels must be [−back] before one of the three subjunctive morphemes, *li*, *na*, and *no*.

In (50), we factored the set of threefold desinences which triggered predesinential ablaut into two pieces: i) a person/number suffix which was aligned with the right edge of the preceding stem or auxiliary, and ii) the mood or medial agreement suffix which actually surfaces with three allomorphs. We can perform the same kind of factoring with the set of subjunctive morphemes, positing an abstract subjunctive morpheme and a morpheme indicating the precise semantic value of the suffix (e.g., future medial, jussive):

(66) Stem + Subjunctive + {li, na, no}

Like the person/number suffix of (55), the right edge of the subjunctive suffix is aligned with the right edge of the verb stem:

(67) ALIGNSUBJ:
Align (Subjunctive, R; stem, R)

Given that presubjunctive stems are uniformly front, we can posit the following morphemic constraint:

(68) $\text{FRONT}]_{subj}$:
Align (Subjunctive, R; [−back], R)

As with predesinential ablaut, the alignment constraint (67) will result in a situation where the verb stem and the subjunctive suffix are competing for the same vowel position. There will be no visible effect with *mi*-class verbs, since the requirements of the verb stem are consistent with the requirement of (68). But the occurrence of front vowels in subjunctive *hu*-class and *do*-class verb stems indicates that both (67) and (68) must outrank the general constraint, $\text{BACK}]_V$, requiring verb stems to have a back vowel.

(69)

		ALIGNSUBJ	$\text{FRONT}]_{subj}$	BACK_V	*[+high]
	$\text{d[i]}_{subj}]_{eat}$			*	*!
☞	$\text{d[e]}_{subj}]_{eat}$			*	
	$\text{d[a]}_{subj}]_{eat}$		*!		
	$\text{d[o]}_{subj}]_{eat}$		*!		
	$\text{d[u]}_{subj}]_{eat}$		*!		
	$\text{do]}_{eat}\text{[e]}_{subj}$	*!			

3.2.3 General ablaut

Unlike the other two kinds of ablaut, general ablaut is not triggered by any particular morphological environment. Two things are worthy of note. First, any non-first person non-singular must undergo at least one of the three kinds of ablaut. Second, the morphological environments in which a verb or suffix undergoes general ablaut have in common only the fact that the verb or suffix is not in either a predesinential or a presubjunctive position. Together, these facts would lead us to suspect that general ablaut is actually the default case and that all non-first person non-singular verbal morphemes will undergo general ablaut unless they are subject to the more highly ranked predesinential or presubjunctive ablauts.

Since general ablaut is not sensitive to the identity of the surrounding morphemes, it must be something inherent to the undergoing morpheme that triggers the ablaut. It is for this reason that I assumed earlier that the morphosyntactic principles or rules of Hua would ensure that the person and number features, most clearly localized in the Person/Number morpheme of (50), are propogated through all the morphemes of the verb. The last suffix of a verb does not undergo general ablaut; if we analyze the final mood suffix as a complementizer and the anticipatory suffix, as Haiman suggests, as a cliticized pronoun, we might characterize the remaining morphemes by means of a morphosyntactic feature such as [+verbal].

General ablaut can now be stated as an alignment condition requiring the feature [−back] at the right edge of all morphs whose morphosyntactic terminal nodes bear the features [+verbal, −first, −sing]:

(70) GENABLAUT:
Align ([+verbal,−first,−sing], R; [−back], R)

All verb classes undergo general ablaut, which indicates that GENABLAUT outranks $\text{BACK}]_V$, the general constraint on verb stems and auxiliaries that results in back vowels in, for example, the singular imperatives *hu!* and *do!*. On the other hand, if a verb is in a position where it is subject to predesinential ablaut as well as general ablaut, it will always undergo predesinential ablaut, indicating that GENABLAUT is outranked by $\text{FRONT}]_{3sg}$ and $\text{LOW}]_2$. In our initial summary of constraint rankings in (64), we had no evidence to impose a ranking between $\text{LOW}]_2$and $\text{BACK}]_V$. The interaction of the two constraints with GENABLAUT indicates that the correct ranking for that portion of the hierarchy must be:

(71) $\text{FRONT}]_{3sg}$
$\text{LOW}]_2$
GENABLAUT
$\text{BACK}]_V$

These constraints result in a front vowel in the verb stem of 2pl *hi-bai-e* 'you all are doing'. The final indicative *–e* is a threefold desinence and triggers predesinential on the preceding progressive auxiliary *bai*, which behaves like a *mi*-class verb. But *bai* itself is neither a threefold desinence nor a subjunctive suffix. So the verb stem *hu* is not forced to share its final vowel with a person/number or a subjunctive morpheme, and constraints such as $\text{LOW}]_2$ and $\text{FRONT}]_{subj}$ have nothing to say about it. The only ablaut constraint that will affect it is GENABLAUT, sensitive to its constellation of features [+verbal, −first, −sg].

(72) $\text{hV}]_{+verbal,-first,-sing}$

	$\text{LOW}]_2$	GENABLAUT	$\text{BACK}]_V$	$\text{HIGH}]_{hu}$
☞ hi			*	
he			*	*!
ha		*!		*
ho		*!		*
hu		*!		

If the verb were 1sg instead of 2pl, no violations of GENABLAUT would be incurred, and the decision would be passed to the lower constraints $\text{BACK}]_V$ and $\text{HIGH}]_{hu}$, which will correctly select [hu], the default form of this verb when none of the kinds of ablaut apply.

3.2.4 Identical vowel reduction

Sequences of identical vowels are collapsed in Hua, so that instead of the expected 3sg indicative *de-e* we find *de*, and instead of the expected 2sg *baa-ne* we find *ba-ne*.

One analysis would be to set up a constraint against sequences of identical vowels, say $^{*}V_{\alpha}V_{\alpha}$. It is possible that this constraint really is active in the phonology of Hua, but it would have to be motivated by the phonotactics of tautomorphemic sequences. Cases of vowel reduction that take place across morpheme boundaries or as a result of ablaut can be handled quite well by the kinds of constraints we have already been looking at.

The analysis of *de* is quite similar to the analysis of Nisgha *naks*. Not only does the vowel *e* "belong to" the verb stem morpheme 'eat' and the 3sg person/number morpheme, it also "belongs to" the indicative mood suffix, a threefold desinence whose 3sg allomorph is *–e*:

(73) $[\ \mathrm{d}\ [\ [\ \mathrm{e}\ ]_{3sg}\ ]_{indic}\ ]_{eat}$

The situation is also like Nisgha in that the coalescence will only apply if the two segments are compatible. Coalescence is not forced in the 1sg *do-e*. This indicates that the constraint responsible for the coalescence (74) must be ranked lower than any of the morphemic constraints involved.

(74) Align-Indic:
Align (Indicative, R; Person/Number, R)

When not all the morphemic constraints can be satisfied by the same vowel, Align-Indic is violated. The following tableau illustrates this. (The morphemic constraint for this allomorph of the indicative, schematically mid,front$]_{indic}$, has arbitrarily been placed below back$]_V$. The only crucial ranking is that it occur above Align-Indic.)

(75) $[\mathrm{do}]_{eat,1sg}[\mathrm{e}]_{indic}$ 'I eat'

	front$]_{3sg}$	back$_V$	mid,front$]_{indic}$	Align-Indic
☞ [do][e]				*
[d[o]]			*!	
[d[e]]		*!		

But when the relevant morphemic constraints can be satisfied by the same vowel, Align-Indic is strong enough to force coalescence:

(76) $[\mathrm{d}[[\mathrm{e}]_{3sg}]_{indic}]_{eat}$ 'he eats'

	Align-P/N	front$]_{3sg}$	back$_V$	mid,front$]_{indic}$	Align-Indic
[d[o]][e]		*!			*
[do][[e]$_{P/N}$]	*!				
[d[e]][e]			*		*!
☞ [d[[e]]]			*		

When identical vowel reduction occurs as a result of ablaut within what seems to be a single morph, this has been forced by anti-structure constraints. For example, the *hu*-classverb *bau*, the progressive auxiliary and independent verb 'be', which has the 1sg form [ba[u]][e], has the 2sg form $[b[a]_{2sg}][ne]_{indic}$ rather than the expected $[ba[a]_{2sg}[ne]_{indic}$. The morpheme for *bau* expects to find a consonant *b* followed by a low vowel followed by a high vowel, the last being the requirment we called HIGH$]_{hu}$ when dealing with *hu* and which we can assume is ranked at the same level as HIGH$]_{hu}$. As we have seen, ALIGN-P/N and LOW$]_2$can force a violation of HIGH$]_{hu}$. In a 2sg form, no candidate that survives to be checked by the morpheme *bau* is going to contain a stem final high vowel. *bau* is not going to find its required high vowel no matter what; this being so, there is nothing to be gained by having a second low vowel. Any number of anti-structure constraints (focusing on root nodes, moras, etc.) would rule out the unmotivated second vowel, but since we have already been working with *[+low], let us illustrate the competition using it:

(77)

	ALIGN-P/N	LOW$]_2$	HIGH$_{bau}$	*[+low]
[ba[a]]			*	**!
☞ [b[a]]			*	*
[bau][a]	*!			**
[ba[u]]		*!		*
[b[a]u]	*!			*

The morphemic constraint analysis we developed to explain vowel changes influenced by person/number agreement can be applied without difficulty to explain seemingly unrelated phonotactic phenomena like identical vowel reduction.

4 Some implications

It is time to consider some of the implications of the architecture I have been arguing for, an architecture where there are no underlying representations and no Gen. First, we should consider what does the work of Gen in the new architecture.

4.1 Gen

First of all, much of the work done by Gen simply does not need to be done. One of the two main functions of Gen is to translate underlying representations into candidate sets, since Eval can only work with the latter. It is the implicit commitment to the morphemes-as-representations or Item-and-Arrangement approach to morphology that leads linguists to assume that the starting point for any derivation must be an underlying representation. In fact, the only starting point forced on us by the harmonic application of constraints is the candidate set. The main work of Gen is to be a bridge between the starting point forced on us by our tacit assumptions and the starting point forced on us by the mechanisms of constraint interaction. If we change our assumptions, we do away with the need for a bridge.

I argue that the logical starting point of any "derivation" is the infinite set of all conceivable representations. Eval selects the most optimal member(s) of this universal candidate set to be paired with any given morphosyntactic structure. It is irrelevant where this universal candidate set comes from. As emphasized frequently in the OT literature, most notably in Prince and Smolensky (1993), the job of a grammar is simply to identify the structures of a language, not to build them. The position argued for here simply removes one of the last constructivist assumptions from OT.

The second major purpose of Gen in standard OT is to ensure that all members of the candidate set are in fact legitimate phonological representations. We would not, for example, want one of our fragile coda conditions to come face to face with a "representation" like:

(78)
$$\begin{array}{c} \text{COR} \\ | \\ \sigma \\ | \\ [+\text{cont}] \\ | \\ \mu \end{array}$$

Traditional OT spares its constraints such a traumatic experience by assuming that Gen would never produce a monstrosity like (78) in the first place. We are reassured that Gen will build, somehow, only legal syllable structures, feature hierarchies, etc.

I find such a move somewhat disturbing. Many of the most important insights in phonology during the past decade have come from attempts to replace constructivist accounts of universals by constraint-based accounts, for example, Itô's (1986) theory of syllable structure as the result of templates instead of Steriade's (1982) or Levin's (1985) theory of syllable structure as the result of extrinsically ordered rules that build only the right kinds of syllables. The tendency within OT to sweep all noticed universals into Gen with the vague promise that somehow Gen will contrive to build only candidates that conform to the universals may in fact be a step backwards for phonological theory.

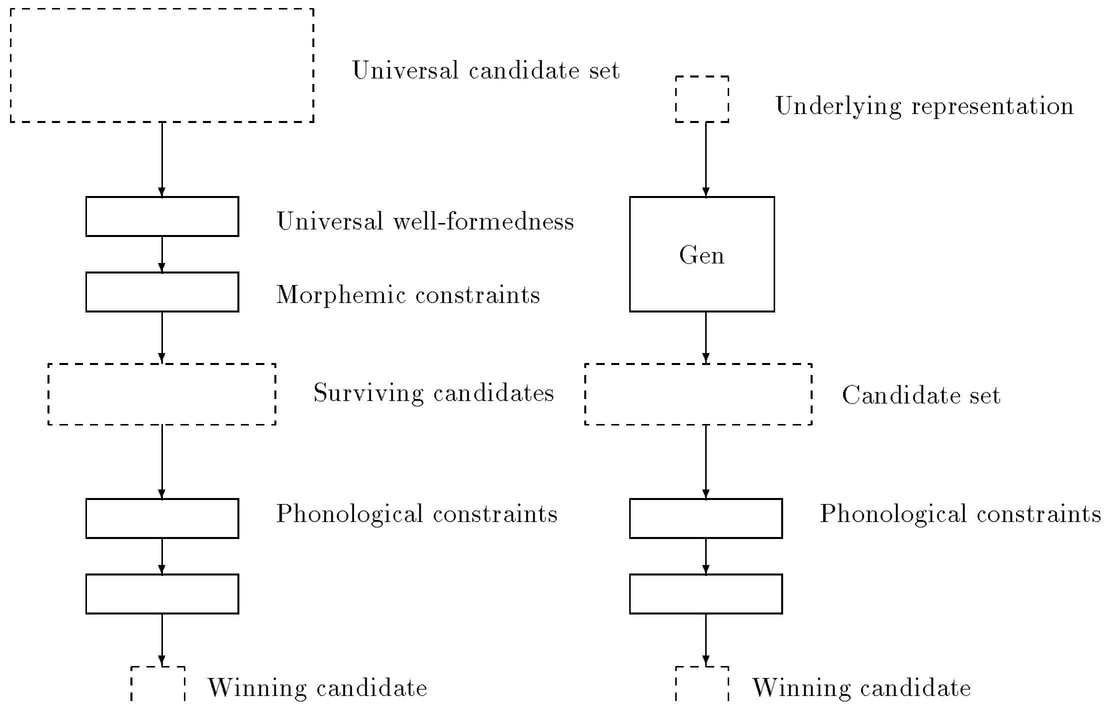
An OT framework without Gen captures these universals directly, with constraints. There is a universal group of constraints, undominated in any language, that determines what it means to be a syllable, what it means to be a place node, and so on. While representations like (78) may indeed be in the candidate set of all conceivable representations, the universal well-formedness constraints will immediately throw them out of the competition before any other rankable constraints have a chance to see them.

It is interesting that the Gen model does come quite close to simulating the usual operation of the model argued for here. It is a strong tendency across languages for the morphemic constraints that deal with segmental content, e.g., (38) above, to occur in a single block high in the hierarchy, usually very soon after the universally undominated constraints.[18] This means that the highest part of the hierarchy will often simulate the operation purported for

[18]This claim will be weakened somewhat in the discussion in section 4.3 of the difference between exceptional and regular vocabulary items.

Gen, that is, the output of the first two blocks of constraints will often be indistinguishable from the candidate set that Gen is argued to produce. We can compare the two approaches in the following diagram, which ignores the extra processes of the Gen model discussed in section overview:

(79)



Suppose the two models are attempting to find the most harmonic phonological representation for the semantic and syntactic information associated with 'dog'. In model (a), after the universal well-formedness constraints have thrown out representations like (78) and the morphemic constraints have thrown out representations like [kæt] and [təmeitou], we will be left with a number of surviving candidates, all bearing a certain resemblance to [dɑg]. This will usually be the same set of candidates that we are assured Gen will produce in model (b) when given the underlying representation /dɑg/.

Besides the greater theoretical simplicity and transparency of (79a), there are empirical differences between the two. The occurrence of morphemic constraints in a block in (79a) is simply a strong tendency; the model makes the prediction that it should be possible for a language to rank some of its segmental morphemic constraints lower than its alignment or other phonological constraints. We saw an example of this in Hua, where the segmental constraints of the verb stem and the suffixes were ranked lower than the alignment constraint that forced them to be apply to the same vowel.

We can see how a framework which relies on morphemic constraints rather than Gen nonetheless preserves the effects of McCarthy and Prince's three principles of Gen operation, given in (7). Freedom of Analysis is given for free: all possible variations of a candidate exist in the universal candidate set; there is no need for Gen to build them. The effects of

Containment, insofar as it works, are also obtained: a candidate that disobeys one of the segmental content requirements imposed by a morpheme, say [kæ] trying to pose as 'cat', will most probably be thrown out by that constraint before anything else of interest can happen to it; there is no need for Gen to refrain from building that candidate. Consistency of Exponence becomes somewhat irrelevant. While there are still morphological boundaries, there is no longer any need for pieces of a representation that fall between those boundaries to be marked as belonging, or failing to belong, to some morpheme or other. Pieces of a representation do not inherently belong to some morpheme; at most, they are the object of interest from a morphemic constraint. Since the closest thing to "morphological affiliation" in the current framework is being the object of interest from a morpheme, the correlate of Consistency of Exponence follows trivially: if a morphemic constraint is not interested in the segmental content of an epenthetic segment when it is not there, it will be no more interested in its content when it is there.

4.2 Faithfulness constraints

One point in favour of underlying representations and the resulting architecture in (4) would be if the URs did their job of inciting Gen to build a candidate set and then, as suggested by the flowchart, gracefully dropped out of the picture. But researchers in OT have often found it necessary to bring the UR back at certain points of the constraint hierarchy in order to compare it explicitly with the candidates. This strongly suggests that the phonological information inherent in morphemes cannot be reified into a representation that plays a role at one point in a derivation, rather that phonological information can be relevant at several rankable points throughout the constraint hierarchy. This is the situation predicted by the morphemic constraint hypothesis; accounting for the situation under the UR hypothesis requires a number of (of ad hoc) constraints with global power.

Most of these constraints are usually lumped together under the rubric of "faithfulness constraints". (See Itô, Mester, and Padgett (to appear) for a preliminary typology of faithfulness constraints.) Many of the constraints that go by the term "faithfulness" can operate in a purely local manner by examining only the candidate at hand: PARSE need only look for stray nodes that are not integrated into any higher structure; FILL, under most interpretations, need only look for root nodes that dominate no features. But other proposed faithfulness constraints need to actively compare a candidate with the UR that gave rise to it, for example:

(80)	*SPEC:	Underlying material must be absent. (Prince and Smolensky 1993:196)
	MSEG:	Every segment belongs to a morpheme. (McCarthy 1993b)
	INSERT-μ:	(Inkelas 1994)

Morphemic constraints make many of these proposed faithfulness constraints superfluous. Consider constraints such as MSEG or those of the *INSERT-X schema, designed to assess violation marks against pieces of a representation that were not present in UR. This work can be done by very generic anti-structure constraints—we don't need to ban occurrences of [+cont] that weren't present in UR, we can simply ban all occurrences of [+cont]. If a morphemic constraint requires the presence of [+cont] and if this constraint outranks the general anti-structure constraint *[+CONT], all candidates that survive till the part of the hierarchy where *[+CONT] applies will have instances of [+cont] and nothing *[+CONT] has to say about the matter will get rid of them. *[+CONT] will make a difference only to those forms where morphemes do not require a [+cont] and some of the surviving candidates have none. So an anti-structure constraint ranked below a morphemic constraint has the same effect as a faithfulness constraint like *INSERT[+cont] that must globally compare a candidate with a UR. We saw examples of this above, in the explanation of why Nisgha *limx-t* does not appear as *limx-s*, and in the explanation of why Hua *de* does not appear as *di*.

Even the PARSE family will probably prove expendible. Nothing in the ideas I have been arguing for militates against a situation where morphemic constraints require the presence of a node but the node remains unparsed except under the influence of PARSE. But it seems reasonable to try to push the ideas to their logical conclusion and simplify this two-step concept of how morphologically required phonological content is realized. If a morphemic constraint requires the presence of a *parsed* node, we can still obtain the phonetic effects of underparsing.

Consider a hypothetical example where a morpheme requires the presence of the string [mult], and that the final [t] appears when there is a vowel-initial suffix. But when the morph occur alone in a word it is realized as [mul]. This could plausibly be the result of a constraint like *COMPLEXCODA, and a fairly high-ranking FILL to rule out candidates that try to use resolve the problem using epenthesis. One possible analysis is that the winning candidate in fact contains an unparsed *t* which is not phonetically interpreted, i.e., both the morphemic constraint (let us schematically abbreviate it as $m \prec u \prec l \prec t$) and *COMPLEXCODA outrank PARSE. A simpler analysis is that there is no *t*, parsed or otherwise, in the winning candidate. *COMPLEXCODA does not outrank PARSE, it outranks the morphemic constraint itself:

(81)

	COMPLEXCODA	$m \prec u \prec l \prec t$
mult	*!	
☞ mul		*
mu		**!

4.3 Grammar multiplication

One of the ways available to standard OT for handling lexical exceptions is morpheme-specific constraint reranking. The general grammar of a language may rank constraint A over constraint B, but there may be a subset of lexical items which idiosyncratically select a grammar that ranks B over A. In (4), I diagrammed this situation by having a number of parallel constraint hierarchies inside Eval and a gatekeeper at the entrance of Eval which scans the input for idiosyncratic morphemes and selects which hierarchy to submit the candidate set to.

The possibility of multiple grammars has troubled some researchers. Inkelas (1994) notes that grammar multiplication makes underlying representations redundant. There are other important problems. Morphemes don't always go into Eval alone, they are usually combined with at least one other morpheme. What would happen if one of the morphemes in the input lexically required the order A over B while another morpheme lexically required the order B over A? Is there a meta-hierarchy that selects which morpheme's hierarchy is used?

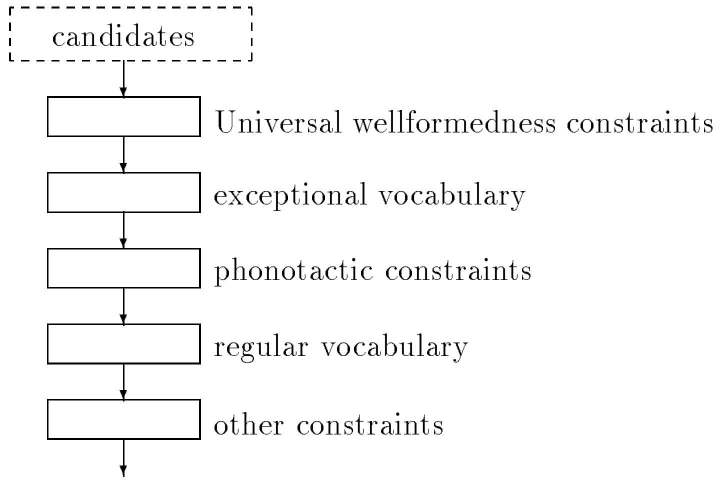
But it is not obvious that multiple grammars will still be needed in a morphemic constraints framework. Even in standard OT, the kinds of parallel grammars we actually find used in analyses are a small subset of the set of conceivable grammars. In other words, the full power of grammar multiplication is seldom needed, rather the device is used for very specific ends. One of the most common of these purposes is to exempt some vocabulary items from the usual phonotactics of the language.

For example, Kirchner (1993) proposes that unregularized loanwords involve a reversal in the rankings of the constraint PARSE[front] and the alignment constraints requiring that every feature be aligned with both the leftmost and the rightmost syllable of a word, i.e., the constraints that encourage spreading. In normal circumstances, the alignment constraints outrank PARSE[front]. The vowel sequence [u...a] is preferred over [ü...a] because this ranking would rather leave the feature [front] unparsed than parse it in such a way that it is not aligned with the rightmost syllable of the word. But unregularized loadwords, such as *nüfus* 'population' (which alternates with regularized *nufus*), must lexically specify a parallel constraint hierarchy where PARSE[front] outranks the alignment constraints.

This move is more or less necessary for Kirchner. Standard OT has no way of directly expressing the idea that unregularized loanwords are more fussy about having their features realized than native words are. The relatively blunt instruments at its disposal, such as PARSE, apply with equal force in all candidates, whether loanword or native, and the only way to weaken or strengthen their force is to set up a parallel constraint hierarchy where they are ranked lower or higher.

This problem does not exist in a morphemic constraints framework. Causing features to be realized in a candidate is not the responsibility of PARSE but of the morphemic constraints themselves. In the Turkish example, the morphemic constraints requiring the presence of [front] in exceptional words such as *nüfus* outrank the constraints responsible for spreading, which in turn outrank the morphemic constraints responsible for the presence of [front] in the regular words of the Turkish vocabulary—all within a single hierarchy. The general situation where exceptional morphemes are more highly ranked than regular morphemes can be diagrammed as:

(82)



It is not necessary to have multiple grammars in order to handle this kind of lexical exceptionality. It is quite possible that similar strategies can eliminate the need for using multiple grammars to handle any of the kinds of exceptionality they have been used for in the OT literature.

Further research is necessary to see if all cases can be eliminated. For example, Cohn and McCarthy (1994) argue for parallel grammars in Indonesian which differ in the position of the constraint MParse. It is possible that this could be handled by making MParse a schema that can take morphosyntactic features as a parameter. Instances of the MParse schema referring to very specific morphosyntactic features such as the indices of individual morphemes, e.g., MParse('print'), may be ranked higher than instances referring to more general features, e.g., MParse(verb) or MParse(stem).

More narrowly specifying the arguments of a schema might also work for the case of reranking proposed by McCarthy and Prince (1993b) for Ulwa possessive infixation, where the following two constraints change position:

(83)	a.	Align-To-Foot	Align ([poss]$_{Af}$, L; Ft', R)
	b.	Align-In-Stem	Align ([poss]$_{Af}$, R; Stem, R)

In regular vocabulary, Align-To-Foot outranks Align-In-Stem. This causes, for example, the possessive *ka* to be suffixed to the head foot of the stem *siwanak*, giving *siwa**ka**nak* rather than *siwanak**ka***. But in exceptional words, the ranking is reversed, resulting in *gobament***ka** rather than *goba**ka**ment*. Again, it might be possible to more fully specify the Align schema in (83b) to refer to individual morphemes as well as to the entire stem category. Align ([poss]$_{Af}$, R; 'government', R) could be more highly ranked than Align-To-Foot, which would continue to be more highly ranked than the generic Align ([poss]$_{Af}$, R; Stem, R).

This is not without problems. The more specific constraint would have the effect of requiring *every* instance of a possessive morpheme to come attached to an instance of 'government' and would assess violation marks to every candidate that neglected to do so, regardless of whether the candidate was trying to express the notion of 'government' or the notion of 'cat'. In order for this reanalysis to work, we would need a more fully developed theory of the morphosyntax/phonology interface which could guarantee that these violation marks would have no effect on the harmonic evaluation of the candidates and would not, for example, select candidates for 'my cat' that contained spurious instances of the 'government' morpheme. Until such an interface theory is developed, this particular reanalysis and probably the hypothesis that multiple grammars are unnecessary must remain tentative. But it is intriguing that trying to force exceptional and regular constraints onto the same hierarchy results in a Pāṇinian picture that has become familiar throughout OT, the ranking of special cases higher than general cases.

5 Conclusion

In this paper we have looked at the architecture of the standard Optimality Theory model and seen both that it is more complex than is usually suggested in the OT literature and that most of the extra complications arise from OT having adopted an Item-and-Arrangement approach to morphology. We then looked at two cases which were problemative for the assumption that the phonological information of morphemes is encoded in discrete underlying representations. Nisgha coronal coalescence and Hua verb ablaut both involve pieces of a representation that seem to belong to more than one morpheme at the same time. In a framework where the phonological information of constraints is encoded in constraints, these are simply cases where the same piece of a representation is satisfying (or sometimes in Hua failing to satisfy) more than one morphemic constraint. In both languages, the realization of the morphemes in the same segment resulted from an alignment constraint that lined up the edges of the stem and particular suffixes, Align (Suffix$_i$, R; Stem, R). Further evidence that morphemes are best encoded by constraints comes from their interaction with this alignment constraint: in Nisgha the morphemic constraints outrank the alignment constraint; in Hua the alignment constraint outranks the morphemic constraints.

For the purposes of encoding the phonological information inherent in morphemes, underlying representations are neither necessary nor sufficient, while morphemic constraints (including those of the Generalized Alignment family) are both necessary and sufficient. On purely conceptual grounds, therefore, we should prefer the framework that uses only constraints, especially if this will allow us to avoid many of the problematic mechanisms of standard OT, e.g., Gen, faithfulness constraints, and possibly multiple grammars. One of the main purposes of this paper has been to try to show that such a framework might be empirically superior as well.

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