MOT: Sketch of an OT approach to morphology
DRAFT

Kevin Russell
krussll@cc.umanitoba.ca

July 24, 1999

Contents

Chapter 1

Introduction

This sketch presents a version of Optimality Theory (MOT) which can be used to analyze cases where generalizations crucially depend on the relations between more than one kind of linguistic representation. Most of the sketch will be devoted to illustrating how problem cases in the theory of morphology can be handled using constraints on the interface between phonology and syntax. Such a framework allows a synthesis of the strengths of both word-syntax and realizational approaches to morphology.

Some of the features of the current proposal include:

- An OT grammar evaluates all sub-representations (e.g., phonology, syntax, semantics) in parallel. There is no serial derivation between modules such that, for example, syntax is the "input" to morphology or phonology.
- An OT grammar can impose interface constraints on which phonological, syntactic, and semantic representations can co-occur with each other.
- The information of "lexical entries" is nothing more than specialized versions of such interface constraints.
- There is no need for the "lexicon" to contain pieces of representation, such as partial syntactic nodes or phonological underlying representation.

1.1 Parallel representations

The job of a grammar/lexicon within MOT is to judge complete linguistic representations for whether or not they are legal structures of the language. I will assume that a complete representation consists of at least three sub-representationas, one each for phonological, syntactic, and semantic information.

(1) $\langle$ Ph, Sy, Se $\rangle$

1.1.1 The assembly-line model

The most common assumption within formal linguistics has been that the relationship between sub-representations is serial and derivational. Figure 1.1 shows one typical view of the architecture of a linguistic theory. Non-linguistic content like an idea is taken as “input” and transformed, by a series of steps, into a different non-linguistic content like a sound wave. In between are a series of black boxes, or “modules”, which cannot communicate with each other except by passing a representation in a single direction. Each module takes an input representation and creates an output representation, which serves as the input representation to the next module in the assembly line.

⟶ Semantics ⟶ Syntax ⟶ Morphology ⟶ Phonology ⟶ Phonetics ⟶

Figure 1.1: An assembly line view of grammar

Most work in OT seems to have implicitly adopted this assembly-line view of the overall architecture of language. While individual modules (specifically phonology and syntax) are argued to function non-derivationally, the relationship between modules is usually assumed to be linear and directional. Each module has an input and an optimal output — the inputs come from somewhere, and the outputs go somewhere for further processing.

1.1.2 Parallel evaluation of sub-representations

MOT rejects the assembly-line view of how sub-representations are related to each other. It takes seriously the claim that the job of a grammar is not to construct a representation to order (or even to choose a representation based on some input), but simply to look at a complete linguistic representation and judge whether it is a legal or illegal representation of the language.

In MOT, a complete representation ⟨Ph,Sy,Se⟩ is a legal representation of the language if and only if each of its sub-representations is optimal in an evaluation that holds the others constant. Consider the following schematic representation of a single-word utterance of English, *cats.*

(2) ⟨ [k^hæts], [N^0,plural], { , , ,...} ⟩

This representation is legal in English because each of its sub-representations is optimal, given the other two. It is the most optimal of an infinite number of candidates that are identical to (2) except possibly in having a different Ph:

(3) ⟨ [k^hæts], [N^0,plural], { , , ,...} ⟩
⟨ [kæts], [N^0,plural], { , , ,...} ⟩
⟨ [k^hætz], [N^0,plural], { , , ,...} ⟩
⟨ [dɑgz], [N^0,plural], { , , ,...} ⟩
⋮

It is the most optimal of an infinite number of candidates that are identical to it except in possibly having a different Sy:

(4)
⟨ [kʰæts], [N^0,plural], {🐈,🐈,🐈,...} ⟩
⟨ [kʰæts], [N^0,singular], {🐈,🐈,🐈,...} ⟩
⟨ [kʰæts], [V^0,plural], {🐈,🐈,🐈,...} ⟩
⟨ [kʰæts], [Prep^0,past], {🐈,🐈,🐈,...} ⟩
⋮

It is the most optimal of an infinite number of candidates that are identical to it except in possibly having a different Se:

(5)
⟨ [kʰæts], [N^0,plural], {🐈,🐈,🐈,...} ⟩
⟨ [kʰæts], [N^0,plural], 🐈 ⟩
⟨ [kʰæts], [N^0,plural], {🐕,🐕,🐕,...} ⟩
⋮

It is possible, and sometimes helpful, to think of each of these evaluations as having the other two sub-representations as "inputs". Even so, the MOT approach is not directional. Sy could conceivably be seen as an input in the calculation of Ph, but Ph can also be seen as an input in the calculation of Sy.[1]

1.1.3 Lexical entries as interface constraints

In judging a representation like (2) to be grammatical or ungrammatical, the grammar does not only need to make sure that each of the individual sub-representations, Ph, Sy, and Se, are as well-formed as possible, it needs to make sure that those particular sub-representations "belong" with each other. While [kʰæt] may be a well-formed Ph and 🐕 may be a well-formed Se, the result of putting them together into ⟨ [kʰæt], [N^0, sing], 🐕 ⟩ is not well-formed. We need some way of ruling this out.

There will clearly need to be interface constraints to make sure that the sub-representations in a linguistic representation can co-occur with each other. One of the most fully studied kinds of constraints on the Ph/Sy interface are the principles that determine where prosodic phrase boundaries should go in Ph, based on various aspects of the Sy (cf. Selkirk (1995), Nespor and Vogel (1986), Truckenbrodt (1999)). Many long-recognized soft universals are probably also interface constraints that may be outranked: "An X^0 in Sy corresponds to a prosodic word in Ph", "An object in Se corresponds to a nominal in Sy," and so on.

One of the claims of MOT is that the information that has traditionally been seen as "inside" a lexical entry is really just another kind of interface constraint. Lexical entries are essentially constraints one which pieces of one sub-representation can be associated with which pieces of another sub-representation. For example, if a terminal node in Sy corresponds to a piece of Se that represents a feline entity, then that Sy node had better be an N^0

[1] pace Pullum and Zwicky's phonology-free syntax

and bear the feature [+count]. Further, if a piece of Ph is associated with that Sy node (and there had better be one), then that Ph piece had better contain three root nodes, the first of which dominates the features for [k], and so forth.

This view contrasts with the traditional approach to the lexicon, where a lexical entry actually *contains* small pieces of Ph, Sy, and Se representations. In Generative Phonology, the phonological information of a lexical entry is stored somewhere in an Underlying Representation (UR), /kæt/, which is supposed to be qualitatively the same kind of thing as the Ph representation that is computed on-line when planning an utterance. While one could imagine an MOT approach to the Ph/Sy interface that uses a warehouse of URs, an MOT approach can also do all the same work using those kinds of constraints which will be needed anyway whether we assume URs or not. This sketch will explore the kinds of MOT approaches where there is no lexicon containing pieces of representation.[2] Since, unlike standard OT, we will not be using URs, we will also not need many of the additional mechanisms that standard OT uses to cope with URs, such as Correspondence Theory,[3] lexicon optimization, or morpheme-specific constraint re-ranking.

1.1.4 The Grammar/Lexicon

Since lexical information will be expressed using the same formal stuff (constraints) as more general principles that presumably come from Universal Grammar (UG), we might ask whether lexical constraints are brought to bear on candidate representations in the same way as well. I argue that this is the case, that both "grammatical" and "lexical" constraints exist in a single constraint hierarchy and are brought to bear on candidate representations in a single evaluation, that otherwise operates much as it does in standard OT. Because of the dificulty in drawing any firm dividing line between purely "lexical" constraints and wider constraints of the grammar, I will often refer to the **grammar/lexicon** of a language, treating it as a single formal system.

There are two senses in which "grammatical" and "lexical" constraints are inextricable. First, even if there were a way of telling them apart, they are interleaved together in the OT constraint hierarchy of the language, with no noticeable difference in their manners of application. But there is no clear-cut way of telling them apart. Lexical constraints can usually be viewed simply as very specific grammatical constraints, or to paraphrase an insight of many construction-based approaches to linguistics, grammatical constraints can be seen as very general lexical constraints. There is no difference in form or mechanism between the

[2] As we proceed, it will become clearer what some of the consequences are of treating the content of morphemes as interface constraints rather than as pieces of representation. To some extent, the ideas are notational variants. One of the differences is that, if we treat lexical information as constraints, there is no a priori reason why that information should be representationally coherent, e.g., there is no reason to expect that we should be able to condense all the phonological information of a lexical entry and encapsulate it within a single well-formed Ph representation. Instead, lexical constraints on the phonology might demand contradictory properties (only one of which could be satisfied in a particular environment), might completely underspecify linear order, and so on.

[3] Some version of Correspondence Theory might still be needed to deal with reduplication or with cases of paradigm faithfulness, if such really exist, but this is an open question.

general constraint of XXX requiring all nouns to have the prosodic form of a trochee and the lexically idiosyncratic constraint of Moroccan Arabic requirng the singular noun ‘girl’ to have the prosodic form of a trochee (where the more general constraints of the language would ordinarily result in it being an iamb, cf. Russell 1999). The two constraints simply have different ranges of applicability. The XXX constraint is at work in every utterance containing a N^0 node; the Moroccan Arabic constraint applies non-vacuously only to those representations that contain the noun ‘girl’.

There are no good criteria for splitting these two constraints into two water-tight categories. (If two nouns of a language behaved the same idiosyncratic way, is it still a lexical constraint, or a grammatical constraint sensitive to a class? If ten do? A hundred?) Any attempt to do so would run into the “mini-modularity” problems that I inveigh against in section 1.3.3. In this sketch, I will not attempt to do so.

(Similar problems exist in trying to draw firm distinctions between word-sized lexical items and idioms that are necessarily lexically listed, and between idioms and constructions.)

1.2 Overview and plan

1.2.1 Structure of a chapter

Chapters will typically follow the same general outline.

The first section, “What we still need,” will be a quick overview of a question that the theory still needs to address and a piece of formalism or some other idea that can help address that question. The “Implementation” section will work out the formal details of the idea, together with any additional assumptions that are needed, so that it can be used in an MOT framework. This will usually be followed one or more short examples of the formalized idea applied to a small problems.

The “Elaboration” section will explore the ideas of the chapter and some of their implications in more detail. Some of the typical subsections will be:

1. “Connections”, where I discuss the similarities and differences of the implementation just discussed compared with other proposals in the literature. Rather than constantly sprinkling the rest of the text with long lists of citations and historical digressions, I have generally tried to keep references to other work in this section, even when I have adopted that work wholesale. This is merely an attempt to improve the readability of the text, not to minimize the intellectual debt I owe to the work of others.

2. “What’s MOT and what’s not” — As I go along, I generally try to make it clear which claims are central to MOT as a research program and which are simply assumptions adopted to allow concrete analyses. This section re-emphasizes the distinction, trying to point out the variety of ways in which an MOT theory could be fleshed out.

3. “Tangential defences” — I have made many choices in this sketch which are not central to an MOT research program, but which I believe in more strongly than if they were

mere working assumptions. For some of these, I will offer arguments in the "Tangential defences" section that, even if an MOT-based theory could choose differently, such a theory would be less explanatory.

1.2.2 Overview of chapters

Chapter 2 offers a brief review of Optimality Theory and the mechanics of constraint evaluation.

In order to give concrete analyses, some assumptions have to be made about what syntactic and phonological representations look like, assumptions which are not necessary features of an MOT framework. Chapter 3 outlines some of the specific assumptions that I will be using in this sketch. In phonology, I assume the standard ideas of feature geometry and the prosodic hierarchy. In syntax, the representations are roughly of the kind used in the Principles and Parameters framework (of the late pre-Minimalism era). I use a single Sy sub-representation for both "morphological" (sub-X^0) and "syntactic" (X^0 and above) levels.

In chapter 4, I introduce the idea of a morphemic index, a feature that can be borne by a Sy node to uniquely identify which "morpheme" it represents. Many constraints on the Ph/Sy and Sy/Se interfaces will be sensitive to the presence and identities of these indices. I distinguish between **lexemic** and **functional** morphemic indices, which roughly reflects the traditional distinction between lexical categories (or open-class items or "content" words) on the one hand and functional categories (or closed-class items or "function" words) on the other. Chapter 5 looks at some of the kinds of constraints that apply purely within Sy that are sensitive to the presence of individual lexemic indices. (Intuitively, such constraints encode the syntactic properties of a lexical item.) Chapter 6 looks at the kinds of constraints on Sy that are sensitive to individual functional indices. Chapter 6 also discusses how the framework developed so far offers an interesting compromise between "realizational" or "Item-and-Process" approaches to morphology and "word syntax" or "Item-and-Arrangement" approaches, maintaining the strengths of both.

Chapter 7 deals with the primitive relation between Sy nodes and sequences in Ph that allows them to be associated with or correspond to each other. I refer to this as the **spell-out** relation. Much of the information of a lexical entry is essentially constraints on the possible spell-out relationships. In chapter 8 I discuss some mechanisms by which such constraints can work, for example, how the grammar/lexicon can require that the spell-out of the Sy node with the lexemic index 'cat' should contain a [k]. Chapter 9 looks at how the grammar/lexicon can place requirements on *where* in Ph the spell-outs of different Sy nodes occur, using the Generalized Alignment constraint schema of OT (McCarthy and Prince, 1993a).

The next three chapters explore three configurations where the same stretch of a Ph sub-representation "contains" two or more "morphemes", that is, where the same root nodes are subject to two or more sets of morphemic interface constraints. Chapter 10 looks at those cases where the two morphemic indices involved are in two different Sy nodes which, through the vagaries of OT alignment constraints, are spelled out in the same stretch of Ph. Chapter 11 looks at those cases where a lexemic and a functional index on the same Sy node may impose conflicting requirements on that node's spell-out. Finally, chatper 12 deals with cases where one index's node is the mother of the other's, for example, where the N^0 node of the derived noun *electricity* dominates the A^0 node of its base *electric*.

1.3 Miscellaneous issues

1.3.1 Connections

The main ideas of this sketch are hardly original.

Many different strands of linguistic theorizing have converged on the view of linguistic structure as several sub-representations that co-exist in parallel and the grammar and lexicon as the way of constraining or licensing that co-existence.

Unificiation-based theories of syntax have been based on this idea. From the beginning, Lexical Functional Grammar (e.g., Bresnan, 1982) has been concerned with the relationship between the independent levels of constituent-structure (or phrase structure) and functional structure. Some more recent LFG work has proposed additional possible levels, such as morphological structure or argument structure. Head-driven Phrase Structure Grammar (Pollard and Sag, 1994) is concerned with properly coordinating parallel representations in syntax, semantics, and phonology (though they use a slightly different division than the tripartite ⟨Ph, Sy, Se⟩ assumed here). Much of the work in Declarative Phonology (e.g., Bird, 1990; Scobbie, 1991) assumes the same kind of parallel representation and explores how the phonological sub-representation could best be integrated into a unification-based grammar.

Another strand of theory using the same idea is Autolexical Grammar (Sadock, 1991).

One of the most extended and deliberate arguments for parallel representations and against a derivational relationship between them is Jackendoff (1997). Indeed, most of the present sketch could be seen as an attempt to implement within OT the same research program being pursued by Jackendoff (1997).

There are also antecedents for the idea that the content of morphemes is encoded in constraints rather than representations. It has been explored in some detail in Declarative Phonology (e.g., Scobbie, 1991; Russell, 1993; Walther, 1995, 1997). Within OT, it has been argued for by Hammond (1995) and Russell (1995) and applied, in a limited form, in work such as **?**) and **?**). A related idea, with a slightly different implementation, is explored in Golston (1996).

1.3.2 What does "MOT" mean?

The letters "MOT" stand for absolutely nothing.

Several people have told me that any new proposal needs a flashy acronym in order to be accepted. I resisted this advice for a long time, swore I would never succumb to such a barbarism, and began writing this sketch with a pure heart. As I wrote, however, I found myself using circumlocutions such as "the general sort of framework outlined in this sketch" and "the kind of proposal I am arguing for here" so often that I despaired of ever fitting the less and less sketch-like sketch into under a thousand pages. Reluctantly, I admitted defeat.

Though I have been forced to resort to an acronym to refer to "the general sort of framework that I am arguing for here", I refuse to have that acronym stand for something. The proposal is some kind of version of Optimality Theory, so the letters "OT" make sense. The proposal relies crucially on Multiple representations, and its main use in this sketch is to explore problems in the theory of Morphology, so "M" is as good a choice as any for a third letter. But I still deny that "MOT" actually means anything.

(As a special accommodation for those readers who simply can't cope with an abbreviation that doesn't abbreviate anything, you may, if you insist, choose to believe that MOT is named in honour of the annual Montreal-Ottawa-Toronto phonology workshop.)

1.3.3 Against small-scale modularity

There is one philosophical stand which informs many of the individual choices made in this sketch, though it is not logically related to the general MOT framework: I believe that it is usually inappropriate to use formal categories or devices such as modules to explain statistical correlations between phenomena, especially when the modules divide things which are substantially the "same".

To illustrate what I mean, consider the much-debated distinction between inflectional and derivational morphology. Both deal with the "same" material, the internal structure of words, but tend to do so in slightly different ways. Inflectional morphology, such as *heal* → past tense *healed*, typically has a number of properties:

1. Inflectional morphology tends to be productive. (You can add the past tense morpheme onto practically any verb of English.)

2. It tends to be phonologically transparent. (The base *heal* undergoes very few phonological changes in the past tense.)

3. It tends to be compositional, or semantically transparent. (If you know the meaning of *heal* and the meaning of the past tense, you automatically know the meaning of *healed*.)

4. Inflectional morphemes tends to occur in an outer position, specifically, further away from the root than any derivational morphemes.

5. It is sometimes argued that inflectional morphology never changes the category given by the base. (*heal* is a verb, *healed* is still a verb.)

The opposite tendencies are found in derivational morphology, such as verb *heal* → noun *health*: it tends to be unproductive (you can't add *-th* onto any verb you feel like), phonologically opaque (the base *heal* undergoes phonological changes), and non-compositional or semantically opaque; it can change the category of the word; derivational morphemes tend to occur closer to the root than inflectional morphemes.

So we have a number of logically independent properties — compositionality, productivity, phonological transparency, position in the word, ability to change category — which have a strong statistical tendency to occur together. The standard response of formal linguistics theory to such a correlation is to posit modules. There would be an inflectional morphology module, set up in such a way that its results are necessarily compositional, productive, and so forth. And there would be a derivational morphology module, set up in such a way that its results are unproductive, non-compositional, phonologically opaque, category-changing, and close to the root.

Some problems immediately arise for this simplistic description of inflection and derivation. First, it is not true that derivational morphology necessarily has the attributes we just attributed to it. Derivational morphology *can* be productive, compositional, and phonologically transparent — the *-ness* of, for example, *healthiness* can be added to practically any adjective, gives a predictable meaning, and doesn't change the phonology of the base. Derivational morphology *need* not change category (e.g., adjective *good* $\rightarrow$ adjective *goodly*). So our two modules don't have a complementary set of abilities. Instead, the derivational module has all the abilities of the inflectional module, which seems to have a proper subset of derivational abilities. But even this generalization is too strong. Inflectional morphology *can* be phonologically opaque (e.g., *feel*$\rightarrow$*felt*). It can be less than fully productive (there can be odd gaps in paradigms). It can be less than completely compositional. Possibly, it can even change the category of the word.[4]

There are two general responses to these problems that can be made by formalists who are committed to a modular analysis: adding escape hatches to the modules and narrowing the explanatory scope of the modular analysis. Neither is very attractive.

We might weaken the modular analysis by adding special escape hatches that will allow the observed but rare combinations of properties. In actual analyses, these escape hatches have tended to be dangerously vaguely defined. But even if escape hatches could be rigorously defined, using them vitiates the entire purpose of a modular analysis. We are interested in explaining why properties A and B go together so often. By dividing work between two modules, we can get a straightforward (if empirically inadequate) implementation that will allow only the logical possibilities A&B and ∼A&∼B. If formal escape hatches also allow the possibilities A&∼B and ∼A&B, we are exactly back where we started.

An account using no modules and freely allowing all four possible combinations is an incomplete explanation. We would like some explanation why so few As are not-Bs, and this explanation will likely have to be functionalist rather than formal. But modularity with escape hatches merely postpones the explanation. If there is an escape hatch that allows As to be not-Bs, we need an explanation why so few As avail themselves of the escape hatch — in short, why so few As are not-Bs — and this explanation too will likely have to be functionalist. (Pseudo-functionalist non-explanations like "The escape hatch is expensive" can only satisfy us for so long.)

The second possible response is to narrow the range of properties whose correlation is to be explained by the segregation into modules. This is essentially the approach of the

[4] English *-ing* creates nouns and adjectives out of verbs. It seems to have all the other properties of inflection. The only excuse for not classifying it as inflection would be a stipulation that any category-changing is by definition derivation.

Lexical Phonology to English morphology, which tries to account only for the correlation between phonological transparency and an affix's position in the word. Some English affixes affect the stress or phonemic content of their base (such as *-ian* in *Darwinian*); some do not (such as *-ism* in *Darwinism*). Overwhelmingly, the phonologically opaque affixes tend to occur closer to the root than phonologically transparent affixes (so *Darwinianism* is a legal word, but **Darwinismian* is not). Lexical Phonology explains this with two modules (usually called strata or levels), the module which does opaque affixation applying before the module which does transparent affixation (and therfore adding its affixes closer to the root). There is a tendency for the results of the inner and opaque module to be non-compositional, unproductive, category-changing, and so on, and a tendency for the outer and transparent module to be composition, productive, category-preserving, and so on. But Lexical Phonology has relinquished any claim to account for these tendencies formally. The statistical correlation between several logically independent properties has been reduced to a formal relationship between just two of them.

But even this separation is too strong. It turns out that phonologically transparent affixation can occur closer to the root than phonologically opaque affixation. In *developmental*, for example, the stress-neutral *-ment* occurs inside the stress-shifting *-al*. One solution to this within Lexical Phonology has been the idea of the "loop" — an escape hatch which allows the opaque module to work after as well as before the transparent module. The escape hatch gives us the problems already discussed: instead of coming up with functionalist explanations why transparent suffixes are outside of opaque suffixes so often, we must come up with functionalist explanations why the loop is used so infrequently.

The escape hatch is more or less mandatory at this point. We can't narrow the scope of the account any further, since we have only two properties left. A modular separation that handles only one property is utterly useless. We might as well set up a module that handles words with [k] and a module that handles all other words, or a module that handles sentences about sleeping and a module that handles all other sentences.[5]

To sum up, in order for a modular account to be useful, it must account for a perfect correlation between two or more logically independent properties. If there is no correlation at all, a modular account is pointless. If the correlation is merely statistical, a modular account must eventually come up with exactly the same kinds of functional explanations for why the full power of the formal system is used in a lopsided way. It gets to slightly rephrase the question needing a functional explanation, but only at the cost of carrying a great deal more formal baggage (modules, interfaces between them, escape hatches) that must be defined and somehow constrained.

Unfortunately, natural languages offer very few correlations that are perfect enough to benefit from a modular analysis. We're going to have to come up with functionalist explanations for how exactly formal systems are used.[6] If we're going to need such functionalist explanations anyway, I believe the formal system itself might as well be as simple as possi-

[5]In fact, preserving a Lexical Phonology modular account could still be useful, since the single "property" I have been designating as phonological transparency is actually a practically perfect correlation between a few logically independent phonological properties, such as stress shifting, vowel changing, and geminate reduction.

[6]See Boersma (1998) for a good example of how this can be done in a rigorous way for phonology.

ble. This is the underlying reason for many of the specific choices I make in this work, for example, the choice in chapter 3 that it is not worth having a module to deal with a "morphological word" as distinct from phonological words and syntactic words. This general stand and the specific choices that flow from it are not necessary parts of the MOT framework. It would indeed be possible to have a much higher degree of small-scale modularization and still maintain the basic guiding principles of MOT — indeed, OT in general and MOT in particular probably offer the most convenient mechanisms for formalizing and implementing the necessary escape hatches in a rigorous way. But I believe the less modular version presented in this work is considerably simpler than the alternatives — and that makes it better at least for the purposes of presenting a new approach, if not for the purposes of accurately modelling the human language faculty.

None of this argues against linguistic modules on a larger scale. There are good reasons for treating phonology and syntax as different modules, because they deal with qualitatively different kinds of formal stuff. (Inflectional and derivational morphology, on the other hand, deal with the same kind of formal stuff, just in ways that are quantitatively different.) Nevertheless, while accepting Ph, Sy, and Se as different levels of representation, I do not wish to place *a priori* restrictions on what kinds of interface constraints can hold between them.

The experience of linguistics strongly suggests that interface constraints do not have unfettered access to any piece of a sub-representation they want. Ph constraints on nasal assimilation do not seem to have direct access to Sy information about tense. Sy extraction constraints do not seem to have access to Ph information about voicing. Ultimately we will want a full theory to explain what structural aspects interface constraints can refer to and what aspects they cannot. But this is an empirical issue.

One possibility is that the interface constraints between sub-representations must use one of a limited number of schemata provided by Universal Grammar. In the Ph/Sy interface, for example, the Generalized Alignment schema of McCarthy and Prince (1993a) seems to play a role. As we go along, I will be making proposals for other interface schemata that may be needed in a complete theory. But I believe it would be a mistake to choose a set of schemata ahead of time or to place restrictions on their number and powers (e.g., Pullum and Zwicky's claim that Ph/Sy constraints can only affect the shape of Ph, not Sy), before trying to account for a wide range of phenomena in an MOT framework.

Chapter 2

Overview of Optimality Theory

Chapter 3

Representations

MOT sees the business of grammar as determining in a declarative way the legality of complete linguistic representations. The declarative principles can certainly be used for other tasks, e.g., creating new lexemes, parsing, generating utterances, even assigning the best interpretation to ill-formed utterances, but their main theoretical work is to distinguish licit from illicit representations.

These complete linguistic representations contain all the kinds of information which are grammatically relevant for the utterance. Following a common practice, I will assume they consist of three sub-representations — phonological, syntactic, and semantic — and I will diagram them (usually in an abbreviated form) with the sub-representations in that order between angle brackets:

(1) $\langle$ Ph, Sy, Se $\rangle$

Note that (1) contains no representation specifically devoted to morphology. This absence is not a necessary feature of MOT. It would certainly be possible to use a 4-tuple, $\langle$Ph, M, Sy, Se$\rangle$, or any number of other divisions of labour with an explicit morphological representation. Here, I merely point out my assumption that no such sub-representation is needed. Some reasons for this additional assumption will be discussed more fully in the "Tangential defences" section at the end of the chapter.

The main ideas of MOT are compatible with a very wide range of theories on the natures of Ph, Sy, and Se. In order to present concrete analyses of morphological phenomena, however, we need to narrow down the options and make some assumptions about the sub-representations. Where possible, I will try to distinguish between those conclusions which follow from the main ideas of MOT themselves and those which only follow with the additional assumptions.

3.1 Semantic representations

The semantic aspects of morphological and sentential structure are important and are undeservedly slighted in this sketch. I will not make any concrete assumptions on the nature of the Se sub-representations. Instead, I will usually depict the Se representation in an iconic form, such as . For semantic contents that are harder to represent, I will use .

3.2 Phonological representations

The assumptions made here about phonological representations will be rather conservative within the tradition of autosegmental phonology. There will be a central coordinating tier of root nodes (the “skeleton”), which is the nearest equivalent of the traditional notion of segment. Root nodes themselves are organized into larger constituents, such as feet, syllables, and phonological words.

For the most part, the phonological sub-representations of candidates will be depicted by means of a phonetic transcription rather than a diagram. Transcriptions will be in the 1996 version of the International Phonetic Alphabet rather than in the perhaps more familiar North American system, e.g., IPA [ʃ] will be used instead of [š]. Such transcriptions should be understood to be abbreviations for fuller phonological representations.

3.2.1 Features

The phonological feature system assumed here will be more or less familiar to phonologists. The features will generally have their usual SPE definitions (Chomsky and Halle, 1968), as modified by later consensus in the autosegmental tradition. For example, place of articulation will be represented by privative articulator nodes (COR, LAB, DOR) as proposed in Sagey (1986). For concreteness, I will assume the features listed in table 3.2.1

The analyses presented here will seldom be so phonologically involved that they would benefit from a hierarchical arrangement of features, so I make no specific assumptions concerning feature geometry, though occasionally I will make non-crucial use of intermediate nodes such as Place, Vowel-Place, and Laryngeal.

3.2.2 Root nodes (or the skeleton)

I will assume that all features are dominated (either directly or indirectly) by a root node, and further that the tier of root nodes constitutes the central organizing skeleton of the phonological representation. While a more sophisticated theory of the phonology-phonetics interface is clearly needed, for the purposes of this sketch it will suffice to think of a root node (together with the features it dominates) as representing certain aspects of the state of the vocal tract at a particular instant in time. Linear order between root nodes corresponds to temporal order between the instants of time.

There will be no need to assume individual tiers for each feature. Adjacency and order of features can be determined by reference to their dominating root nodes (cf. Scobbie, 1991; Archangeli and Pulleyblank, 1994).

Unless otherwise indicated, violations of a Generalized Alignment constraint will be measured in terms of root nodes. For a simplistic example, the constraint ALIGN(PWd, Left; [d],

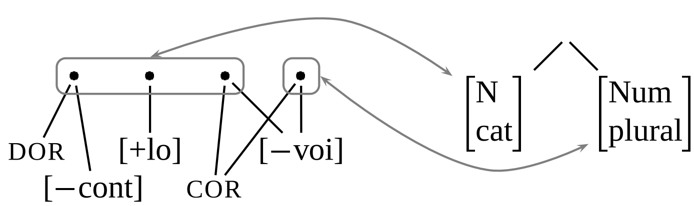
Table 3.1: Features assumed in this sketch

Consonant features:	
[+son]:	sonorants, e.g., [m], [n], [l], [w], [ɹ]
[−son]:	obstruents, e.g., [t], [b], [s], [v]
[+cont]:	fricatives and approximants, e.g., [s], [v], [θ]
[−cont]:	oral and nasal stops, e.g., [t], [d], [n], [ŋ]
[±nas]:	nasal vs. oral sounds
[±lat]:	lateral vs. central sounds
LAB:	labial sounds, e.g., [p], [m], [w], [f], [ɱ]
COR:	coronal consonants, e.g., [t], [n], [l], [s], [ʃ], [ɹ]
DOR:	dorsal consonants, e.g., [k], [ŋ], [q], [x], [ç]
[+ant]	anterior coronals (dentals and alveolars), e.g., [θ], [s]
[−ant]	post-anterior coronals (postalveolars and retroflexes), e.g., [ʃ], [ɖ]
Vowel features:	
[±high], [±low]	
[±back]	
[+ATR]	“tense” vowels, e.g., [i], [u], [e], [o]
[−ATR]	“lax” vowels, e.g., [ɪ], [ʊ], [ɛ], [ɔ]
[±round]	

Left) would assess the candidate [kandi] three violation marks because there are three root nodes separating the [d] from the left edge of the word (rather than, for example, one violation mark because there is one syllable separating [d] from the left edge, or two because there are two consonants).

The root node tier will play a major role in the relationship between the phonological and morphosyntactic representations. I will assume that syntactic nodes can be associated with a stretch of root nodes in the phonological representation:

(2)

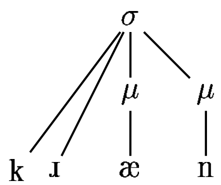


Other parts of the phonological representation are not available for this kind of association. Where earlier autosegmental phonology might have said that some morpheme “consists of” nothing but a floating [±back] feature, in MOT the syntactic node of the morpheme is associated to the entire root node that dominates the [±back] feature.

3.2.3 Prosodic structure

I will assume a syllable structure familiar from moraic theory (e.g., Hayes, 1989):

(3)

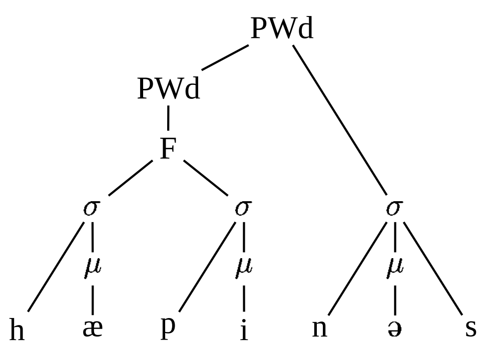


Informally, the term **nucleus** will be used to refer to the first mora and (if it dominates a vowel) the second. **Onset** will be used to refer to the consonants that occur before the nucleus, **coda** to the consonants after the nucleus.

Syllables can be organized into feet, which for the most part will be either binary left-headed Trochees or binary right-headed Iambs.

Feet can be organized into phonological words or prosodic words (PWds). I will assume that PWds can recursively dominate other PWds. For example, English *happiness* can be analyzed as having the stem *happy* footed in a complete PWd but with the suffix *-ness* being outside this minimal PWd, but included in a higher one. (This corresponds to the SPE analysis that there is a phonological word boundary inside *happy#ness*.)

(4)



As can be seen in (4), where the syllable for *ness* is dominated immediately by the higher PWd without a mediating Foot, I do not assume the Strict Layer Hypothesis (cf. Selkirk, 1984; Nespor and Vogel, 1986) as an absolute condition on phonological representations. Instead I follow Selkirk (1995) in assuming that strict-layer behaviour is the result of a collection of structural constraints, any of which may be outranked by other constraints and therefore potentially violated.

Above the level of the PWd, I assume there are phonological phrases. While these (and possibly still higher units) will be necessary in any account of sentence pronunciation, they will not play an important role in this sketch.

3.2.4 Underspecification

Underspecification in underlying representations

Since MOT has no underlying representations (URs), autosegmental phonology's notion of UR underspecification cannot be carried over. The MOT idea that does the equivalent work of underspecified representations is underspecifying constraints, that is, constraints that simply do not care about certain aspects of the candidates.

For example, the initial [k] of [kæt] has the unmarked value [−voice] rather than the marked [+voice]. In autosegmental phonology with underspecification, this would have been expressed by having no [voice] feature at all in the UR and a default rule inserting [−voice]. In MOT the morphemic constraints that enforce the lexically unpredictable aspects for ‘cat’ are simply uninterested in the laryngeal features of the initial stop. While there are morphemic constraints that will assess violation marks against the candidates [tæt] and [pæt] for having the wrong place of articulation, there are no similar morphemic constraints for laryngeal features. The candidate [ɡæt] will receive no violation marks from morphemic constraints, nor will [kæt], [ɡʱæt], or [k’æt]. The tie (from the point of view of morphemic constraints) between the candidates will be broken by general structural markedness constraints that assess violation marks against voicing, breathy voicing, ejection, and other marked laryngeal features. (See section 8.1.2 for a more radical approach to this kind of underspecifying.)

Underspecification in candidates

There remains the question of whether candidates (i.e., potential surface forms) are fully or partially specified. In the earliest work on OT (e.g., McCarthy and Prince, 1993b; Prince and Smolensky, 1993) it was assumed that Gen could insert root nodes with no features at all (i.e., epenthetic segments). If, despite the efforts of constraints like FILL, any of these empty root notes survived in the winning candidate, they would be interpreted as the relevant default segments of the language by some undefined, language-specific phonetic interpretation component.

Some OT work (e.g., Smolensky 199xxx) argued for fully specified candidate representations. If a word has a default [t], it is not because the winning candidate has an empty root node which has been interpreted as a [t]. Rather, the candidate is specified for all the features of [t]: COR, [−voice], etc. The reason this candidate won over all the other is that, according to the constraint hierarchy of this language, [t] is the least bad segment, i.e., *DOR and *LAB outrank *COR, *[+VOICE] outranks *[−VOICE], and so on.

For concreteness, I will assume the latter view, that is, that optimal candidates are fully specified for all phonetically relevant features. There is no need to build this assumption into the workings of Gen. It is logically possible for candidates to lack certain (or all!) feature specifications, but such candidates can be filtered out by cooccurrence and “downward structure” constraints, such as COOCCUR(ROOT, [SON]), ROOT▶PL, LAR▶[VOICE].[1]

The benefit of fully specified candidates for analytic self-discipline is that everything must be verifiably derivable from the interaction of constraints — nothing is consigned to an undocumented wrinkle of Gen or the phonetic interpretation component. Specifically, every phonological feature that influences the phonetic interpretation is present in the phonological representation of the optimal candidate.

[1]Following the terminology and notation of Bernhardt and Stemberger (1997), the downward-structure constraint ROOT▶PL is to be interpreted as “All root nodes dominate a place node.”

This leaves open the possibility of phonetic underspecification (as in Keating 198xxx). For example, a language might pronounce an unstressed [ə] in such a way that everything about the height of the tongue body can be predicted by purely phonetic principles from the phonetic context, with no evidence that the tongue body is aiming toward a mid height. In such cases, it is reasonable to assume that the optimal candidate has no phonological height specification. (This might be possible if, for example, a constraint like COOCCUR([HIGH], STRESS) and the constraint requiring that the syllable have no stress both outrank the downward structure constraint requiring the presence of a height feature, V-PL▶[HIGH].)

One of the distinguishing traits of theories like Dependency Phonology (Anderson and Ewen, 1987) and Government Phonology (Kaye, Lowenstamm, and Vergnaud 1986) is that any collection of primitive features, no matter how impoverished, can be assigned a coherent phonetic interpretation. There is no guarantee that the same is true under this sketch's assumptions — a conservative feature system without the safety net of a phonetic interpretation component that can fill in default values. Given the potentially free ranking of constraints, there is nothing in principle that prevents an optimal candidate from having, say, [−son,+cont] but no place features, but it's not clear that we ever find such cases of phonetic underspecification: "Give me a fricative — labiodental, retroflex, uvular, I don't care — whatever is most convenient." This possible ability to choose optimal candidates that are phonetically uninterpretable is a disadvantage of the present set of assumptions. I do not address the problem here (though I suspect that revising the feature system will prove to be a more productive strategy than trying to gerry-rig restrictions into Gen or imposing meta-constraints on Eval).

3.3 Morphosyntactic representations

As with semantic and phonological representations, the broad outlines of an MOT framework is compatible with a wide range of syntactic theories. I will try to keep syntactic analyses as theory-neutral as possible, though I will almost never be successful. For concreteness, I have chosen to be as conservative with my Sy assumptions as with my Ph ones. I assume, where necessary, that the syntactic representation looks much like the level of S-structure (or perhaps Logical Form) in pre-Minimalist generative theory. Some specific assumptions will be outlined in the following subsections.

The Sy sub-representation in a ⟨Ph,Sy,Se⟩ triple is seen here as a unified representation of both syntactic properties and properties which are often thought to be strictly morphological. For this reason, an X^0 node will not necessarily be a terminal node. I will assume that Sy sub-representations do not code linear order, but that linear order results from the application of alignment constraints at the Sy/Ph interface (see chapter 9).

3.3.1 Syntax above the X^0 level

Apart from the assumption that inflectionally complex words are assembled through head movement, syntactic structure above the X^0 level will not play a large role in this sketch. For concreteness, I will make the following assumptions.

1. Sy will respect X-bar theory. For concreteness, I will assume a conservative version with three bar levels, indicated by X^0, X', and XP or X^{max}.

2. Sy can contain empty categories, such as traces and empty pronouns. (Using the ideas of Chapter 4, an empty category is a syntactic terminal node which does not bear a morphemic index and which therefore has no effect on the phonological subrepresentation.)

3. Sy will have an "exploded" set of functional heads (cf. Pollock, 1989) which will have their own maximal projections. These functional categories include, for example, Tense, Aspect, AgrS, AgrO, Mood, Neg, Kase, and Number.

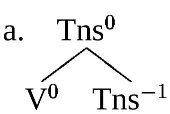
4. Heads may participate in head movement.

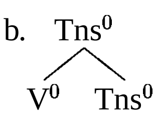
5. There may be primitive chains of coindexed positions. These encode representationally the derivational effects of Move-alpha.

3.3.2 Syntax below the X^0 level

Sy also represents structure below the X^0 level. Subject to the terminological quibbles in chapter 6, we can say that affixes have their own positions in morphosyntactic structure. So, while MOT is in many ways a realizational approach to morphology, it is also possible to have a constituent structure analysis of words.

I will adopt the practice of using negative bar levels to represent heads below the X^0 level (cf. Selkirk, 1982; Lieber, 1992, among others). Applied to head movement structures, this would result in (5a) rather than the Chomsky-adjunction structure of (5b) that is usually assumed in syntactic treatments of head movement.

(5) a. 

b. 

It is assumed in most work in the word-syntax tradition of morphology, and is argued for within the Principles-and-Parameters framework of syntax by Ouhalla (1991), that affixes can subcategorize for what they attach to in the same way that X^0 heads can subcategorize for their complements. Under this assumption, (5a) would seem to be a more accurate picture. The difference between the two possibilities will usually not be crucial in this sketch.

3.3.3 Morphosyntactic features

Nodes of a syntactic representation can bear a wide variety of features. Some of those which will be used in this sketch are as follows:

- major category features for part of speech — noun, verb, adjective, preposition, possibly adverb — as well as functional categories, e.g., Tns, Asp, Det.
- bar level. An X^0 node will have [bar: 0], X' [bar: 1], and XP [bar: 2].
- relevant categories of the verb and/or clause (e.g., tense, aspect, mood, polarity) and other syntactically relevant features, such as [±Wh] or [±anaphor].
- agreement features, such as case, gender, person.
- well-motivated diacritic features, such as inflection class (cf. Aronoff, 1994; Lieber, 1992).
- features which uniquely identify morphemes, discussed in the next chapter.

Morphosyntactic features should not be confused with lexical or functional categories. The categorial information that a node is a Tns^0 is different from the information of what tense the clause has. (The latter feature, for example, can typically percolate.) The features of a Tns^0 node might look like (6). Note that the category feature [cat: Tns] and the tense feature [tense: past] are distinct.

(6)
$$\begin{bmatrix} \text{cat:} & \text{Tns} \\ \text{bar:} & 0 \\ \text{tense:} & \text{past} \\ \text{mood:} & \text{subjunctive} \end{bmatrix}$$

Inflection class features will play an important role in any realistic theory of morphology. Aronoff (1994) offers cogent arguments for not identifying morphological classes with syntactic features. At the same time, he manages to account for the strong relationship between the two with default rules. This kind of analysis can be expressed naturally within an OT framework. A classic example of the mismatch between syntactic and morphological categories is the Latin noun *nauta* 'sailor', which is syntactically masculine (it triggers masculine agreement on its modifiers) but inflects morphologically for case and number exactly as if it were a feminine noun of the Latin inflection class traditionally called the "first declension". We can't base *nauta*'s inflections on its syntactic gender, nor can we base its syntactic gender on its inflection class. The two properties must be represented independently:

(7)
$$\begin{bmatrix} \text{cat:} & \text{N} \\ \text{bar:} & 0 \\ \text{num:} & \text{sing} \\ \text{gend:} & \text{masc} \\ \text{class:} & \text{1st declension} \end{bmatrix}$$

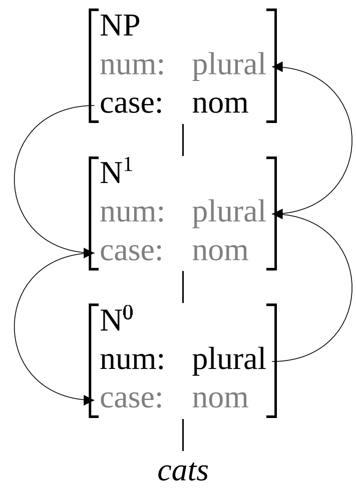


Figure 3.1: Percolation of features

Stopping here would be unsatisfactory. The overwhelming majority of first declension nouns are syntactically feminine, and most syntactically feminine nouns belong to the first declension. Using Aronoff's approach, we can have a default rule relating feminine gender and the first-declension inflection class, but this default can be overridden be lexically specific rules for those first-declension nouns that happen to be syntactically masculine as well as for feminine nouns that belong to a different declension. An example of this sort will be discussed more fully in chapter 5.

3.3.4 Mechanisms for featural identity

There are a couple of different mechanisms which can cause the same value of a feature to occur in several different places in a tree: percolation and chain-agreement.

Percolation causes mothers and (at least) their head daughters to share certain features. (Figure 3.1 illustrates a rather derivational view of percolation, where features are actually copied up or down the tree.) The subset of features which are shared includes major category features and agreement features.[2] It does not include bar level, which is controlled by the constraints of X-bar theory, or diacritic features like inflection class (Lieber, 1992).

For concreteness, I will assume that percolation is formed by constraints that use the following two schemata:

(8) PERCOLATEHEAD([F])
A mother and its head daughter must have identical values for the feature F.
PERCOLATEALL([F])
A mother and all daughters must have identical values for the feature F.

[2]Lieber (1989, 1992) refers to this set as the *categorial signature*. A related notion is the set of head features in HPSG (Pollard and Sag, 1987).

I will assume a universal meta-constraint that PercolateHead([F]) must be ranked higher than PercolateAll([F]) for all [F]. The following transposed tableau illustrates the effect of these constraints. (In the last two candidates, assume the right daughter is head.)

(9)

<table>
<tr><th></th><th>[F]
|
[ ]</th><th>[ ]
|
[F]</th><th>[F]
|
[F]</th><th>[ ]
|
[ ]</th><th>[F]
/\
[ ] [F]</th><th>[ ]
/\
[F] [ ]</th></tr>
<tr><td>PercolateHead([F])</td><td>*</td><td>*</td><td></td><td></td><td></td><td></td></tr>
<tr><td>PercolateAll([F])</td><td>*</td><td>*</td><td></td><td></td><td>*</td><td>*</td></tr>
</table>

Clearly PercolateAll is not an undominated constraint. It will be overridden if the feature value of the non-head daughter conflicts with the feature value of the head daughter. It can also be overridden by categorial appropriateness constraints. Constraints like *[N, tense] can keep a tense feature from percolating onto a noun phrase, even if the noun phrase is a non-head daughter of a tensed verb phrase.

The second mechanism of feature “copying” operates in chains (the representational trail of virtual Move-alpha rules). Every element in a chain must have the same values for a certain subset of features, which includes at least the major category features and agreement features, perhaps the same set of agreement features relevant for percolation. (Bar level is also preserved, though this may be the result of independent syntactic constraints and not a matter of feature copying.)

3.4 Elaboration

3.4.1 Connections

The implementation of percolation in section 3.3.4 is more or less a direct formalization using OT constraints of Lieber’s (1989, 1992) Percolation Conventions.

(10) *Head Percolation:*
Morphosyntactic features are passed from a head morpheme to the node dominating the head. Head Percolation propagates the categorial signature.
Backup Percolation:
If the node dominating the head remains unmarked for a given feature after Head Percolation, then a value of that feature is percolated from an immediately dominated non-head branch marked for that feature. (Lieber, 1992, 92)

In this sketch, the work of Lieber’s Head Percolation convention is done by constraints of the schema PercolateHead([F]). Her Backup Percolation is implemented by constraints of the schema PercolateAll([F]). While PercolateAll does not refer specifically to non-head daughters, the assumed universal domination of PercolateHead([F]) over PercolateAll([F]) for any F will ensure that the features non-head daughters percolate only in the absence of conflict with the features of the head daughter.

The implementation of percolation adopted here is less consistent with that formalized in the theory of Head-Driven Phrase Structure Grammar (e.g., Pollard and Sag, 1987). In HPSG, the set of percolating Head features form a sub-structure which is literally shared by mothers and head daughters. In this implementation it is impossible for a mother and a head daughter to share some percolating features but not others — a possibility which is left open here if it turns out that PercolateHead constraints can be dominated.

It is also worth emphasizing that the definition of percolation assumed here is symmetrical. That is (11a) and (11b) are equal violations of the PercolateHead([F]) constraint:

```
(11)    a.  [f:a]   b.  [   ]
              |           |
            [   ]       [f:a]
```

In contrast to Lieber's conventions, where percolation is always upwards, it does not make sense to give priority to one direction over another. A case feature might end up on a DP because it was lexically required by the head N^0 and "percolated up", or it might end up on the N^0 because it was required on the DP (by a verb's argument structure, say) and "percolated down" — or both.

This isn't a logically necessary view of percolation. It might be possible to tease the two directions apart. For example, a constraint PercolateUp might penalize (11b) but not (11a), while a PercolateDown constraint would penalize (11a) but not (11b). Since this more complex implementation of percolation will never be necessary in this sketch, I will continue to use the simpler, non-directional version outlined above.

3.4.2 What's MOT and what's not

The broad MOT framework forces no particular choices on the number or identity of the sub-representations. (Though, empirically, it would seem to be impossible to use fewer than three levels of representation.) Specifically, the MOT framework itself is compatible with the idea of Strict Lexicalism (e.g., Bresnan and Mchombo, 1995). There are many theories which have similarities to the one outlined here which argue for a separate level of morphological representation, for example, Autolexical Syntax (Sadock, 1991) and to some extent Distributed Morphology (Halle and Marantz, 1993).

Unlike many other approaches, however, I assume no level of representation that is uniquely morphological. While using a 4-tuple of sub-representations, ⟨Ph, M, Sy, Se⟩, would be fully compatible with the main ideas of MOT, it would make the model more complex (at least for the purposes of exposition) and I am unconvinced that the supposed benefits of this particular modularity justify the extra complexity. For simplicity, I will assume the three-part model of (1).

3.4.3 Tangential defences

Although this sketch's denial of morphology as a separate module is not a necessary feature of MOT, in this section I address some of the reasons why I believe it to be the right move. Many of the standard arguments in favour of uniquely morphological properties are compelling, but I do not believe that they motivate morphology as a level of representation that is as indepedent from syntax as, for example, phonology is.

We can dissociate ourselves immediately from a common straw-man portrayal of the morphology-as-syntax position: that believing in a unified morphological and syntactic representation commits one to denying any difference at all between structures above and below the X^0 level. If there is the slightest difference between the order of morphemes in a word and the order of words in a sentence, the argument goes, then morphology must be an independent module (cf. Anderson, 1992). If the morphemes inside a word fail to show the same degree of anarchy that syntax allegedly shows — for example, if you can't rearrange the morphemes in any order you feel like or if you can't separate them with a modifier anywhere you feel like — then morphology must be an independent module. Clearly, the fact that X^2s and X^{-1}s exist in the same Sy representation does not prevent one from having constraints that refer only to X^0s or only to X^{-1}, any more that we are prevented from having constraints that talk only about Vs or only about functional categories.

Nevertheless, many of the most considered defences of the Lexicalist Hypothesis involve variations of much the same idea, that there are certain things that word-internal structure cannot do that wider syntactic structure can (sometimes) do. For example, consider Bresnan and Mchombo's 1995 five tests of lexical integrity:

1. *Extraction:* Constituents of words cannot be extracted by syntactic opertations, such as relativization, clefting, or topicalization.

2. *Conjoinability:*

3. *Gapping:* Gapping or ellipsis can apply to syntactic, but not morphological, constituents. E.g., **John outran Bill and Mary -swam Patrick.*

4. *Inbound Anaphoric Islands:* While phrases can contain anaphoric and deictic uses of syntactically independent pronouns, derived words and compounds cannot. E.g., *McCarthy-ite*, but **him-ite.*

5. *Phrasal Recursivity:* Word-internal constituents generally differ from word-external phrases in disallowing the arbitrarily deep embedding of syntactic phrasal modifiers. E.g., *[happy]-ness*, but **[quite happy]-ness, *[more happy [than sad]]-ness.*

It is telling that syntax and morphology don't have mutually exclusive sets of powers, rather the powers of morphology, as described above, are a subset of those of syntax. Each of the inabilities ascribed to the morphological module is an inability that is also found in certain syntactic configurations. There are many syntactic "islands" — constituents that rules of relativization, topicalization, and clefting cannot extract out of — but few have suggested that entire clauses are assembled by morphology if they happen to be sentential subjects or the complements of noun. Not all languages allow you to conjoin prepositions, but this does not necessarily mean that prepositional phrases in these languages are assembled by morphology.

Not all syntactic constituents can be gapped. Not all arbitrarily chosen pairs of syntactic constituents can stand in an anaphoric relationship. Given this, the explanation of why, for example, constituents usually can't be moved out of words might be similar in kind, if not in detail, to the explanations of why constituents can't be moved out of noun complements and sentential subjects. There is no logical need for a separate module to explain it.

The situation is reminiscent of the discussion in chapter 1 of inflectional and derivational morphology, where at first glance it seemed that the powers of inflection were a proper subset of those of derivation. And, as it turned out there, the claim that morphological powers are a proper subset of syntactic powers also seem to be exaggerated. Many of the things claimed to be impossible for morphology in fact are merely rare. Bresnan and Mchombo (1995) need an escape hatch to let English words contain recursive syntactic phrases, such as Lieber's 1992 examples, *employee of the month program, I told you so attitude, who's the boss wink*. This only postpones the functional question from "Why do languages so rarely put entire phrases inside words?" all the way to "Why do languages so rarely use the escape hatch that allows them to put entire phrases inside words?" Similar escape hatches are needed for those cases where morphological constituents do in fact conjoin (*the pre- and post-war periods*) or gap (*smoking or non?*), with the same explanatory hollowness that escape hatches bring to a modular account.

To sum up, I have avoided positing a separate sub-representation devoted entirely to representing morphological constituency, because I do not believe that morphological constituency is so qualitatively different from syntactic constituency that segregating them into different modules is worth the redundancy and additional escape-hatch complexity introduced into the archictecture. It is likely that many of the common restrictions on sub-word structure, such as the inability to conjoin or extract, can be implemented perspicuously using OT constraints applying to a single Sy level of representation. An immediate advantage is that the "escape hatches" can also be implemented naturally by having those constraints dominated.

Chapter 4

Morphemic indices

4.1 What we need

According to the idea of Sy representation that we have developed so far, the sentences *Fred baked the turkey* and *Sally fried the chicken* have identical syntactic trees, with the same clusters of morphosyntactic features in the same nodes. Traditionally in generative syntax, the leaves of the two trees would "contain" different lexical items — and this would be what distinguished the two sentences. While MOT rejects the idea that a terminal node "contains" a lexical entry in any interesting way (especially the idea that a syntactic terminal node will carry phonological or semantic information), the problem of distinguishing sentences still exists in a MOT framework. We need some way of expressing the idea that in the sentence *Cats hate dogs*, the subject NP node of Sy is related to the part of Se that represents felinity (not the part that represents caninity) and to the first four segments of Ph (not the last four).

In this sketch, I will make heavy use of the idea of a **morphemic index** — which is probably the MOT concept that comes closest to the traditional concept of morpheme. The N^0 node for *cat* would bear, as one of its features, a different morphemic index from the N^0 node for *dog*. In essence, a morphemic index can be seen as a kind of central "hook" in the syntactic representation that allows information to be coordinated properly by interface constraints (of both the Sy/Se and Sy/Ph interfaces).

4.2 Implementation: Lexemic and Functional Indices

One of the earliest and most persistent distinctions drawn between types of linguistic elements is the distinction between "lexical" or "content" words/morphemes and "grammatical" or "function" words/morphemes.

Morphemic indices seem to come in two flavours, which will be referred to as **lexemic** and **functional indices**.

A lexemic index will be denoted by a feature whose attribute is 'Lex' and whose value is a mnemonically convenient English gloss. Some examples:

(1) [Lex: ‘cat’]
[Lex: ‘purple’]
[Lex: ‘football’]
[Lex: ‘educate’]

A functional index will be denoted by a feature with the attribute ‘Func’.

(2) [Func: past]
[Func: future/potential]
[Func: 3rd-plural-feminine/zoic-object]
[Func: ‘-ed’]

The value of the feature will be represented by the name of the grammatical category that is most closely associated with the functional index, as in [Func: past], or else by an orthographic or phonemic abbreviation, as in [Func: ‘-ed’]. Using the name of a grammatical category is simply a mnemonic convenience, not a claim that the content of the index is formally identical with some other morphosyntactic feature. What is important is that morphemic indices have unique values — they could just as easily (if less readably) be represented by integers.

I assume that the Lex and Func features are unique within a single Sy node. A node cannot bear two lexical indices or two functional indices. But there is no reason that a node may not bear one of each. Indeed, I will argue that this often occurs. For example, I propose that the suppletive past tense form *went* is most appropriately represented by a terminal node that simultaneously expresses its association with the lexeme GO and its irregular realization of the past tense:

(3) $\begin{bmatrix} \text{V}^0 & \\ \text{Lex:} & \text{‘go’} \\ \text{Func:} & \text{irreg.past} \end{bmatrix}$

4.3 Elaboration

4.3.1 Connections

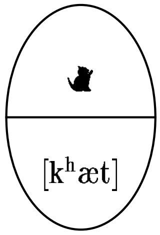
Halle and Marantz (1993) and McCarthy and Prince (1993a)

But Jackendoff’s arguments against

4.3.2 Morphemic indices need not be Saussurean signs

One of the most enduring ideas in morphology is that morphemes have units of meaning. For example, Harris (1958: 123) defined morpheme as “the smallest individually meaningful element in the utterances of a language.” In other words, the traditional view is that morphemes are essentially Saussurean signs, arbitrary associations of semantic content and phonological content:

(4)



Aronoff (1976) offers one of the most extended and compelling arguments against this conception of morphemes. Aronoff points to the existence of "cran" morphs — morpheme-sized elements which have no meaning independent of the single word they occur in (e.g., *cranberry*) — as well as to compounds like *blackberry*, the meaning of which is not completely predictable from the meanings of its parts.

An extreme example of "cran"-type elements can be found in many of the Latinate prefixes and roots of English. Not only can the meaning of *permit* not be predicted from the meanings of *per-* and *-mit*, the element *-mit* has no consistent meaning at all that can be identified across the words it is used in: *permit*, *admit*, *submit*, *transmit*, *commit*, etc. If morphemes are minimal units of meaning, then *-mit* cannot be a morpheme. But simply treating each of the *permit*-type words as unrelated and essentially monomorphemic is also unsatisfactory. The *-mit* in each one undergoes the same kind of allomorphic alternation before derivational suffixes:

(5)				
	permit	permission	permissive	
	submit	submission	submissive	etc.

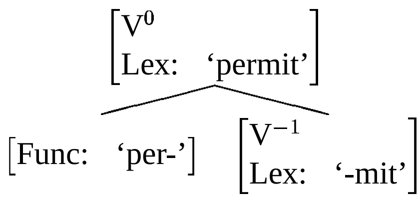
The change of *t* to [s] before *-ive* is not a phonologically governed process (compare *prohibit* ∼ *prohibitive*, *excrete* ∼ *excretive*). .....

Aronoff concludes that "what is essential about a morpheme [is] not that it mean, but rather merely that we be able to recognize it. A morpheme is a phonetic string which can be connected to a linguistic entity outside that string. What is important is not its meaning, but its arbitrariness."

The present proposal is quite consistent with Aronoff's view of morpheme. In fact, we can go further. MOT morphemic indices are not minimal units of meaning or even minimal units of sound (the "phonetic string" of Aronoff's definition). It is a purely morphosyntactic object. It may stand in correspondence relations to pieces of the semantic representation and phonological representation, indeed it does so in the unmarked case, but the correspondence relations are not essential. A morphemic index might have no correspondent in the semantics, e.g., roots like *-mit* or "empty morphs" such as the *-i-* that appears in *authorial* but not *doctoral*. Equally, a morphemic index might have no correspondent in the phonology ("zero morphs").

As suggested by Aronoff, rather than being units of sound or units of meaning, morphemic indices are, if anything, best seen as units of unpredictability. These units of unpredictability may occur at many levels, including recursively. In chapter 12, I will propose that the structure of *permit* is something like:

(6) *permit*



The unpredictable aspects of the meaning of the whole will be handled by syntax/semantics correspondence constraints that are sensitive to the presence of the index [Lex: 'permit']. The phonologically unpredictable alternations of the stem-final consonant will be handled by syntax/phonology correspondence constraints that are sensitive to the presence of [Lex: '-mit']. In this way, the various kinds of unpredictability can be assigned to their appropriate level, and we avoid the dual problems of feeling we have to assign a "meaning" to *-mit*, on the one hand, and denying that *permit* has any interesting internal structure, on the other.

4.3.3 Indices in chains

The position of morphemic indices in the syntactic tree allows us to reconstruct the "level" of syntax called S-structure in the Principles and Parameters framework, or the point in the derivation at which spell-out occurs in the Minimalist framework.

Traditional accounts of "movement" require at least two distinct representations. Consider a (simplified) analysis of the sentence *Ebenezer hates everyone* in a late P&P framework. In the original D-structure of the sentence illustrated in figure 4.1, all lexical material is VP-internal: the subject *Ebenezer* is in specifier position, the verb *hates* in the head, and object *everyone* in the complement position of VP. The subject undergoes movement to the specifier position of IP and the verb undergoes head-movement to adjoin to I^0, resulting in the S-structure in (b).The object *everyone* then undergoes Quantifier Raising and adjoins to IP, resulting in the Logical Form (LF) representation in (c).

Accepting chains as primitive elements of syntax goes a long way toward removing the need for temporal derivations and allowing us to use a single mono-stratal Sy representation. But by itself it is not enough. The structure in figure 4.2 encodes in a purely representational way the effects of movement transformations. But it has a serious weakness. Not all chains are equal when it comes to the pronunciation of the sentence. There is no way to tell in (4.2) that *everyone* is supposed to realized at the bottom of its chain, while *Ebenezer* and *hates* are supposed to be realized at the tops of their chains. Encoding the positions in the chains which affect the pronunciation of the sentence is the main work done by S-structure in the P&P framework, or by privileging one stage of the derivation (the "spell-out" stage) in the Minimalist framework.

But it is also work that can be done by morphemic indices. As we will see in chapters 7 to 9, morphemic indices in Sy have an effect on the phonological content of corresponding stretches of Ph, but their position in Sy also determines where in Ph those corresponding stretches will be. Figure 4.3 is a revision of the chained representation in figure 4.2 which uses

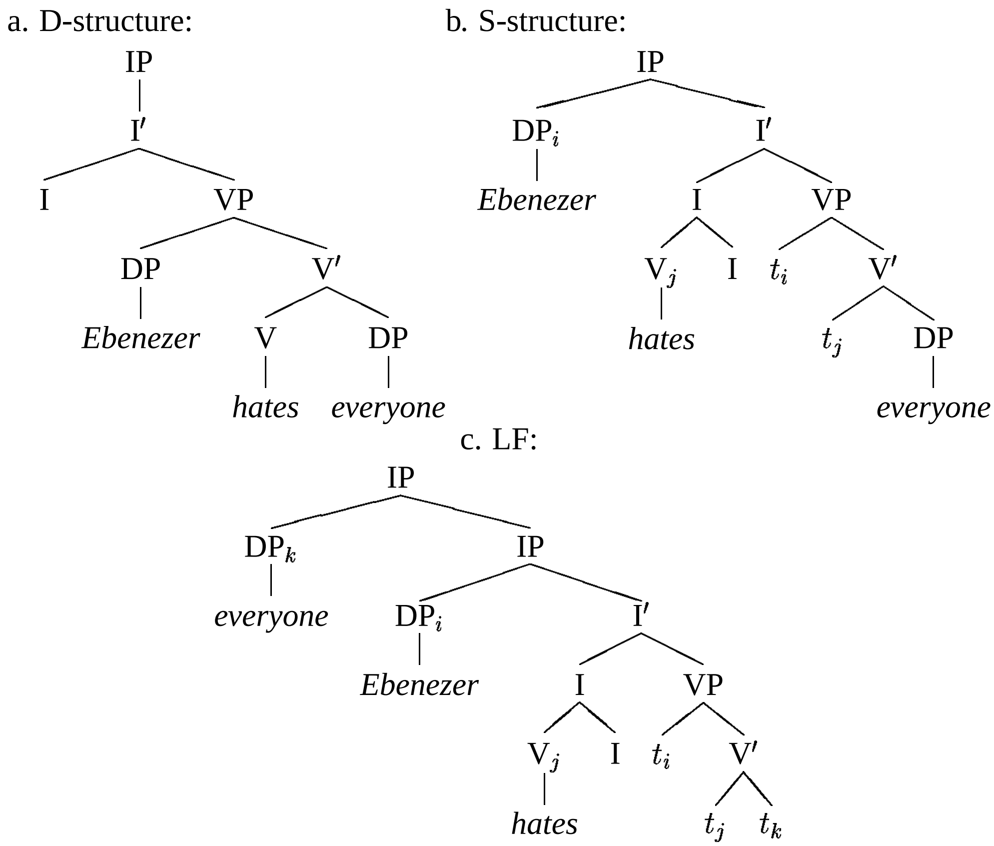


Figure 4.1: Derivational creation of chains

morphemic indices to mark the position in the chain where lexical material is phonologically realized.[1]

I propose the following constraints to govern, in part, the position of morphemic indices within chains:

(7) TOPOFCHAIN
A morphemic index must occur at the topmost node of its chain.

(8) BOTTOMOFCHAIN
A morphemic index must occur at the bottommost node of its chain.

(9) ONCEPERCHAIN
A morphemic index must occur at only one node in its chain.

BOTTOMOFCHAIN does the same work as the STAY constraint of Grimshaw (1997). When BOTTOMOFCHAIN and ONCEPERCHAIN outrank TOPOFCHAIN, lexical items will occur in their "base-generated" positions, all else being equal.

[1]Of course, a complete explanation would need a way to handle those DP-chains where the DPs inconsiderately contain more than a single word.

Figure 4.2: Sy with primitive chains:

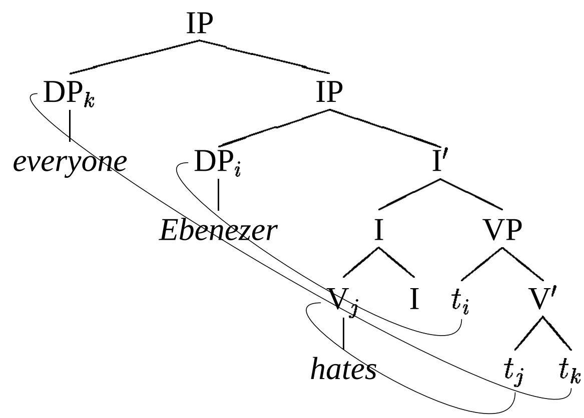
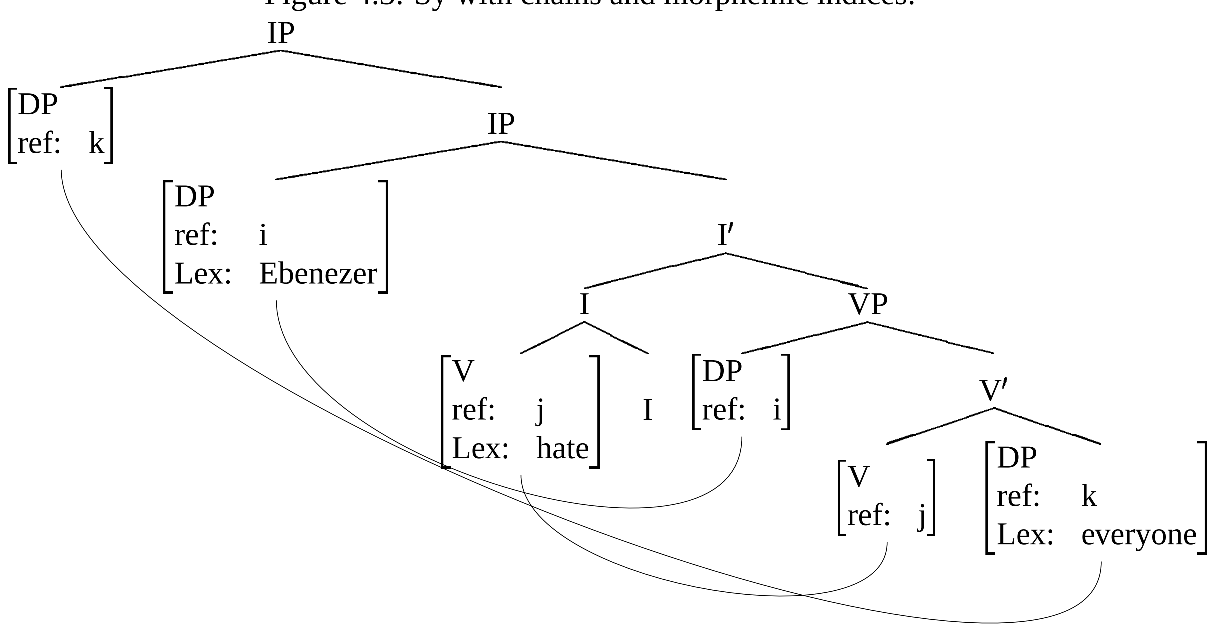


Figure 4.3: Sy with chains and morphemic indices:



(10) *Selecting an "in situ" position:*

	BOTTOMOFCHAIN	ONCEPERCHAIN	TOPOFCHAIN
☞ [ ]...[ ]...[Lex]			*
[Lex]...[ ]...[ ]	*!		
[Lex]...[ ]...[Lex]		*!	

If both TOPOFCHAIN and BOTTOMOFCHAIN outrank ONCEPERCHAIN, then the ideal candidate would look like (10c). This is perhaps what is going on in the predicate focus construction of Vata (Koopman, 1984), where a verb that moves to the front of the sentence for focus reasons leaves behind a copy in its base position.

(11) pā ǹ ka mɛ́ pa ā
throw you FUT-A it throw Q 'Are you going to THROW it?

(12) yē kpē` lagɔ̀ yē
come really rain come 'It is really RAINING.'

In chapter 14, I will argue that a similar situation (double indexes in a verb-movement chain) is what underlies many cases of reduplication.

4.3.4 What's MOT and what's not

The idea of indices seems to be integral to any MOT-like theory, especially if it also accepts the idea that morphemic information is encoded in constraints not representations. Not having morphemic indices would not only require all morphemic information to be encoded in representations, but these representations would have to be fairly rich (see Jackendoff (1997) for some examples), they would probably have to have essentially diacritic features, and the evaluation component would probably have to be complicated in order to interpret the diacritics and other aspects of the enhanced representations.

4.3.5 Tangential defences: the lexemic vs. functional distinction

Distinctions similar to the one I draw between lexemic and functional indices have a long-established place in linguistics — from the traditional distinction between "content" words/-morphemes and "grammatical" or "function" words/morphemes to the Principle and Parameters framework's distinction between lexical and functional categories. In this section, I briefly point to some of the arguments in favour of such a distinction.

The two kinds of morphemes have some interesting differences in terms of phonological size. As noted by McCarthy and Prince (1994), for example, lexical morphemes are very often subject to minimal size constraints (e.g., they must have at least two moras or two syllables), while functional morphemes are very often subject to maximal size constraints (e.g., at most one syllable or one segment). See also Selkirk (1995). Maintaining a distinction between lexemic and functional indices allows such constraints to be expressed simply.

Beard (1995) has one of the most thorough arguments against what he calls the Lexical Morpheme Hypothesis — the idea that grammatical affixes form a natural class with lexical stems and are treated in essentially the same way by the lexicon. For example, Beard argues that grammatical affixes are very often phonologically unrealized (or realized by a "zero" morph), while the stems of lexemes never are. As well, among lexical stems allomorphy and homonymy are the exception, while among grammatical morphemes they seem to be the rule. Not all of Beard's differences follow automatically merely from positing two kinds of morphemic indices, nor is it entirely obvious how all the differences would follow even with additional stipulations, but positing two kinds of "morphemes" does seem to be a necessary starting point for an adequate theory.

Chapter 5

Morphosyntactic constraints I: Lexemic constraints within syntax

5.1 What we need

In traditional generative syntax, a partial representation such as [N^0, 🐕] would be taken out of the lexicon and inserted into a terminal node of the syntactic tree. It would be impossible for a terminal node ever to have [P^0, 🐕], because the lexicon simply would not contain that particular partial representation and there would be no other way it could spontaneously come into being.[1]

One of the overall strategies of an MOT approach is to express substantive restrictions on possible linguistic structures using constraints that are applied during evaluation, rather than by assuming that (perhaps even defining how) Gen simply does not produce the undesirable candidates. Under this strategy, we don't want to blame the ungrammaticality of [P^0, 🐕] on some undocumented property of Gen. We must accept that [P^0, 🐕] is present in the infinite candidate set of all conceivable linguistic representations and we must find some principled way of excluding it with constraints. The constraints that do this kind of work are the subject of this chapter.

5.2 Implementation

In later chapters, we will be examining the kind of Sy/Ph and Sy/Se interface constraints that are interested in morphemic indices. But many constraints that are sensitive to the presence or absence of morphemic indices apply completely within a syntactic representation without any reference to phonological or semantic information. For lexemic indices, such constraints encode what has traditionally been seen as the syntactic information in the lexical entry, for example, category and subcategorization information. They check whether the presence of

[1]The incantation to accomplish this limitation on the freedom of syntactic structures is "projection from the lexicon".

the lexemic index is consistent with the other features in its environment. Other constraints can require the presence of a functional index based on the presence of other features, or vice versa.

One of the constraints sensitive to [Lex: ‘cat’], for example, requires the syntactic node that bears it to be a N^0.

(1) [Lex: ‘cat’] → [cat: N]

I will continue use this more familiar “redundancy rule” notation. In fuller logical detail, this constraint would be read as: “For all syntactic nodes M, if M bears the feature [Lex: ‘cat’], then M also bears the feature [cat: N].” Unlike some constraints, this one is a unidirectional implication: it does not require all N^0s to be *cat*. Another constraint of English would be:

(2) [Lex: ‘catch’] → [cat: V]

The following tableau shows the results of a hypothetical competition between a number of candidates, each with a Sy consisting of a single node, assuming that the grammar/lexicon of English has only the two constraints (1) and (2), which are equally ranked

(3)

Sy	‘cat’→[N]	‘catch’→[V]
[Lex: ‘cat’, cat: N]		
[Lex: ‘cat’, cat: V]	*!	
[Lex: ‘cat’, cat: A]	*!	
[Lex: ‘catch’, cat: N]		*!
[Lex: ‘catch’, cat: V]		
[Lex: ‘dog’, cat: P]		

Three of the candidates survive the evaluation: (3a) the noun *cat*, (d) the verb *catch*, and (e) the preposition *dog*. Candidates (b) and (c) receive violation marks from constraint (1) — their nodes bear the lexical index [Lex: ‘cat’], yet it does not also bear the category feature [cat: N] that constraint (1) demands. The remaining candidates (d-f) satisfy (1) vacuously. In the verb version of *catch* in (d), for example, constraint (1) demands that every node with a [Lex: ‘cat’] feature also have the [cat: N] feature, and sure enough, there is no node in (d) which has a [Lex: ‘cat’] feature but no [cat: N]. This example highlights the central premise of MOT that in Eval, every candidate is assessed by every morphemic constraint.

On the other hand, (d) is ruled out by (2), because a node with [Lex: ‘catch’] does not bear the category feature of a verb. Candidate (e) satisfies constraint (2) — all nodes with [Lex: ‘catch’] also have [cat: V] — and vacuously satisfies (1). Finally, candidate (f) vacuously satisfies both constraints and receives no violation marks. The two constraints in this hypothetical grammar/lexicon have no interest in the index [Lex: ‘dog’], with the effect of allowing [Lex: ‘dog’] to cooccur with anything.

The overall collection of legal utterances allowed by this two-constraint grammar is not terribly interesting. Some of the apparent problems in the evaluation, such as allowing *dog* to be a preposition, would be easily avoided in a more realistic grammar/lexicon simply by having more intra-syntactic morphemic category constraints. In this respect, the differences between the toy grammar and a realistic grammar are differences of degree, not of kind. But other possibly counterintuitive aspects of the evaluation are not so simple. Tableau (3) implies that [Lex: ‘cat’, cat: N] is a legal syntactic structure, even if one is trying to say “dog” — and undeniably it *is* legal. Being told the legal set of syntactic structures might seem like little use if we’re given no additional guidance on when to use which one. But in MOT this makes perfect sense. The purpose of MOT (and many other theories) is to define legal utterances, not to give an algorithm that will accept mental intentions as input and crank out the one correct utterance as output. By extending our view to include the semantic sub-representations and the possibility of Sy/Se interface constraints that are sensitive to morphemic indices, we can alleviate much of the indeterminacy, but not all. An MOT grammar could tell you that (4) and (4b) are legal representations, while (4c–e) are not. But, as is proper, it will give you no guidance on how to choose between (a) and (b) for use in any particular real-world situation.

(4)
a. ⟨ [Lex: ‘cat’, cat: N] , ⟩
b. ⟨ [Lex: ‘dog’, cat: N] , ⟩
c. ⟨ [Lex: ‘cat’, cat: N] , ⟩
d. ⟨ [Lex: ‘dog’, cat: N] , ⟩
e. ⟨ [Lex: ‘cat’, cat: V] , ⟩

The point of this discussion is to highlight the fact that illegality of a potential utterance can come from several sources. (4c-d) are bad because they violate Sy/Se interface constraints. (4e) is bad because it violates the kind of intra-syntactic morphemic category constraints we have been discussing. Even the structures and pairings suggested in (4a) and (4b) could be illegal if they were not complete utterances but part of some larger utterance where, say, the *dog* or *cat* Sy nodes tried to head a verb phrase. In this sketch, we’ll often restrict our attention to one specific source of illegality, as we did in looking at morphemic category constraints in the mini-evaluation in (3). The fact that a candidate survives through one of these mini-evaluations does not imply that that candidate is a legal utterance (or even that it would be alive in the full hierarchy after the last constraint given in the mini-hierarchy); it simply means that the candidate does not violate the kind of constraints we are focusing on.

5.2.1 Some other uses for intra-syntactic constraints

Constraints sensitive to lexemic indices can restrict cooccurence with other types of syntactic information than major category. The most obvious of these involve subcategorization and valency requirements.

There are a couple of ways in which the arguments required by a verb might be coded. One possibility is that constraints code for some arguments directly. For example, a constraint might require that any V^0 that has [Lex: ‘hit’] must have an NP complement.

(5) GOVERNS ([V^0, Lex: 'hit'] , [cat: N])

(See section 6.2.1 for more on this kind of constraint.) Alternatively, such requirements might be coded indirectly through representational stand-ins for argument structure (such as theta-grids, Kase-grids, argument lists, and so on). I will take no position on this question.

Another kind of morphosyntactically relevant feature whose distribution is sensitive to the identities of lexemic indices is inflection class. I follow many other researchers (e.g., Lieber, 1992; Selkirk, 1982; Aronoff, 1994) in assuming that the nodes of the morphologically relevant representation (for me, Sy) may contain an essentially diacritic feature representing a lexical item's membership in an arbitrary inflectional class.

If Lieber's (1992) formulation of percolation is essentially correct, then this diacritic does not belong to the set of features that percolates, meaning that it will generally be found only at the X^0 level or lower — it is therefore unremarkable that we never find cases where, for example, the verb two-clauses upstairs cares about the inflectional class of an item two-clauses downstairs.[2]

5.3 Example: Spanish noun classes

To illustrate the kind of default mapping that languages typically establish between pure syntactic features like gender and morphosyntactic diacritics like inflection class, I present Aronoff's analysis of Spanish noun classes (which relies heavily in turn on work by Harris (1991a,b)). The rest of this section can be seen as simply implementing Aronoff's default-based analysis using the default-handling abilities of OT. A reasonably good first approximation of a description of noun morphology in Spanish is that feminine nouns end in *-a* and masculine nouns end in *-o*:

(6)	*el muchacho*	'boy'	*la muchacha*	'girl'
	el tio	'uncle'	*la tia*	'aunt'

But there are feminine nouns which end in *-o* (e.g., *mano* 'hand') and about 600 masculine nouns which end in *-a* (e.g., *día* 'day'). As well, there are many nouns, both masculine and feminine, which have no final vowel at all or an epenthetic *-e* motivated by syllable structure conditions:

(7)	*el dia*	'day'	*la mano*	'hand'
	el Cid	'Cid'	*la sed*	'thirst'
	el padre	'father'	*la madre*	'mother'

[2] One way of expressing in MOT that inflection class doesn't percolate would be to say that the PERCOLATEHEAD and PERCOLATEALL schemata of section 3.3.4 are not open schemata like ALIGN that a language can fill in any way it chooses, but is a closed family of universal constraints referring to a limited number of universal feature attributes, such as tense, gender, case, and so on (the features of the "categorial signature"). Crucially, a language could not make up percolation constraints referring to parochial feature attributes like inflection class or sub-vocabulary (Latinate, Sino-Japanese, etc.).

Aronoff sets up three inflectional classes which have no direct relationship with gender:

(8)

class	ending
1	*-o*
2	*-a*
3	∅ or epenthetic *-e*

It is clear that there are both masculine and feminine nouns in all three classes. But it is unsatisfactory to simply leave it at that and treat inflectional class as an arbitrary category that must be memorized for each and every noun. Doing so would say nothing about the relationship between gender and inflection class that holds most of the time, the relationship that prompted our first approximation. In Aronoff's words:

(9) Generalization 1: Feminine gender nouns may be idiosyncratically specified as belonging to class 3 [*KR:* or 1]. Otherwise they belong to class 2.

Generalization 2: Masculine gender nouns may be idiosyncratically specified as belonging either to class 2 or to class 3. Otherwise, they belong to class 1.

So nouns may (exceptionally) contain an inflection class feature as part of their lexical entries. Nouns which do not will undergo one of the following default rules:

(10) Masculine → class 1
Feminine → class 2

As there is no default rule placing nouns into class 3, nouns can only belong to class 3 by virtue of lexical specification.

Within an OT framework, this analysis is implemented naturally by having lexeme-specific constraints outrank more general (default) constraints. The grammar/lexicon of Spanish would have a number of lexemic constraints like those in (11) and the two general syntactic constraints in (12) which refer to no particular morphemic index at all:[3]

(11) [Lex: 'hand'] → [class: 1, gend: fem]
[Lex: 'day'] → [class: 2, gend: masc]
[Lex: 'mother'] → [class: 3, gend: fem]
[Lex: 'boy'] → [gend: masc]

(12) [gend: fem] → [class: 2]
[gend: masc] → [class: 1]

[3](11) lists the inflection class feature (if any) in the same constraint as the gender feature. It is possible that Spanish will need two different sets of constraints ranked at two different places.

The constraints in (11) must outrank those in (12), otherwise those in (11) would never get a chance to influence an evaluation and be learned by the next generation. A lexemically required class feature can overrule the default constraints of (12), but if a lexeme makes no demands on inflection class, the default rules hold sway.

Tableau (13) shows how the high-ranking constraints sensitive to [Lex: 'hand'] give rise to the feminine noun *mano*, contrary to the default relationships between gender and inflection class.

(13) *Tableau for mano 'hand':*

	Sy	hand→1,fem	day→2,masc	masc→1	fem→2
☞	[Lex: 'hand' class: 1 gend: fem]				*
	[Lex: 'hand' class: 2 gend: fem]	*!			
	[Lex: 'hand' class: 1 gend: masc]	*!			*
	[Lex: 'hand' class: 2 gend: masc]	*!*		*	

(The constraint for 'day' appears in tableau (13) to remind us that all other morphemic constraints also apply and are vacuously satisfied.)

Muchacho 'boy' is a regular noun, which has no constraint interested in its inflection class, only one that's interested in its gender. In the absence of an idiosyncratic inflection class constraint, the choice of inflection class for *muchacho* is left to the lower-ranked default constraints, which will place it in class 2, as shown by tableau (14).

(14) *Tableau for muchacho 'boy':*

	Sy	boy→masc	hand→1,fem	masc→1	fem→2
☞	[Lex: 'boy' class: 1 gend: masc]				
	[Lex: 'boy' class: 2 gend: masc]			*!	
	[Lex: 'boy' class: 1 gend: fem]	*!			*
	[Lex: 'boy' class: 2 gend: fem]	*!			

It is reasonable that similar default rules operate would in the mapping between syntax and semantics and contribute to the determination of syntactic gender. Many or most nouns will need an intrasyntactic constraint sensitive to their lexemic indices in order to determine syntactic gender, e.g., [Lex: 'hand']→[gend: fem]. But there are a large number of nouns whose syntactic gender can be predicted from their semantics. In Spanish for example, nouns referring to male creatures have masculine syntactic gender, those for female creatures feminine gender. In Latin, a significant number of tree names have feminine gender. When such generalizations are possible, the relevant nouns need no lexemic constraint like [Lex: 'man']→[gend: masc], but receive syntactic gender features by default constraints that operate on the syntax/semantics interface. Of course, these default constraints too can be overridden, for example, Latin *acer* 'maple' would have a constraint [Lex: 'maple'] → [gend: neut] which outranks the default gender constraint for tree names.[4]

Analyses similar to this are possible for most cases of mismatches between syntactic features and their most closely associated morphological features. Some examples:

1. Similarly in Cree, intransitive verbs with animate subjects and transitive verbs with inanimate objects correlate strongly with two different morphological classes, but there are many examples of each syntactic type in the wrong morphological class. For example, *apacihtâw* 'use it' and xxx belong to the same morphological class as most of the intransitive verbs, while *xxx* and *xxx* belong to the same morphological class as most of the transitive verbs.

2. Similarly, Dyirbal transitive and intransitive verbs correlate very strongly, but not perfectly, with two morphological verb classes.

[4] I tentatively consign the other kind of agreement mismatches to constraint conflict in the semantics/syntax interface, e.g., the masculine agreement of French feminine nouns *la sentinelle* and *sa majesté*, and the Russian hermaphrodites discussed in Beard (1995).

3. Latin has a class of verbs known as “deponent verbs”, which inflect morphologically as though they were passive, though they are semantically and syntactically active. E.g., *minor* ‘I threaten’, *conor* ‘I try’, *loquor* ‘I speak’, *adgredior* ‘I approach’.

5.4 Elaboration

The discussion of legal and illegal candidates in (4) reinforces an important point. We are so used to thinking of the grammar/lexicon as an utterance factory inside the speaker’s head that it can be hard to accept a claim that the grammar/lexicon could ever be so wasteful as to “generate” linguistic representations when the speaker has no intention of uttering them.

Obviously a speaker does have something like an utterance factory. The claim of MOT is that this factory is not the same thing as the grammar/lexicon. Stretching the factory analogy, the grammar/lexicon plays a slightly different role: its constraints as quality control inspectors. For example, certain constraints will find defective blenders. They’ll pass any perfect blender — it’s not their job to worry that the owner of the factory wants to make toasters. Some other quality control inspector will notice if the blender gets packaged in a toaster box and reject the entire package for that reason — so the factory will never be shipping shoddy merchandise. Conceivably, the factory could be churning out a thousand rejected blenders in toaster boxes and a dozen unrejected blenders in blender boxes for every toaster in a toaster box that it manages to get out. C’est la vie. The job of an OT grammar is to define quality control standards for the merchandise, not to manage an efficient factory.

5.4.1 Are category constraints violable?

MOT claims that the category of syntactic nodes is determined (in part) by the operation OT constraints like those we have been discussing. It is not an accident of the grammar only being able to use the finite number of Sy representation fragments that happen to be stored in a warehouse called the lexicon. If OT constraints really are the explanation, then we might expect to find occasional violations forced by even higher-ranked constraints. If there turn out to be no such cases, we could, with some loss of plausibility, claim that category constraints like this are undominated in every language; or there may be something in the nature of semantic representations and the Sy/Se interface (whose constraints are likely the only ones that could force category violations) that would suggest a principled explanation of why category mismatches would always be less optimal than some competitor. But it may turn out that there really are cases of forced category mismatches. It may be possible to analyze conversion (“zero derivation”) along these lines: using *cat* as a verb would involve a category-violating terminal node like (4e) rather than a zero-derived structure with or without zero-morphemes. Other possibile violations of category constraints might include gerunds, predicate nominals with zero copulas, and “exocentric” structure generally.

It is often argued that lexical items must belong to a restricted set of categories (e.g., N, V, A). If so, there may be a universal constraint sensitive to the mere presence of any lexical index which requires one of the acceptable category features. The ‘cat’ constraint (1) demands an N but makes no mention of the bar level of the node. Very likely, a universal constraint requires a node with any lexical index at all to be an X^0:

(15) [Lex: X] $\rightarrow$ [bar: 0]

In principle, this constraint too could be violated, and perhaps is by such apparently phrase-sized things as proper names or by phrases inside words, such as *the same old "boy meets girl, boy loses girl, boy gets girl again" story*.

Chapter 6

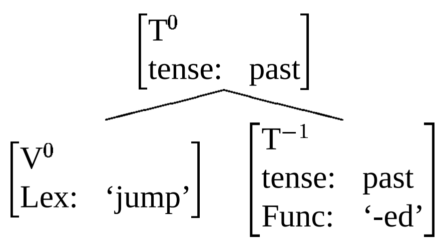
Morphosyntactic constraints II: Functional constraints within syntax

6.1 What we need

Just as we saw for lexemic indices, there are constraints which fuss over whether functional indices are compatible with their environments. Let us illustrate with a simple example from English.

With a head-movement analysis of inflection, a sentence with the past-tense verb *jumped* would have a section of its Sy representation which looked like:

(1)



There are a number of ways in which the sub-tree in (1) could be made worse. As we saw in the last chapter, there are constraints which would complain if the category of the left terminal node were P^1 rather than V^0. Constraints enforcing X-bar structures would complain if the right terminal node had category NP rather than T^{-1}. But there is another dependence within the T^{-1} node. We would get a bad structure if the tense feature were replaced by [tense: non-past], since this could no longer cooccur with [Func: '-ed']. We would also get a bad structure if the functional morphemic index [Func: '-ed'] were replaced by the one which represents regular noun plurals or the *-ly* of regular adverb formation. Since all these possibilities are lurking in the infinite candidate set which faces an MOT grammar, there must be constraints which eliminate them.

6.2 Implementation

Just as with lexemic indices, there can be cooccurrence restrictions between functional indices and the other morphosyntactic features of a terminal node. The constraint that would favour (1) in English would simply be:

(2) $[T^{-1}$, tense: past$] \leftrightarrow$ [Func: '-ed']

Read formally: For all Sy nodes N, N bears $[T^{-1}]$ and [tense: past] if and only if N bears [Func: '-ed'].

One important thing to note about this constraint is that it is bidirectional. With lexemic indices in the last chapter, we required that all *cat*s be N^0s, but we didn't foolishly require that all N^0s be *cat*. With functional indices, the cooccurrence restrictions usually run both ways: we want [Func: '-ed'] to coocur only with $[T^{-1}$, tense: past], similar to the category constraints on lexemic indices, but we also always want [Func: '-ed'] to occur whenever there is a $[T^{-1}$, tense: past] — unless, of course, this is prevented by a more highly ranked constraint forcing an irregularity.[1]

The mention of the category T^{-1} in the constraint is important. Tense is a percolating feature, in English if not in all languages, and a (potentially quite large) number of nodes in a sentence will bear the feature, including the non-terminal T^0 node of (1). It would be undesirable to demand that all these nodes also have the functional index [Func: '-ed'] and so (by the kind of constraints to be discussed in Chapter 8) encourage numerous alveolar stops scattered through the phonological representation.[2] Only one Sy node bears the brunt of the demand for this functional index, the one with the category T and the bar level -1.

In a way, the T^{-1} position in the syntactic tree acts much like a template slot in those approaches to morphology that rely on position classes, but embedding functional morphemic indices in an OT framework also allows us to express in a fairly natural way many of the central insights of realizational approaches to morphology. This will be discussed in more detail in the "Elaboration" section of this chapter.

6.2.1 Hierarchical structure constraints

We have already been informally using a schema to constrain hierarchical relationships between two nodes in a structure. For example, $\sigma \blacktriangleright \mu$ has been taken to mean that a syllable node must dominate a mora node.

We formalize these kinds of constraints as below, where the DOMINATES and DOMINATEDBY schemata deal with the same relationship, but have different quantificational force:

[1] It is an open question whether the two directions are independent and can be ranked separately (for example, $[T^{-1}$, past$]\rightarrow$[Func: '-ed'] $\gg$ ... $\gg$ [Func: '-ed']$\leftarrow[T^{-1}$, past]) or whether such bidirectional constraints are atomic and always occupy only a single rank on the constraint hierarchy.

[2] This may, though, be the most appropriate way to handle some types of multiple inflection in some languages.

(3) DOMINATES(X, Y) *abbreviation:* X ▶ Y
For each node N1 which is described by X, there exists some node N2 which is described by Y such that N1 dominates N2.

(4) DOMINATEDBY(Y, X) *abbreviation:* Y ◀ X
For each node N2 which is described by Y, there exists some node N1 which is described by X such that N1 dominates N2.

For example, we could enforce part of the X-bar schema with the constraint (5a), or state that a VP is not a complete utterance by requiring it to belong to a larger IP with (5b).

(5) a. [bar: 2] ▶ [bar: 1]
b. VP ◀ IP

It is also useful to be able to talk about other hierarchical relationships, such as c-command or government. I propose the following two schemata:

(6) GOVERNS(X, Y) *abbreviation:* X ↷ Y
For each node N1 which is described by X, there exists some node N2 which is described by Y such that N1 governs N2

(7) GOVERNEDBY(Y, X) *abbreviation:* Y ↶ X
For each node N2 which is described by Y, there exists some node N1 which is described by X such that N1 governs N2

We could use these schemata for various purposes, for example, having a transitive verb subcategorize for a direct object or having a complementizer C^0 subcategorize for a TP, perhaps even for stating Principle B of Chomsky's 1981 Binding Theory.

(8) a. 'hit' ↷ NP
b. C^0 ↷ TP
c. [anaphor, ref.index:i] ↶ [NP, ref.index:i]

The opposite of the GOVERNS schemata is also useful:

(9) NOTGOVERNS(X, Y) *abbreviation:* X ↷̸ Y
For all nodes N1 described by X and N2 described by Y, N1 does not govern N2.

This schema could be used to state Principle A of the Binding Theory (pronouns should not be governed) or for encoding odd morpheme-specific binding requirments (for example, the disjoint anaphor described by Saxon (1986) for Dogrib). It can be used to militate against mutually exclusive morphemes, for example, the English 3sg present agreement morpheme and a modal verb like *can*: [Func: '-s']↷̸[class: modal]. In chapter 12, we will see how it can be used for truncatory morphology, where the addition of one morpheme causes the "deletion" of another. Possibly, we could even state Menn and MacWhinney's (1984) repeated morph constraint:

(10) NOTGOVERNS ([Func: i], [Func: i])

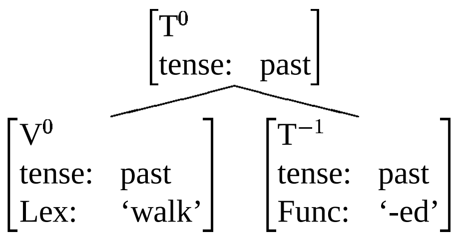
It is an open question as to exactly which hierarchical relationships should count as government for the purposes of this family of schemata. For concreteness, I will assume throughout most of this sketch that the relevant relationship is simply c-command. For example: $X \frown Y$ will be satisfied if you can get from the X node to the Y node by going up one level in the tree then down as many levels you like.

6.3 Short examples

6.3.1 Regular and irregular English pasts

The structure for a regular English past tense is repeated here:

(11) *walked*

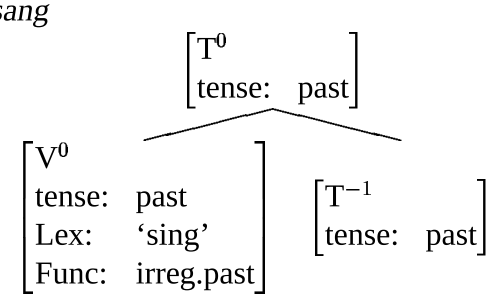


The presence of the *-ed* suffix is enforced by the constraint:

(12) [T^{-1}, tense: past] $\leftrightarrow$ [Func: ‘-ed’]

A different structure is needed for an irregular past such as *sang*. I propose that an irregular form like this involves a special functional index — let’s call it [Func: irreg.past] — on the same node as the lexemic index. The structure for *sang* would be:

(13) *sang*



The combination of [Lex: ‘sing’, Func: irreg.past] will have a different effect on the phonology than the index [Lex: ‘sing’] alone does. For now, I will assume that the Sy/Ph interface has constraints like the following.

(14) a. [Lex: ‘sing’, Func: irreg.past] *sounds like* [sæŋ] ≫
b. [Lex: ‘sing’] *sounds like* [sɪŋ]

The idea of “sounds like” will be formalized in chapter 8. The important point to note for now is that the interface constraints sensitive to the combination (14a) must outrank the constraints sensitive to the lexemic index alone (14b) — an unsurprising manifestation of the Elsewhere Principle.[3]

The presence of the [Func: irreg.past] index can be enforced by a constraint such as:

(15) [Lex: ‘sing’, tense: past] → [Func: irreg.past]

This is one of a number of similar constraints of English such as those in (16), probably all ranked in the same neighbourhood of the hierarchy.

(16)
[Lex: ‘write’, tense: past] → [Func: irreg.past]
[Lex: ‘fall’, tense: past] → [Func: irreg.past]
[Lex: ‘stand’, tense: past] → [Func: irreg.past]
[Lex: ‘sleep’, tense: past] → [Func: irreg.past]
⋮

Constraint (15) is enough to prevent a fully regular realization of the past tense of *sing* as [sɪŋd], since it will assess a violation mark against the following representation:

(17) *singed*

$$\begin{bmatrix}\mathrm{T}^0 & \\ \text{tense:} & \text{past}\end{bmatrix}$$

$$\begin{bmatrix}\mathrm{V}^0 & \\ \text{tense:} & \text{past} \\ \text{Lex:} & \text{‘sing’}\end{bmatrix} \quad \begin{bmatrix}\mathrm{T}^{-1} & \\ \text{tense:} & \text{past} \\ \text{Func:} & \text{‘-ed’}\end{bmatrix}$$

But so far we have no way of preventing the candidate in (18), whose most likely phonological realization would be [sæŋd] *sanged*, which is exactly the structure we would expect to be optimal given only the constraints we have seen so far.

(18) *sanged*

$$\begin{bmatrix}\mathrm{T}^0 & \\ \text{tense:} & \text{past}\end{bmatrix}$$

$$\begin{bmatrix}\mathrm{V}^0 & \\ \text{tense:} & \text{past} \\ \text{Lex:} & \text{‘sing’} \\ \text{Func:} & \text{irreg.past}\end{bmatrix} \quad \begin{bmatrix}\mathrm{T}^{-1} & \\ \text{tense:} & \text{past} \\ \text{Func:} & \text{‘-ed’}\end{bmatrix}$$

[3] In fact, we will see that the only aspects of Ph that need to be specified in (14a) are the features of the vowel, since these are the only specifications of (14b) that need to be overridden.

The idea we need to capture is that [Func: '-ed'] and [Func: irreg.past] are mutually incompatible. This can be enforced by a constraint of the NOTGOVERNS family from section 6.2.1.

(19) NOTGOVERNS ([Func: '-ed'], [Func: irreg.past])
abbreviation: ed$\not\curvearrowright$irreg.past

This constraint can be satisfied through the absence of the governee [Func: irreg.past], but it can also be satisfied through the absence of the governor [Func: '-ed'], as in the actual optimal candidate in (13). Each of the two possible absences violates a constraint — (15) and (12) respectively. It must therefore be the case that (12) is ranked lower than (15). A summary of the constraints we have been considering is given in (20). The tableau in (21) shows how these constraints apply to the candidates *sang* (13), *singed* (17), and *sanged* (18).

(20) { [Lex: 'sing', tense: past] → [Func: irreg.past]
NOTGOVERNS ([Func: '-ed'], [Func: irreg.past]) }
≫
[T^{-1}, tense:past] ↔ [Func: '-ed']

(21)

	Sy	'sing',past→irreg.past	ed$\not\curvearrowright$irreg.past	T^{-1},past↔'-ed'
☞	*sang*			*
	singed	*!		
	sanged		*!	

It is interesting to note that it is not impossible to get a hybrid regular/irregular realization such as *sanged.* It is merely a matter of constraint ranking. With a different ranking, such forms would be possible, as they are in the speech of many children[4] and, as we will see in the next section, in German plurals.

6.3.2 Regular and irregular German plurals

Within masculine nouns in German we can distinguish two basic ways of marking plurality: the "regular" suffix *-e*[5] and umlaut (a phonological change on a vowel of the stem). But where

[4]This approach also offers us a way of understanding the double-regular forms used by many children, for example, [wɑktəd] *walkded.* It is commonly held that children begin learning every past form by memorization, i.e., as if every past form were irregular, and that only after they have memorized a number of adult-regular forms do they formulate a regular "rule". Under the current analysis, the child's initial Sy representation of the past tense *walked* would be [Lex: 'walk', Func: irreg.past] and there would be a corresponding memorized Sy/Ph interface constraint "[Lex: 'walk', Func: irreg.past] sounds like [wɑkt]." Later the regular constraint [T^{-1}, tense: past] →[Func: '-ed'] would be adduced. If at this stage the constraint ed$\not\curvearrowright$irreg.past has not yet been adduced or if its ranking has not yet stabilized, the expected form of the past tense would indeed look liked *sanged* in (18) and be pronounced [wɑktəd].

[5]For brevity, I leave aside here questions such as whether *-e* or *-er* should be considered the more basic allomorph of the masculine plural suffix, how exactly the choice between them is made, and whether it would be better to analyze the system using inflection classes as in section 5.3 rather than referring directly to syntactic gender.

the regular and irregular manifestations of the English past tense were mutually exclusive, the German plural shows all four logical possibilities: plurals with *-e*, plurals with umlaut, plurals with both, and plurals with neither. The possibilities are shown in table 6.1.

Regular -e		
der Tisch	‘table’	die Tische
der Krieg	‘war’	die Kriege
der Pilz	‘mushroom’	die Pilze
Umlaut		
der Ofen	‘oven’	die Öfen
der Vogel	‘bird’	die Vögel
der Bruder	‘brother’	die Brüder
Regular -e plus umlaut		
der Baum	‘tree’	die Bäume
der Stuhl	‘chair’	die Stühle
der Koch	‘cook’	die Köche
Neither regular -e nor umlaut		
der Spiegel	‘mirror’	die Spiegel
der Wagen	‘car’	die Wagen
der Onkel	‘uncle’	die Onkel

Table 6.1: German masculine plurals

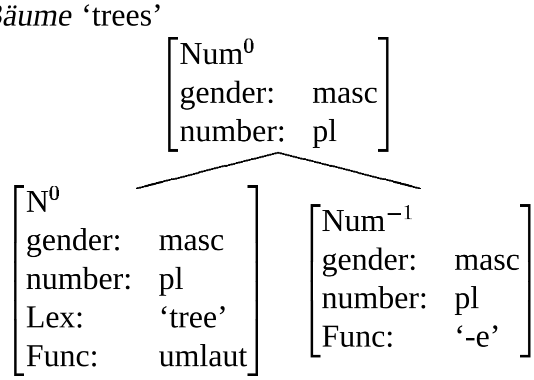
Many of the constraints involved in this system are just like their English counterparts:

(22) [Num^{-1}, gender: masc, number: pl] $\leftrightarrow$ [Func: ‘-e’]

(23) [Lex: ‘brother’, number: pl] $\rightarrow$ [Func: umlaut]
[Lex: ‘tree’, number: pl] $\rightarrow$ [Func: umlaut]
⋮

Unlike the English case, however, we also find hybrid regular/irregular forms with both *-e* and umlaut:

(24) *Bäume* ‘trees’



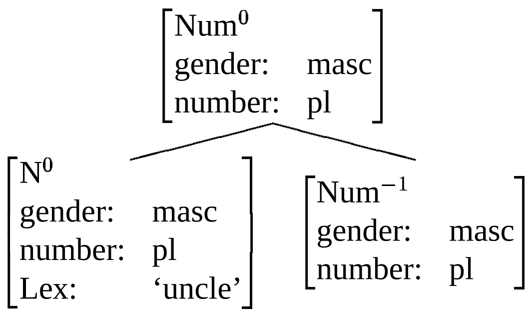
This strongly suggests that the incompatibility is not between the [Func: ‘-e’] index and the [Func: umlaut] index, but between the [Func: ‘-e’] index and individual lexemic indices such as [Lex: ‘brother’].

(25) NOTGOVERNS ([Func: ‘-e’], [Lex: ‘brother’]) *abbr:* -e$\not\curvearrowright$brother

The fourth class of nouns, with neither the *-e* suffix nor umlaut, offers further evidence that the incompatibility is not with the index [Func: umlaut]. *Die Onkel* ‘uncles’ has no [Func: umlaut] feature, yet it still cannot have a *-e* suffix — suggesting that the relevant constraint is (26), which would favour the correct structure in (27).

(26) NOTGOVERNS ([Func: ‘-e’], [Lex: ‘uncle’]) *abbr:* -e$\not\curvearrowright$uncle

(27) *Onkel* ‘uncles’



In order for (27) to be optimal, we also have to prevent spurious occurrences of [Func: umlaut] — merely pointing out that [Lex: ‘uncle’] does not *require* [Func: umlaut] is not enough. A constraint against the mere presence of [Func: umlaut] would do the job, though we might be seeing a (perhaps very low-ranked) constraint against functional indices in general. Constraints like (23) that require [Func: umlaut] for particular lexemes would outrank this *FUNC constraint. But in the absence of a constraint like [Lex: ‘uncle’, number: pl] → [Func: umlaut], a candidate like (27) but with a [Func: umlaut] would fall victim to the low-ranked *FUNC.[6]

6.4 Elaboration

6.4.1 Alternatives to head movement

In this chapter, as elsewhere in this sketch, I have been assuming that the sub-X^0 structures for inflected words are built through the operation of head movement. There are some attractive

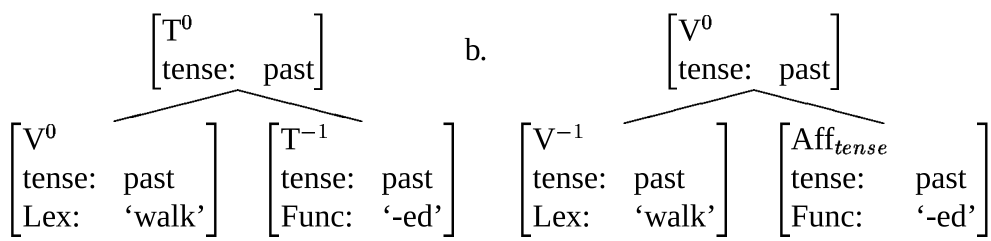
[6]In this analysis, I’m also assuming there’s a coherent phonological interpretation of the feature [Func: umlaut], that is, that the relevant Sy/Ph interface constraint is “[Func: umlaut] souns like...”, rather than there being a separate “[Lex: ‘brother’, Func: umlaut] sounds like...” constraint for each noun stem. If the latter were the case, we could just as well say that *die Onkel* ‘uncles’ also bears [Func: umlaut] but that there’s no interesting “[Lex: ‘uncle’, Func: umlaut] sounds like...” constraint that outranks the general “[Lex: ‘uncle’] sounds like...” constraints. For an idea of what the Sy/Ph interface constraints for [Func: umlaut] might be, see Féry’s (199xxx) OT treatment of German umlaut.

aspects to this assumption. For example, it offers a simple explanation for Baker's Mirror Principle, viewed as a statistical descriptive generalization.[7] More specifically, it can help explain the observation of Bybee (1985) that the strong universal tendencies for the ordering of morphemes inside a verb coincide with the tendencies for ordering the corresponding markers when they are "syntactically" expressed rather than "morphologically" expressed. Finally, the functional categories demanded by a head-movement account can often serve as an excellent skeleton or framework for the distribution of morphemes in languages that seem to make heavy use of "position class" morphology. (See Rice (1993, 1998) for an illustration of how the position classes of an Athapaskan language can be modelled as the result of head-movement through the functional categories in a sentential syntactic structure.)

But head movement is by no means a prerequisite of doing morphology in an MOT framework. Some specific assumptions about sub-X^0 structure are needed in order to offer concrete analyses, and I chose head movement as one of those assumptions mostly for its familiarity rather than for its clear superiority over the alternatives. While I do not have the space to explore (or even mention) all the alternatives to the specific working assumptions I make in this sketch, there are enough other successful approaches to morphology that do not rely on the idea of head movement that it is worthwhile illustrating briefly how some of those alternatives too could be framed in MOT. I will refer to "local construction" of sub-X^0 structure, for lack of a better term to constrast with construction via head movement.

In some cases, different assumptions about headship, etc., result in relatively minor relabellings of word structures. Instead of the regular past tense structure of (1), repeated below as (28a), we could have the structure in (28b), which is more in keeping with the proposals of, for example, Selkirk (1982) and Jackendoff (1997).

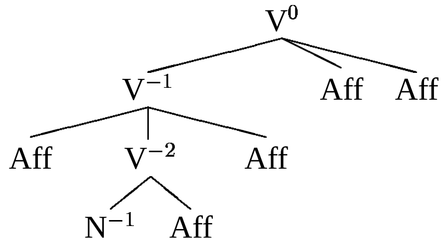
(28) a. b.



There is no inherent limit to the complexity of words built by local construction. Specifically, without some additional constraint, there is no need for them to be binary-branching. For a tree like (29), it might be possible to express the order of the affixes using alignment constraints, as discussed in chapter 9, or else linear order might be added as a primitive relation in syntactic or morphological sub-representations.

(29)

[7] "Morphological derivations must directly reflect syntactic derivations (and vice versa)" (Baker, 1985). Exceptions to mirroring can be handled with parochial morphemic constraints that outrank the usual functional subcategorization constraints.



The question of whether words are best handled using head-movement or local construction is separate from the question of whether word-structure exists as a level of representation independent from wider sentence structure. Structures like (29) could continue to occupy their place in an integrated morphological/syntactic Sy sub-representation, or they could live in their own sub-representation, as assumed in many frameworks.

Finally, it should be noted that head-movement construction and local construction are not mutually exclusive possibilities. The kinds of analyses I give for derivational morphology in chapter 12 are much closer in spirit to local construction than to head movement. It might even be possible for inflectional morphology to be handled by constraints of both types: X^0 structure might normally be handled by head-movement constraints, resulting in words that mostly obey the Mirror Principle, but local-construction constraints may exceptionally demand other nodes and functional indices in addition to or instead of those that would ordinarily arise through head movement.

6.4.2 Word-syntax and realizational morphology

There have long been two seemingly irreconcilable approaches to explaining the forms and orders of inflectional morphemes in a word, perhaps most famously distinguished by Hockett (1954), who dubbed them "Item-and-Arrangement" and "Item-and-Process". The two extremes might be caricatured as follows:

1) Inflectional morphemes are chunks of phonetic matter, stored in the lexicon alongside noun and verb stems. The morphology and/or syntax of a language defines positions within words where the various kinds of morphemes can be used (with template slots or with complex X^0 nodes assembled by head movement, for example). Words are built by choosing a morpheme for each position and putting its phonetic stuff in the appropriate place.

2) Inflectional morphology is accomplished by taking the stem of the word and doing things to it according to rules which are triggered by morphosyntactic features: "Add [s] if we're making a plural noun", "Delete the final consonant if we're making a masculine adjective", "Make the final vowel [+front] if we're making a past tense verb."

Following common terminology, I will refer to the first extreme as the **word-syntax** approach, and to the second as the **realizational** approach. Examples of word-syntax approaches include Selkirk (1984) and Lieber (1992). Realizational approaches have been argued for by a number of researchers, a selective list includes Matthews (1972), Carstairs

(1987), Anderson (1992), Beard (1995), Aronoff (1994), Stump (1991, 1993), and Zwicky (1992).

Pure word-syntax approaches are quite attractive for analyzing languages with low degrees of fusion, i.e., very few portmanteau morphs and a relatively one-to-one relationship between morphs and morphosyntactic features. The more that a morphological system deviates from this agglutinating prototype, the more trouble word-syntax approaches have dealing with them. Much of the history of Autosegmental Phonology can be seen as an attempt to show that apparently intractible types of morphological marking, such as vowel ablaut and Semitic-style root-and-pattern systems, can really be treated as the concatenation of discrete, meaningful URs after all. This has had a high degree of success, but not complete success: no matter how clever you are, it is hard to make the morphologically triggered deletion of segments look like a piece of phonetic content that has been stored in the lexicon.

Realizational morphology can easily take in stride the problem cases for word syntax. But many of the actual formal systems proposed to do relational morphology are so computationally powerful that one might doubt whether there is anything they could *not* take in stride, including manifestly unhuman patterns. Realizational approaches excel at analyzing systems with a high degree of fusion. They don't have any particular formal problem dealing with non-fusional agglutination, but the very lack of fusion often seems to be a pure accident, a mysterious side-effect of the particular system of rules the language uses. There is no clear explanation for the tendency toward a one-to-one correspondence between morphs and morphosyntactic features. Relational approaches often have to go to great lengths to define a concept as simple (from the word-syntax point of view) as "primary exponent" (e.g., Matthews, 1972; Carstairs, 1987; Noyer, 1992; Beard, 1995).

A complex syntactic structure underneath the X^0 level, as used in this sketch, is generally assumed to put a theory squarely in the camp of the word-syntax models. However, the framework argued for here also allows for the natural expression of the insights of realizational analyses of morphology. I argue that the most significant difference between realizational and word-syntax approaches lies not in how they believe the phonetic stuff of prefixes and suffixes ends up in a word, but in what they believe to be the relation between the formatives of a word and its morphosyntactic features, specifically in which one is assumed to be logically prior. Do morphemes determine morphosyntactic features, or do morphosyntactic features determine morphemes? A word-syntax approach would say that the word *loved* has the feature [past] because it has the suffix *-ed* (which introduced the feature, which percolated up to the word level). A realizational approach would say that the word *loved* has the suffix *-ed* because it has the feature [past] (which triggered a rule, which added the suffix).[8]

Word-syntax and realizational approaches each have half of the answer. Realizational approaches are good at expressing generalizations of the form:

(30) $[T^{-1}$, tense: past$] \rightarrow$ [Func: '-ed']

Word-syntax approaches are good at expressing generalizations of the form:

[8] Various other permutations are possible, such as the model of Steele (1995), where neither the features nor the morphs are prior but both result from the application of rules.

(31) [Func: '-ed'] $\rightarrow$ [T^{-1}, tense: past]

Generalizations of both forms are important. Missing either kind of generalization results in a theory which, while it may be descriptively adequate at the formal level, fails to completely explanatory. MOT makes it possible to express (and enforce) both kinds of generalizations simultaneously, with bidirectional implications which will assess violation marks if either direction is violated:

(32) [T^{-1}, tense: past] $\leftrightarrow$ [Func: '-ed']

The tendency toward a one-to-one relationship between features and formatives is often masked and occasionally flouted, though always present, as one would expect to find when dealing with constraints in an OT framework.

Both realizational and word-syntax approaches run into problems because of their assumption that morphological implications can only go in one of these directions. While they make different choices on which direction to use, they share a common commitment to the assembly-line paradigm of grammar: word-level features are the pre-existing raw material out of which formatives must be made, or vice versa. By abandoning the assembly-line paradigm, an OT approach to morphology can enforce (or not) both directions of the default one-to-one relationship and avoid the weaknesses of both the word-syntax and the realizational approaches.

Chapter 7

Spellout, yields, and morphs

7.1 What we need

Until now, we have mostly treated linguistic representations as if they were completely unrelated subparts. This is clearly not the case. Each of the Ph, Sy, and Se sub-representations can be perfect (or as perfect as possible within an OT framework), but the representation as a whole can still be bad.  can be a perfectly good semantic representation. [N^0, Lex: ‘cat’] can be a perfectly good syntactic representation. But they are not good representations *for each other*. A grammar/lexicon will need some way of ensuring that Sy and Se sub-representations are mutually appropriate.

The same can be said of the Ph and Sy sub-representations. [k^{h}æt] may be a good Ph, and [N^0, Lex: ‘dog’] may be a good Sy, but they are not good *for each other*. In chapters 8 and 9, we will look at the kinds of constraints whose job it is to ensure that Ph and Sy sub-representations are mutually appropriate. In this chapter, we look specifically at the fundamental relationship between pieces of Ph and Sy representations that allows them to “belong” to each other.

7.2 Implementation

A candidate in an evaluation does not consist just of three sub-representations, ⟨Ph, Sy, Se⟩, but also of relations between various parts of those representations. We are concerned here with the relations between nodes of the Sy representations and pieces of the phonological representation. Let us refer to the set of Sy/Ph relations as **spellout** relations. Also, if a syntactic node and a string of phonological root nodes stand in a spell-out relation, I will refer to the string of root nodes as the **yield** of the syntactic node.

For example, in figure 7.2, there are three spell-out relations:

1. between the [Lex:‘cat’] node and the three root nodes dominating the features for [kæt]

2. between the [Func:‘-s’] node and the root node dominating the features for [s]

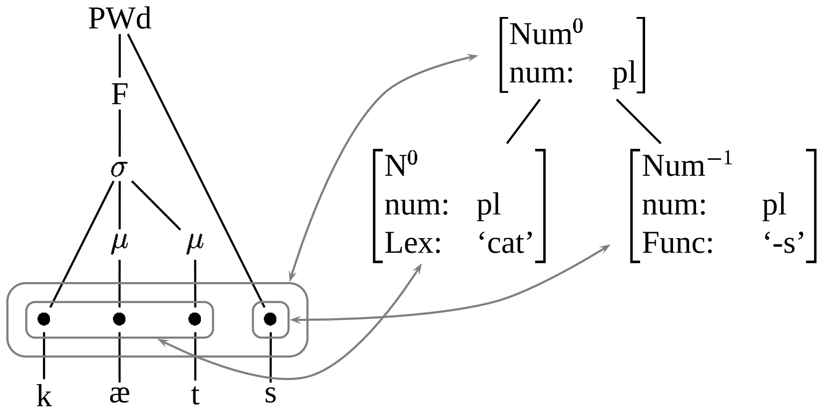


Figure 7.1: Spellout relations

3. between the mother node (Num^0) and all four root nodes

Here, as is usually the case, the yield of the mother node exhaustively contains the yields of its daughter nodes.

If a Sy node bears a morphemic index, let us refer to the yield of that node as the **morph** associated with that index. So we can refer to the string consisting of the first three root nodes in figure 7.2 as the 'cat'-morph, and the string consisting of the fourth root node as the plural-morph. Morphs are objects in the phonological sub-representation.

It is worth pointing out that the definition of the spellout relation used here does not involve some of the assumptions which have often been held of morpheme exponents:

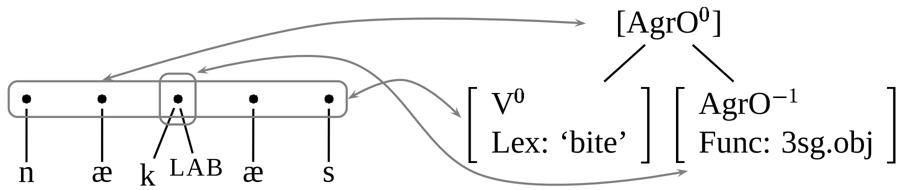
• Yields need not be mutually exclusive. This is obviously true, since the yield of a daughter will almost always be contained within the yield of its mother. But it is also true for terminal nodes. Specifically:

• Morphs need not be mutually exclusive. It is possible for morphs (sequences of Ph root nodes associated with a Sy node bearing a morphemic index) to overlap partially or completely.

(1)

In some languages, this may even be the normal situation. As an example of a morph which is completely contained within another, consider the 3sg object agreement of Chaha: *nækæs* 'he bit' vs. *nækʷæs* 'he bit him'. We can say pre-theoretically that the "object agreement morpheme is realized by the feature LAB." In MOT terms, an Sy node will contain the index [Func: 3sg.obj], and the corresponding Ph morph will be the root node that the labialization feature is associated to.

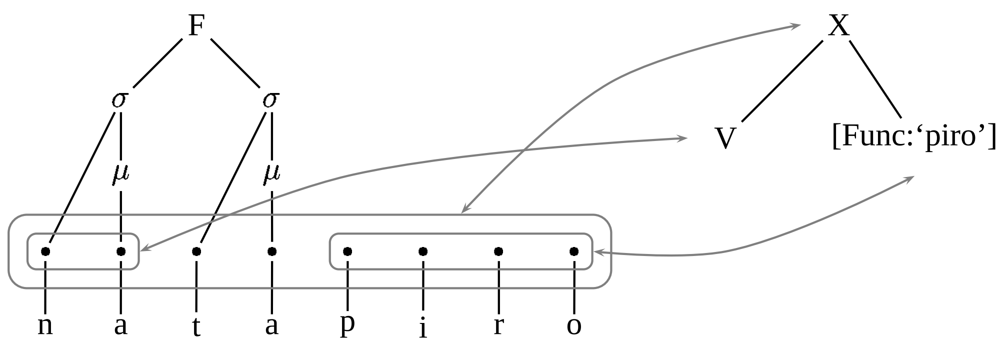
(2)



Here, the root node of the second consonant belongs both to the morph of [Lex: ‘bite’] and the morph of [Func: 3sg.obj].

• Morphs need not be exhaustive. There may be root nodes which belong to no morph. Various anti-structure and alignment constraints will disfavour this situation, but it is not forbidden by the architecture of the theory. For example, the Ph root node of an epenthetic segment might not belong to the yield of any Sy terminal node, though it will belong to the yield of one or more Sy non-terminal nodes. The Axininca Campa word *natapiro* consists of the suffix *-piro* and the verb stem *na-*. The two additional segments *ta* are epenthetic, forced by the suffix’s desire to attach to a prosodic foot (McCarthy and Prince, 1993b). Under the current assumptions the epenthetic segments need not be part of either morph, though they do belong to the yield of the mother node.

(3)



If we count up everything dominated by the root nodes of a morph, the morph may “contain” a great deal more material than can be blamed on its association with any particular morphemic index. For example, in (2) the DOR feature of the second consonant *k* can be blamed on the verb morph’s association with the lexemic index [Lex: ‘bite’], but the feature LAB cannot be. Yet, the LAB feature still “belongs” to the ‘bite’ morph, as much as any feature dominated by the right stretch of root nodes does. Especially if we adopt the “radically underspecifying” model proposed in section 8.1.2, it may that very few of the features dominated by the root nodes of a morph are actively demanded by the idiosyncratic lexical requirements of a morphemic index. In many respects, it is more accurate to view the morph, not as the incarnation of the morphemic index in the phonological sub-representation, but simply as a domain for checking whether interface constraints are satisfied.

For concreteness, I assume that a Sy node with both a lexemic and a functional index will have only one associated morph, not two. That is, morphs (as an interesting sub-type of yields) are related to syntactic nodes, not to individual syntactic features.

7.3 Elaboration

7.3.1 Connections

MOT's laissez-faire attitude to what material can be counted as part of a morph has not been shared by all other approaches. For example, the original version of OT had an almost mystical conception of what it meant to have a morphological affiliation:

> "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... Something similar to Consistency of Exponence was first mooted by Pyle (1972:522), who noted that morphological boundary theory implausibly requires that epenthetic segments be assigned an arbitrary morphological affiliation. (McCarthy and Prince, 1993b, 20–21)

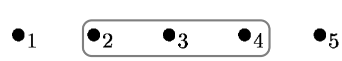
Since morphological affiliation can not be read directly of a Ph representation, this assumption would require some sort of fancy bookkeeping system to keep track of which fragments of a representation "belong" to which morphemes. (Correspondence Theory might be seen as a way of formalizing this fancy bookkeeping system.)

MOT makes it possible to avoid these problems, without making arbitrary choices about morphological affiliation or constructing an additional mechanism of a bookkeeping system. Since "morpheme" *tout court* has no theoretical status in MOT, it makes no sense to ask which morpheme a Ph segment or feature belongs to. The things MOT *is* able to talk about coherently are morphemic indices and morphs. The corresponding questions are easy to answer. Is a Ph node "part" of a morphemic index? Clearly not, since they live in entirely separate sub-representations. Is a Ph node "part" of a morph? Yes or no, but in any case clearly decidable by looking at the root nodes of the Ph representation.

7.3.2 Discontinuous morphemes

I am assuming that a Sy node may have at most one morph. This assumption is not logically necessary. It is quite conceivable that one-to-many yield relationships could be the appropriate implementation for apparently discontinuous morphemes (e.g., the *ge-...-en* "circumfix" of the German past participle) and some other problem cases for structuralism. But other implementations are also possible, so for simplicity I will assume that the possibility of one-to-many yield relationships is not available. Like lexemic and functional indices, the yield of a node may be seen as the value of a feature whose attribute must be unique within the node.

(4)



$$\begin{bmatrix} N^0 & \\ \text{Lex:} & \text{`...'} \\ \text{Yield:} & \{\bullet_2, \bullet_3, \bullet_4\} \end{bmatrix}$$

Another conceivable way of dealing with discontinuous morphemes would be to allow yields themselves to be discontinuous, i.e., allowing morphs and other yields to consist of any arbitrary set of root nodes. Under this assumption, the discontinuous morpheme would still involve a unique relationship — a single Sy node would have a single spell-out relationship with a single Ph object, a yield that just happens to be discontinuous. Again, for simplicity, I assume that this option is not available in the theory and that all yields are contiguous sequences of root nodes.[1]

7.3.3 Sy-Se relations

As pointed out at the beginning of this chapter, there will also be relations between the syntactic and semantic sub-representations, similar to the spell-out relations between Sy and Ph. I will have very little to say about these — an unavoidable consequence of having nothing to say about the nature of semantic representations. Some important points bear mentioning however.

The first is that those constraints on the Sy-Se interface which are sensitive to morphemic indices must be understood within the broad non-derivational framework of MOT. For example, there will be a constraint in English that a Sy node with [Lex: 'cat'] ought to stand in a relation with some piece of Se that represents a feline meaning. But this is not part of a unidirectional assembly line that takes a Se as input and builds a Sy as its output. Nor is it part of a set of interpretive principles that "reads off" meaning from an existing syntactic structure. Or rather, in a way, it can be both. In trying to explain where the morphemic indices in Sy come from, the idea from derivational theories that comes closest to the MOT take on the question is the idea of free lexical insertion: any morphemic index can show up on any node it wants to, although filters can throw out the entire result if the freedom was not exercised appropriately. (In fact, in an OT evaluation, at least logically if not psychologically, every possible result of free insertion is a candidate and almost all of them will be filtered out by the constraint hierarchy.) From this point of view, the constraint encoding the "meaning" of [Lex: 'cat'] is just one of the filters on the free construction of Ph, Sy, Se triples. (An implication of the MOT view is that questions of when lexical insertion takes place are irrelevant and that any explanation that relies on something happening before or after lexical insertion cannot be maintained. The closest MOT can come to a temporal view of lexical insertion is in imposing constraints on which node(s) in a chain may bear morphemic indices; see section 4.3.3.)

The second observation is that there is no a priori reason for these Sy-Se relations to focus on single syntactic nodes. At the very least, in a theory which has representation coding of virtual movement, it is probably more insightful to see the constraints as referring to chains: e.g., for the piece of an Se that has , the corresponding Sy node must belong to a chain

[1]Here and elsewhere when I say that something is not an option in the theory or is universally impossible, the prohibition may be tacitly assumed as part of what defines a potential candidate. Stretching the definition of the word "implemented", this could be implemented by positing a mechanism (call it Gen) that conveniently creates for us all and only the potential candidates. Alternatively, the prohibitions could be implemented as universal constraints on well-formedness that like other constraints are brought to bear in Eval, but which Universal Grammar ensures are never dominated.

which contains [Lex: 'cat'] somewhere within it. More substantively, the best treatment of idioms may involve mapping a single piece of the Se representation to a series of positions in Sy (which may contain several different morphemic indices), just as spell-out relations allow a single part of Sy to be related to a series of positions in Ph.[2]

[2]It may turn out that lexemic and functional indices behave differently with respect to the Sy-Se relation as well. It may be that lexemic indices can be directly subject to Sy-Se interface constraints, while functional indices can only relate to Se indirectly — Se relates with morphosyntactic features and it is the Sy features that are realized with functional indices.

Chapter 8

Phonomorphemic constraints I: Segmental requirements

In the last chapter, we defined the notion of spell-out relations between Ph and Sy representations. A string of root nodes (known as a morph) may stand in a spell-out relationship with a Sy terminal node bearing a morphemic index. In order for this to be useful, we need ways of constraining the properties of a morph based on which morphemic index it is associated with. The three root nodes of a morph associated with [Lex: ‘cat’] should have different properties (e.g., different segmental features) from the three root nodes of a morph associated with [Lex: ‘dog’].

In this chapter and the next, we develop ways in which an MOT grammar/lexicon can impose such constraints on the shape of morphs. This chapter concentrates on segmental features within morphs. Chapter 9 will examine alignment constraints on morphs — that is, how morphs may be constrained by instantiations of McCarthy and Prince’s Generalized Alignment schema.

8.1 Implementation

In this chapter I will present two different possible methods by which an MOT grammar/-lexicon could constrain the featural/segmental make-up of a morph. The first relies on a logical descriptive language based on first-order predicate calculus, and specifically on the possibility for quantified variables to have scope over several constraints, possibly ranked at different points in the hierarchy. For this reason, it will be referred to as the Variables method. The second method (the No-Variables method) does not rely on a grammar’s ability to express coreference between constraints.

The Variables method is fully capable of describing the shape of any morph — it is indeed probably too powerful. The No-Variables method has less expressive power, and to that extent is more interesting, though it may turn out not to be expressive enough to express a real language’s lexicon.

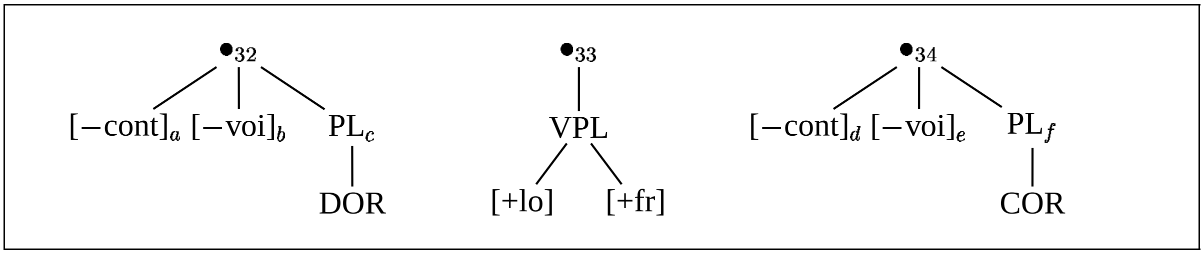


Figure 1: A partial representation for [kæt]

There exist nodes $r_1, r_2, r_3, p_1, p_2, p_3$, f_1, f_2, f_3, f_4, f_5, f_6, f_7, f_8, such that:
r_1 is a root node and r_2 is a root node and r_3 is a root node, and
p_1 is a place node and p_2 is a vowel-place node and p_3 is a place node, and
f_1 is a [−cont] node and f_2 is a [−voi] node and f_3 is a Dorsal node, and
f_4 is a [+lo] node and f_5 is a [+fr] node, and
f_6 is a [−cont] node and f_7 is a [−voi] node and f_8 is a Coronal node, and
r_1 dominates f_1 and r_1 dominates f_2 and r_1 dominates p_1, and
r_2 dominates p_2, and
r_3 dominates f_6 and r_3 dominates f_7 and r_3 dominates p_3, and
p_1 dominates f_3 and p_2 dominates f_4 and p_2 dominates f_5 and p_3 dominates f_8, and
r_1 precedes r_2 and r_2 precedes r_3

Figure 2: Semi-formal description of the representation in Figure 1

8.1.1 The Variables Method

The most straightforward way of constraining the shape of a morph is to provide a formal description of all those phonological properties that any morph associated with a morphemic index should satisfy. For example, consider the (partial) representation of *cat* in Figure 1. The statements in Figure 2 show one way of describing the nodes in Figure 1 and the relationships between them.

There are three main kinds of statements in Figure 2:

1. that a node is of a certain type (e.g., r_1 is a root node, f_6 is a [−cont] feature)

2. that two nodes stand in a dominance relation (indicated by association lines in the representation in Figure 1)

3. that two nodes stand in a precedence relation (implicitly indicated by horizontal placement in Figure 1).

The description in Figure 2 uses no more than the resources of first-order predicate logic. We could express Figure 2 using a formal logical language if we wanted to, either for conciseness, precision, or that impressive patina of scientific authoritativeness. Figure 3 shows one formalization of the description in Figure 2, using $\ell(X, T)$ to express that node X is

$$\exists r_1 \exists r_2 \exists r_3 \exists p_1 \exists p_2 \exists p_3 \exists f_1 \exists f_2 \exists f_3 \exists f_3 \exists f_4 \exists f_5 \exists f_6 \exists f_7 \exists f_8 \mid$$
$$\ell(r_1, \text{root}) \wedge \ell(r_2, \text{root}) \wedge \ell(r_3, \text{root}) \wedge \ell(p_1, \text{place}) \wedge \ell(p_2, \text{vplace}) \wedge \ell(p_3, \text{place}) \wedge$$
$$\ell(f_1, [-\text{cont}]) \wedge \ell(f_2, [-\text{voi}]) \wedge \ell(f_3, \text{DOR}) \wedge \ell(f_4, [\text{+lo}]) \wedge \ell(f_5, [\text{+fr}]) \wedge \ell(f_6, [-\text{cont}]) \wedge$$
$$\ell(f_7, [-\text{voi}]) \wedge \ell(f_8, \text{COR}) \wedge$$
$$r_1 \delta f_1 \wedge r_1 \delta f_2 \wedge r_1 \delta p_1 \wedge r_2 \delta p_2 \wedge r_3 \delta f_6 \wedge r_3 \delta f_7 \wedge r_3 \delta p_3 \wedge p_1 \delta f_3 \wedge p_2 \delta f_4 \wedge p_2 \delta f_5 \wedge p_3 \delta f_8$$
$$r_1 \prec r_2 \wedge r_2 \prec r_3$$

Figure 3: Formal first-order description of the representation in Figure 1

"labelled" as being of type T, $X \delta Y$ to express that node X dominates node Y, and $X \prec Y$ to express that node X precedes node Y.[1]

Dominance relations could include structure above the segment level as well. For example, a long vowel could be described by explicitly mentioning two moras:

(1) There exist r_3, m_1, m_2 such that:
m_1 is a mora, and m_2 is a mora, and r_3 is a root node, and
m_1 dominates r_3, and m_2 dominates r_3, and m_1 precedes m_2

The model-theoretic semantics of description

Tying descriptions to morphs

Issues:

Can statements referring to a single morphemic index be split up? Evidence seems to say yes.

If so, is it the same model for each? I.e., do collections of statements form quantificational domains such that variable identity tracked across several constraint ranks?

If so, such quantificational domains are sort of like underlying representations.

8.1.2 The No-Variables Method

The No-Variables method is conducive to a radically partial view of the phonological information in the lexicon. This is not *underspecification*, in the sense of having URs that contain very little structure — it is underspecify*ing*, in the sense of having constraints that don't ask for much structure. In the absence of a phonomorphemic constraint requiring some feature in a particular position, the choice of which feature to use there will be left up to lower ranked UG markedness constraints, which will choose the candidate with the "default" feature. The specific version of a No-Variables method argued for here also allows a convenient way to achieve *temporal* underspecification — the phonomorphemic constraints for some index may

[1]The descriptions in both Figure 2 and 3 might seem cumbersome. But it is important to keep in mind that they are no more complex than Figure 1. In fact, they contain exactly the same amount of information. The superficial difference between them is that the descriptions use English or a logical language to express the information while Figure 1 expresses the information in a diagrammatic form. The deeper difference is that Figure 1 pretends to be an actual representation (as much as any collection of ink on paper can "be" a mental representation of phonological structure), while Figures 2 and 3 merely *describe* the representation in Figure 1, as well as a number of other representations.

require two features without bothering to specify which order those features should come in in the winning candidate.

In this method, we make use of the same “schema predicates” which were used in the Variables method, and which have been used freely (if tacitly) in countless OT analyses. These schemata include domination and precedence. Unlike the Variable methods, though, the parameters of the schemata have a fixed quantificational interpretation — there is no possibility of having free variables which are bound from outside the schema.

(2) PRECEDES (‘write’; DOR, COR)

(3) PRECEDES (‘write’; COR, LAB)

For example, an instantiated schema like (2) could only be interpreted as: “Within the ‘write’ morph, there exists a dorsal node and a coronal node such that the dorsal node precedes the coronal node.” Specifically, if there is a second instantiated schema (3), the grammar/lexicon has no way of requiring that the node that satisfies the COR description in (2) be exactly the same one that satisfies the COR description in (3).

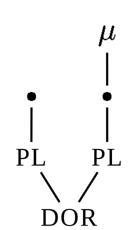
The schemata I will use are CONTAINS, OVERLAP, and PRECEDES. The following are example instatiations of these schemata, together with the abbreviations I will usually use.

(4)	CONTAINS (‘cat’; DOR)	$_{\text{cat}}$(DOR)
(5)	OVERLAP (‘tax’; DOR, μ)	$_{\text{tax}}$(DOR ◀ μ)
(6)	PRECEDES (‘write’; DOR, COR)	$_{\text{write}}$(COR $\prec$ DOR)

$_{\text{cat}}$(DOR) expresses the constraint that the morph for ‘cat’ must contain a dorsal node. (More technically, there exists a root node which dominates a dorsal node and which falls between the left and the right boundaries of the morph associated with [Lex: ‘cat’] in syntax. This is an absolute rather than a scalar constraint — failure to meet any or all of the conditions will result in a single violation mark.)

The instantiated OVERLAP schema in (5) is satisfied if the candidate contains a dorsal node and a mora that have dominance paths to the same root node within the ‘tax’ morph. (7) shows one configuration that will meet this particular requirement, since the second root node is both dominated by a mora and (indirectly) dominates a dorsal node.

(7)



In the abbreviations for OVERLAP constraints, I'll use a solid circle symbol if the two nodes referred to do not stand in a dominance relation, as in (8), and Bernhardt and Stemberger's (1997) triangle symbol if they do, as in (9).

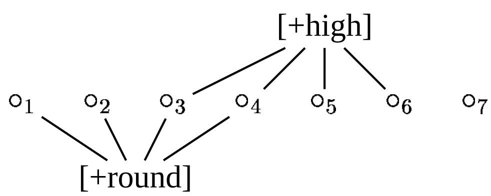
(8) $_{\text{mouse}}$(LAB ● [+nasal])

(9) $_{\text{mouse}}$(COR ◀ μ) or $_{\text{mouse}}$(μ ▶ COR)

There is some question as to the best interpretation of the PRECEDES schema. Specifically, it is not clear whether a candidate that looks like (11) should satisfy the constraint in (10).

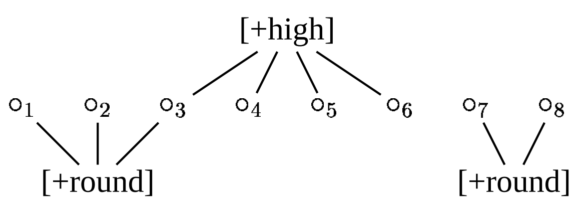
(10) $_{\text{index}}$([+high] $\prec$ [+round])

(11)



There is, after all, a root node ($\circ_3$) connected to [+high] which precedes a root node ($\circ_4$) connected to [+round]. But perhaps it would be more appropriate to insist that there is a precedence relation between entire domains, that is, the rightmost root node connected to the [+round] precedes the leftmost root node connected to [+high]. In this case, (11) would not satisfy the constraint, but a candidate that looked like (12) would:[2]

(12)



It is not clear which of the two interpretations will prove to be the most empirically adequate. For concreteness, I will assume the second interpretation — the rightmost root node of the first domain must precede the leftmost root node of the second.

Sets as parameters

There is an additional enrichment of the notation that may or may not turn out to be necessary. Instead of having only single nodes or features as its parameters, it may be possible for the PRECEDES schema to talk about sets of nodes or features. For example,

[2]This example emphasizes that the positions of the schema are interpreted existentially, not universally. All that is required that some [+round] domain (not every [+round] domain) precedes some [+high] domain.

(13) PRECEDES (‘write’, {DOR, [−son], [−voi]}, {COR, [−son], [+cont], [−voi]})
abbreviation: $_{\text{write}}$(k $\prec$ t)

It is possible that a constraint like (13) will always be replaceable with a number of simpler constraints using no sets as their arguments. This is especially likely if there is a rich enough vocabulary of prosodic descriptors available (e.g., $\acute{\mu}$, $\sigma_{\mu\mu} \prec \sigma_{\mu}$, etc.) While I believe that this possibility of avoiding sets as parameters is more interesting than using them, for simplicity I will usually use abbreviations like (13) in the rest of this sketch.
(Note that using sets as parameters is a reintroduction of some of the ability of the Variables method to enforce coreference between root-node descriptors, but a more limited version. Also, allowing a set to be the parameter of CONTAINS renders the OVERLAP schema superfluous. CONTAINS (‘mouse’; {LAB, [+nasal]}) is indistinguishable from OVERLAP (‘mouse’; LAB, [+nasal]).)

8.2 Illustration

This section illustrates how a No-Variable method of specifying phonomorphemic constraints can succeed in selecting the appropriate surface candidate, even with a very minimal amount of information given for a morpheme. The idea is that, even if set of features asked for by the phonomorphemic constraints is very “unstructured”, general markedness constraints of UG or phonotactic constraints of the language will ensure that the required features end up in their most natural position.[3]

It seems that the morphemic constraints for English ‘cat’ don’t have to specify any more than the following arbitrary facts:

(14) $_{\text{cat}}$(DOR)
$_{\text{cat}}$([+low] $\bullet$ [+front])
$_{\text{cat}}$([−son] $\bullet$ μ)

The morph contains a dorsal node. It contains a root node that dominates both [+low] and [+front]. And it contains a moraic obstruent.

The following observations about markedness allow us to predict where these features should go in the least marked candidate:

1. Unmarked syllables have onsets.
2. Unmarked consonants are plosives.
3. Unmarked consonants are coronals. (*DOR, *LAB)

[3] Prince and Smolensky (1993) took a very similar approach to the distribution of features within a segment. They argued that the UR of a segment was an unstructured collection of features and that the general segment-structure constraints of the language ensured that these features were occurred under the right class nodes. A draft of Golston (1996) posted to the Rutgers Optimality Archive argued that the same approach could be used at the syllable level.

4. Dorsals tend to precede coronals.

5. More sonorant moras precede less sonorant moras within a syllable (a corollary of the Sonority Sequencing Generalization).

The idea that dorsals precede coronals as a universal (though very weak) markedness constraint will be defended in the Elaborations section. For now, it is enough to think of it as a parochial phonotactic constraint of English, for example, as the constraint responsible for the possibility of [ækt] but the impossibility of [ætk].

Let us assume that the three phonomorphemic constraints for ‘cat’ in (14) outrank all of the markedness constraints. So for now we’ll only consider those candidates which satisfy all of the constraints in (14) and see how the markedness constraints are enough to distribute the marked characteristics of the morpheme into the correct places. Some of the candidates which satisfy all of the constraints in (14) are:

(15) [tæk] [kt̩æ] [xæt] [kæs] [kæk] [æk]

The transcription [kt̩æ] is intended to represent a candidate where a moraic [t] precedes a moraic [æ]. All of these candidates would have survived the earlier stages of the evaluation where the constraints of (14) work. The later stages of the evaluation, where the low-ranking markedness conditions come into play, would look like:

(16)

Ph	ONSET	*FRICATIVE	*DOR	DOR≺COR	SONORITYSEQ
☞ [kæt]			*		
[tæk]			*	*!	
[kt̩æ]			*		*!
[xæt]		*!	*		
[kæs]		*!	*		
[kæk]			**!		
[æk]	*!		*		

Note that all candidates that have survived this far will contain at least one violation of *DOR due to the effect of the higher ranking ${}_{\text{cat}}$(DOR) constraint.

In order to get a morph that looks like any of the rejected candidates in (16), additional phonomorphemic constraints would be needed to outrank the appropriate markedness conditions. For example, *tack* would require that the universal DOR≺COR be outranked by:

(17) ${}_{\text{tack}}$(COR ≺ DOR)

The word *act* would also require at least one additional constraint. Some of the possibilities are:

1. explicitly prohibiting an onset (which we haven't developed the vocabulary for),

2. implicitly prohibiting an onset (for example, by a higher-ranking ALIGN ('cat', L; æ, L), somewhat as in the Variables method)

3. requiring both a moraic COR and a moraic DOR, and having anti-structure constraints like *COR and *DOR outrank ONSET.

Which of these possibilities is the most appropriate cannot really be decided in isolation, but would require taking into account the entire phonology of markedness in English. (There is also no necessary guarantee that every learner of English would choose the do it the same way.)

8.3 Elaboration

8.3.1 Connections

The discussion of the Variables method of description comes directly from work in Declarative Phonology. It was pioneered in Bird (1990). See also works such as Scobbie (1991), Russell (1993), Walther (1995, 1997), Coleman (1998), and Bird (1995).

Features associated with higher categories higher than the segment in Prosodic Phonology (e.g., Waterston)

Positional tendencies for different places of articulation (e.g., Macken on templates in child language)

8.3.2 What's MOT and what's not

8.3.3 Ranking phonomorphemic constraints

One of the questions that might be raised is where exactly the phonomorphemic constraints discussed in this chapter are ranked in the constraint hierarchy of a language's grammar/-lexicon. Some of the possible answers are:

1. *Anarchy:* A phonomorphemic constraint can be ranked anywhere. If a language has 500,000 phonomorphemic constraints, then there are 500,000! possible rankings (not counting the possibility of ties and interactions with constraints of UG).[4]

[4] The number 500,000 is a *very* rough estimate of the number of phonomorphemic constraints that will need to be in an average speaker's grammar/lexicon. This number should not cause the reader any undue panic. There is unavoidably a huge amount of unpredictable, idiosyncratic facts that a learner must memorize about individual lexical items, however we choose to account for them in our theory. The number of raw lexical facts to be memorized does not diminish if our theory uses underlying representations instead of constraints — in fact, it may increase. The number 500,000!, on the other hand, probably *is* worthy of panic.

2. *Clumping:* Phonomorphemic constraints tend to be ranked together at the same level(s) in the hierarchy (either at one level or in a small number of levels). If a speaker learns a new lexical item, the phonomorphemic constraints for it should be ranked at the same level as other similar phonomorphemic constraints in the absence of evidence to the contrary.

3. *Lowest possible ranking:* Each phonomorphemic constraint will be ranked at the lowest possible point in the hierarchy that will place it above all the UG constraints that it forces violations of. For example, $_{\text{tack}}$(DOR) will be ranked just above the highest ranked of the UG constraints it overrules (NOCODA, *DOR, etc.), but no higher.[5]

Linguists are by temperament forced to consider the first possibility frightening, or at best intolerably boring. We would like there to be some general principles at work in the ranking of phonomorphemic constraints. It remains an unanswered empirical question whether the correct approach is the second or third, or perhaps some other even more attractive possibility I can't think of.

8.3.4 Tangential defences

How this is related to underspecification

the constraints of (14) are much like a radically underspecified UR

but: phonomorphemic constraints can underspecify time as well

well suited to those phenomena where the choice of which segment bears an "underlying" feature depends on factors in the environment. Esp. C/V tiers in Yawelmani

8.4 Example: Rotuman metathesis

[5] In either the second or third possibilities, the interaction of two phonomorphemic constraint with each other may also serve as evidence that one of them should be ranked more highly than it otherwise would be according to these principles.

Chapter 9

Phonomorphemic constraints II: Alignment

Most work in OT assumes aims to have purely universal constraints, with only the rankings between them being a matter for cross-linguistic variation. In constrast to this, we have been proposing vast numbers of constraints which are sensitive to individual morphemic indices, and therefore clearly language-specific. This is not without precedent in the practice of OT, if not its ideology. It has long been been accepted (though not always in so many words) that alignment constraints can be morpheme-specific.

McCarthy and Prince (1993a) proposed a general-purpose schema for alignment constraints:

(1) ALIGN (Cat_1, Edge_1; Cat_2, Edge_2)
For all instances of Cat_1, there must exist some instance of Cat_2 such that Edge_1 (right or left) of the Cat_1 instance coincides with Edge_2 (right or left) of the Cat_2 instance.

The categories that fill out this schema for a particular constraint in a language may be prosodic constituents (such as a syllable, a foot, a prosodic word), morphosyntactic categories (such as noun, stem, prefix), or even individual morpheme indices. Here are some examples of how alignment constraints have been used in the OT literature (I have recast some of them into the form of the schema):

1. ALIGN (verb, Right; consonant, Right)
   Lardil: verbs must end in a consonant

2. ⋮

In chapter 8, alignment constraints were used in the Variables method of segmental specification — e.g., "*cat* begins with [k]" would be ALIGN([Lex: 'cat'], Left; *k*, Left) — and they would probably be useful in the No-Variables method as well. In this chapter, we look at some examples of more traditional uses of the ALIGN schema — to describe the position of two morphs with respect to each other or of a morph with respect to a prosodic constituent.

9.1 Concatenation

One of the simplest ways of specifying the order of morphs uses the Alignment schema. For example, one obvious way of stating that the 3sg present agreement marker of English is a suffix attached to verb stems is to require the left edge of every 3sg present morph to align with the right edge of some V^0 morph.

(2) ALIGN ([Func: '-s'], Left; [V^0], Right)

Here, as elsewhere, when a position of the ALIGN schema is filled by a morphosyntactic description rather than a phonological one, I assume that the alignment constraint applies to the Ph yield of the Sy node that satisfies the description.

Languages probably do not specify such alignment constraints for every single affix. Instead, they probably rely on more general default constraints most of the time. For example, instead of specifying that a particular agreement marker is a suffix, a language could specify that *all* agreement markers are suffixes:

(3) ALIGN (Agr^{-1}, Left; V^0, Right)

or, more generally still, that all X^{-1} level functional heads are suffixes to a head-moved Y^0 complement:[1]

(4) ALIGN ([bar: −1], Left; [bar: 0], Right)

Similar ordering constraints probably also exist above the X^0 level. For example, Kayne's (1994) demand that phrasal complements follow their head might be expressed in a constraint like the following, though in an OT framework there's no reason to expect a priori that such a constraint will be universally undominated.[2]

(5) ALIGN (Complement-of(X^0), Left; X^0, Right)

Such general constraints could be serve as the Elsewhere case to more specific constraints that override them for particular morphemes or constructions. Jackendoff (1997) suggests that English *ago* can be analyzed as a preposition which exceptionally takes its complement to its left rather than its right. This could be handled in MOT by ranking the special-case constraint (6a) above the Elsewhere-case constraint (6b).

(6) a. *specific case (ago as a postposition):*
ALIGN ([Lex: 'ago'], Left; Complement, Right) $\gg$
b. *elsewhere case (Ps are prepositions):*
ALIGN ([cat: P], Right; Complement, Left)

---

[1]Given the strong cross-linguistic preference for suffixation over prefixation, It is possible that (4) is universal, thouh obviously not always undominated. Cf. Hall (1992), Déchaine (199xxx).

[2]Of course, certain issues of logical vocabulary will have to be worked out. For example: What exactly does the operator *Complement-of* mean? Where in constraints can it occur? Are there any restrictions on the possible vocabulary items, or can an analyst like me can make up an operator like this whenever it's convenient?

If one agreement marker is idiosyncratically a prefix in a language where agreement markers are generally suffixes, the same Paninian ranking would hold:

(7) a. *specific case:* ALIGN ([Agr^{-1}, Func: xxxx], Left; V^{0}, Right) $\gg$
b. *elsewhere case:* ALIGN (Agr^{-1}, Right; V^{0}, Left)

Such general concatenating alignment constraints may also be violated not because there is a more specific outranking constraint sensitive to a particular index, but by their interaction with non-morphemic constraints. For example, Fulmer (1997) shows that the second person singular agreement marker *t* of Afar is generally a suffix, but that it can be realized as a prefix when necessary to satisfy the demands of the more highly ranked ONSET constraint:

(8)

C-initial stem		*V-initial stem*	
nak-t-eʔ	'you drank milk'	*t-okom-eʔ*	'you ate'
bah-t-eʔ	'you brought'	*t-ekk-eʔ*	'you became'
rab-t-eʔ	'you died'	*t-uol-eʔ*	'you saw'

(9) Afar tableau:

	Ph	ONSET	ALIGN(2sg,L; Verb,R)
	[okom-t]	*!	
☞	[t-okom]		*

Another possible method of enforcing the concatenation of a morph through alignment constraints is by referring to the Sy node's mother rather than its sister.[3] That is, we could use (10b) instead of (10a).

(10) a. *Concatenation through sister alignment:*
ALIGN (X^{-1}, Left; Complement-of(X^{-1}), Right)
b. *Concatenation through mother alignment:*
ALIGN (X^{-1}, Right; Mother-of(X^{-1}), Right)
ALIGN (Complement-of(X^{-1}), Left; Mother-of(X^{-1}), Left)

It is not yet clear to me to what extent mother alignment is used in addition to or instead of sister alignment. The analysis of English *inflate* in chapter 12 is one case where mother alignment is crucially needed. But there must also be some kind of pressure toward sister alignment as well, otherwise the kinds of haplologies discussed in chapter 10 should be far more common than they seem to be.

9.2 Prosody

In this section I discuss alignment constraints of the form ALIGN (morphemic index, L/R; prosodic category, L/R). The discussion is divided into three parts, which do not reflect real differences in the format or substance of the alignment constraints, merely pre-theoretical differences in their "effect".

[3] I am grateful to Andrew Carstairs-McCarthy for pointing this out to me.

9.2.1 Prosodic "content"

Often prosodic information seems to be an inherent part of the phonological content of a morpheme, so much so that representation-based theories would typically include prosodic consitituents as part of the underlying representation (UR) of the morpheme. The prosodic constituents may merely be one part of a larger UR, or the UR may consist of nothing but prosodic constituents.

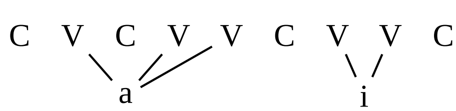
In non-linear phonology, a reduplicative morpheme with a distinctive prosodic shape was typically assumed to *consist* of that prosodic constituent in its UR (cf. McCarthy and Prince, 1986). If the reduplication resulted in a trochaic copy, the UR of the reduplicative morpheme would actually *be* a trochee, a little piece of representational structure at the proper level of the prosodic hierarchy. This assumption is no longer necessary in OT.[4] For reduplication, McCarthy and Prince (1993b, 1995) have argued that the prosodic shape of the reduplicant does not come from the UR (which in fact has no phonological content at all), but from constraints that will assess violation marks if the reduplicant does not have a certain prosodic shape.

One can extend this strategy to situations where the morpheme's content has segmental as well as prosodic information. Hammond (1995) argued that irregularly stressed words of Spanish are better handled using morpheme-specific alignment constraints rather than by tweaking the URs of the morphemes. Where Spanish usually has penultimate stress, some words don't, like *pájaro* 'bird' and *Panamá*. Hammond proposes morpheme-specific constraints like those in (11), which would outrank the more general Spanish constraints responsible for iambs and final-syllable extrametricality.

(11) ALIGN (*pájaro*, Left; Head-of-foot, Left)
ALIGN (*Panamá*, Right; Head-of-foot, Right)

As another example, a broken plural in Moroccan Arabic has two primary phonological manifestations: the vocalism *a* and an iambic prosodic shape at the beginning of the plural noun. Non-linear analyses would typically propose a representational template incorporating both the vowel and the prosodic shape, such as the template for broken plurals in Classical Arabic proposed by Hammond (1988):

(12)



[4]Indeed, alternatives were also possible in non-linear phonology (cf. Steriade, 1988).

Russell (1999) shows that these two manifestations can be independent of each other. About 90 percent of broken plurals have an iambic shape and about three-quarters use the vowel *a*, but only about half do both. Those broken plurals which irregularly do not have the *a* vocalism will typically still have an iambic shape, and those which irregularly do not have an iambic shape will still often have the *a* vocalism. The situation can be analyzed with two phonomorphemic constraints sensitive to the functional index of the broken plural: a segmental constraint as in chapter 8 requiring the vowel *a*, and a prosodic alignment constraint requiring an initial iamb:

(13) a. ALIGN ([Func: broken plural], Left; *a*, Left)
b. ALIGN ([Func: broken plural], Left; Iamb, Left)

Constraint (13a) might be overruled, for example by a more specific constraint sensitive to a combination, such as:

(14) ALIGN ([Lex:'cheek', Func: broken plural], Left; *u*, Left)
results in: [x̩.duːd] 'cheeks'
rather than: [x̩.daːd]

But the iambic shape requirement of (13b) will still be respected.

9.2.2 Prosodic subcategorization

English comparative *-er* and superlative *-est*.
Axininca Campa *-piro*.
Spanish stress-shifting suffixes (Hammond) and perhaps English too

9.2.3 Prosodic positioning

Navajo (see Speas, McDonough, Fountain)
Ulwa?
some possible effects:
Sometimes an affix will demand to come first or last in the prosodic word, regardless of its position with respect to its sisters in the hierarchical structure of Sy. Or an infix may demand to be positioned before or after the prosodic head, or an ablaut feature targets the strong syllable.

9.3 Example: French elision, liaison, and h-aspiré

As an illustration of the use of morpheme-specific alignment constraints, this section presents a short analysis (essentially a recast of Tranel (1994)) of the interaction in French between consonant elision and liaison and those idiosyncratic vowel-initial words traditionally said to begin with an *h-aspiré*.

French articles typically take different forms depending on whether the following word begins with a consonant or a vowel.

(15)

	_ # C	_ # V
feminine definite	[la]	[l]
masculine definite	[lə]	[l]
masculine indefinite	[œ̃]	[yn]
plural definite	[le]	[lez]

(16)

Feminine	[la vwatyr]	*la voiture*	'the car'
	[l istwar]	*l'histoire*	'the story'
Masculine	[lə ʃjɛ̃]	*le chien*	'the dog'
	[l ami]	*l'ami*	'the friend'
Plural	[le ʃjɛ̃]	*les chiens*	'the dogs'
	[le.z ami]	*les amis*	'the friends'

There are however a small group of nouns that begin with a vowel but which act, for the purposes of this alternation, as if they began with consonants. For example, *le hibou* 'the owl' has a schwa in the definite article, even though we would expect elision to **l'hibou* since the following word begins with a vowel.

(17)

[lə.ibu]	*le hibou*	'the owl'	*[l ibu]
[le.ibu]	*les hiboux*	'the owls'	*[le.z ibu]
[la.aʃ]	*la hache*	'the axe'	*[l aʃ]
[le.aʃ]	*les haches*	'the axes'	*[le.z aʃ]
[lə.ɔki]	*le hockey*	'hockey'	*[lɔki]

These words are often, somewhat misleadingly, said to begin with an "h-aspiré". In earlier autosegmental theory (e.g., Clements and Keyser, 1983), they were often analyzed as beginning with an empty consonant slot.

Within OT, Tranel (1994) analyzed this as a case of morpheme-specific constraint reranking involving the following two constraints, among others:

(18) ONSET
ALIGN-LEFT: Align (Word, Left; Syllable, Left)

Ordinarily in French, ONSET outranks ALIGN-LEFT. With the regular nouns it is more important for the noun's first syllable to contain an onset, as in [l a.mi], than it is for the noun morph's initial boundary to coincide with a syllable boundary, as in [lə .a.mi]. But exceptional nouns like *hibou* and *hache* cause this the hierarchy to be re-ranked, so that it is becomes more import for the noun morph boundary to coincide with a syllable boundary, as in [lə .i.bu], than for the noun's first syllable to contain an onset, as in [l i.bu].

In MOT, it is not necessary to re-rank the constraint hierarchy based on the presence of an exceptional morpheme. Instead, the exceptional morpheme can simply be the subject of a more specific constraint that outranks the general case.

(19) Exceptional nouns:

Align (‘owl’, L; Syllable, L) $_{\text{owl}}[\ = {}_{\sigma}[$

Align (‘axe’, L; Syllable, L) $_{\text{axe}}[\ = {}_{\sigma}[$ $\gg$

General case:

Align (Noun, L; Syllable, L) $_{\text{noun}}[\ = {}_{\sigma}[$

These interact with the phonomorphemic constraints that determine the segmental content of the articles, including:

(20) Constraints for the “deleteable” segments of *la*, *le*, and *les*

$_{\text{the,fem}}(\text{ a })$

$_{\text{the,masc}}(\text{ ə })$

$_{\text{the,pl}}(\text{ z })$

(There are other phonomorphemic constraints for the articles, of course, such as $_{\text{the}}(l)$ and $_{\text{the,pl}}(e)$, but these aren’t violated in the forms under consideration, and are probably higher ranked than those in (20).)

Tableau (21) shows how liaison [z] ends up in the onset in ordinary vowel-initial forms. Tableau (22) shows the failure of elision in an exceptional “h-aspiré” word, where one of the high-ranking alignment constraints of (19) prevents the article’s [z] from occurring in an onset.

(21) *les amis* ‘the friends’

	Ph	$_{\text{axe}}[\ = {}_{\sigma}[$	ONSET	NOCODA	$_{\text{noun}}[\ = {}_{\sigma}[$	$_{\text{the,pl}}(\text{ z })$
	[le . ami]		*!			*
	[lez . ami]		*!	*		
☞	[le . zami]				*	

(22) *les haches* ‘the axes’

	Ph	$_{\text{axe}}[\ = {}_{\sigma}[$	ONSET	NOCODA	$_{\text{noun}}[\ = {}_{\sigma}[$	$_{\text{the,pl}}(\text{ z })$
☞	[le . aʃ]		*			*
	[lez . aʃ]		*	*!		
	[le . zaʃ]	*!			*	

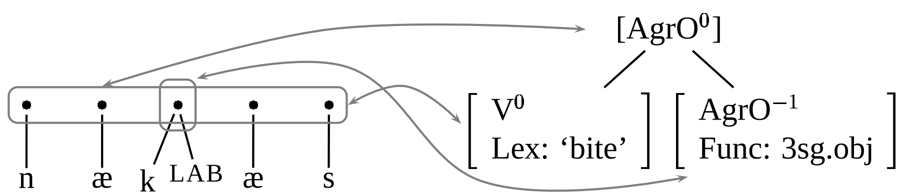
Chapter 10

Overlapping exponence I: sisters, aunts, great^{n}-aunts

10.1 What we need

We have seen several cases where more than one morphemic index has an effect (through phonomorphemic constraints) on the same part of a Ph representation. For example, in the Chaha form *nækʷæs* 'he bit it' repeated below, the features dominated by the third root node are ultimately attributable to two different morphemic indices.

(1)



Constraints sensitive to [Lex: 'bite'] are responsible for the [k] features — DOR, [−voice], [−cont], etc. A constraint sensitive to [Func: 3sg.obj] is responsible for the labialization.

Informally, we can talk about such cases as **overlapping exponence**. The same stretch of a Ph representation "realizes" two different "morphemes". In these next three chapters we will look at the ways in which overlapping exponence can arise. This chapter will examine cases that arise from syntactic structures like (1), where the two indices involved occur on Sy nodes that are in a relation of c-command, that is, if one node is the sister, aunt, or great^{n}-aunt of the other. Chapter 11 will look at cases where the two indices are a functional and a lexemic index on the same Sy node, so that the corresponding morph appears to merge two "morphemes". In chapter 12 we will look at cases where the nodes of the two indices are in a dominance relation, especially cases where one node is the mother of the other, as in the structure proposed earlier for *permit*, repeated here:

(2) *permit*

[V^0, Lex: 'permit']

[Func: 'per-'] [V^{-1}, Lex: '-mit']

10.2 Haplology

Stemberger (1981) offers several examples of morphologically conditioned haplology. Two of his examples are:

- The Swedish present-tense suffix *r* undergoes haplology after verb stems ending with *r*: *bygg-* 'build' has present *bygger*, but *rör-* 'move' has present *rör*, not **rörer*.
- In Mandarin Chinese, the post-verbal perfect aspect clitic *le* and the sentence-final aspectual particle *le* can occur separately in a sentence (3a), but undergo haplology rather than occurring adjacently, as in one of the possible readings of (3b):

(3)
a. tā mǎi le shū le — 'It has transpired that he has bought the book'
he buy PERF book ASP
b. tā mǎi le — 'It has transpired that he has bought it'
he buy PERF&ASP

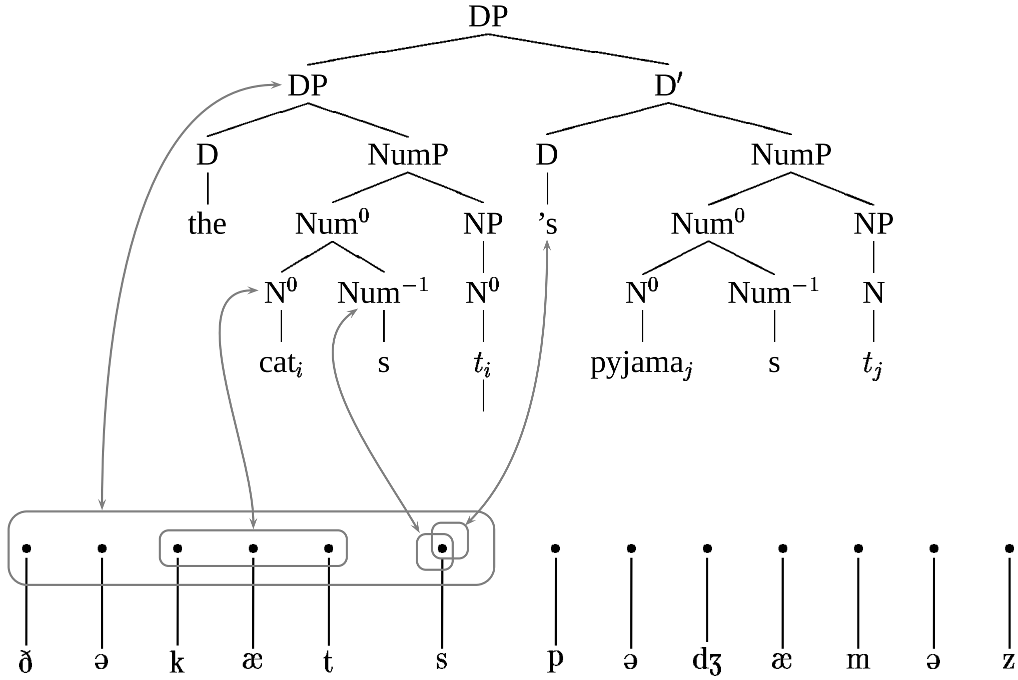
It is certainly possible to analyze such haplologies as cases where one of the two morphemes has been "deleted" or has in some other way failed to be realized. But OT frameworks offer another possibility. In Correspondence Theory, the same part of a candidate can stand in correspondence relations to more than one underlying representation. In MOT, the same root node of a Ph representation can belong to two or more morphs.

I offer here a brief account of how such an MOT analysis could work for one of the most famous cases of morphologically conditioned haplologies, the plural possessive nouns of English. (For a fuller discussion of the data, see Stemberger (1981) and Carstairs-McCarthy (199xxx), and for a partial account using Correspondence Theory, see Russell (1997).)

10.2.1 Example: English plural possessive nouns

The possessive marker and the regular plural marker have an identical set of allomorphs whose distribution is determined by identical phonological principles — [s], [z], or [əz] depending on the properties of the preceding segment. But they have different positional properties. The plural marker is a suffix that attaches to the stem of the noun lexeme (except in the case of an irregular plural, which can be handled in the same way as irregular past tense verbs were in section 6.3.1). The possessive marker, on the other hand, is a clitic that attaches to the right of the final word of the entire noun phrase, even if the noun phrase contains a relative

Figure 10.1: Representation for *the cats' pyjamas*



clause and its final word is not the head noun, as in *the man who came yesterday's hat.* When the plural noun *is* at the right edge of the possessor NP, however, the plural and the possessive are not both realized separately; instead we find only one apparent suffix, typically spelled *-s'* in English orthography.

(4)

	singular	plural
non-possessive	[kæt] *cat*	[kæts] *cats*
possessive	[kæts] *cat's*	[kæts] *cats'*

Neither the plural nor the possessive marker has been deleted in the plural possessive *the cats' pyjamas.* The two are just realized by the same stretch of the phonological representation. That is, the yield of the Sy node bearing [Func: plural] overlaps completely with the yield of the Sy node bearing [Func: possessive]. The situation is illustrated in figure 10.1.[1]

We can only get this kind of behaviour if there is an alignment constraint with both edges the same, outranking the more general concatenation constraints of chapter 9 which have opposite directions. For example:

[1]For convenience, the Sy representation in figure 10.1 is shown with traditional lexical items in the leaves. This should be understood as an abbreviation for a terminal node that contains both the category features and a morphemic index. For example, the N^0 together with the leaf *cat* stands for a single terminal node bearing [cat: N, bar: 0, Lex: 'cat', ...].

(5) ALIGN (M_i, Right; Specifier-of-M_i, Right) $\gg$
ALIGN (M, Left; Specifier-of-M, Right)
or
ALIGN (M_i, Left; Specifier-of-M_i, Left) $\gg$
ALIGN (M, Right; Specifier-of-M, Left)

In this case, there must be an aligment constraint that attempts to merge the yield of the possessive D^0 head into the right edge of the yield of its specifier. This must outrank the usual constraint for specifier ordering in English.

(6) ALIGN ([Func: possessive], Right; Specifier, Right) $\gg$
ALIGN (Head-of-XP, Left; Specifier-of-XP, Right)

10.3 Elaboration

10.3.1 Connections

Chapter 11

Overlapping exponence II: two indices, one morph

Continuing our examination of cases where the same stretch of Ph is subject to the phonomorphemic constraints of more than one morphemic index, in this chapter we examine those cases where the two indices involved are a lexemic and a functional index on the same Sy node. By the assumptions of chapter 7, Ph morphs correspond to entire Sy nodes, not to individual morphemic indices in Sy. So a Sy node with two morphemic indices spells-out as only one morph. This single morph though, can be subject to three different kinds of phonomorphemic constraints: those sensitive to the lexemic index, those sensitive to the functional index, and those sensitive to the combination of the two. The analysis of English irregular pasts in section 11.1.1 illustrates the last possibility; the analysis of Yawelmani templatic morphology in section 11.2 illustrates the first two.

11.1 Simple examples

11.1.1 English irregulars

We are now able to redeem the promissory note from chapter 6 that we could formalize the informal abbreviation "[Lex: 'sing', Func: irreg.past] sounds like [sæŋ]." We saw in chapter 8 that phonomorphemic constraints could easily express the segmental requirements of "[Lex: 'sing'] sounds like [sɪŋ]," for example, as:[1]

[1]I am assuming the "No-Variables" model of chapter 8. Without drawing a tableau, the way the surface form comes from these constraints is roughly as follows. (As usual, "English" means "my dialect".) Given the higher-ranking phonotactic constraints of English, a dorsal nasal will necessarily occur in a coda. There should be an onset, which is optimally filled by the coronal fricative, which in the absence of evidence to the contrary is preferably voiceless. There is a one-syllable candidate consistent with these requirements, and no way in which a candidate with more than one syllable could be more optimal. So the one vowel will be high and front, with [sɪŋ] preferred over [siŋ] by the phonotactic constraint forbidding a tense vowel before a nasal coda.

(1) Phonomorphemic constraints for ‘sing’ (first version):

$_{\text{sing}}$(COR ● [+cont])
$_{\text{sing}}$([+high] ● [+front])
$_{\text{sing}}$(DOR ● [+nas])

Recall that $_{\text{sing}}$([+high]●[+front]) is an abbreviation for an instatiation of the OVERLAPS schema:

(2) OVERLAPS ([Lex: ‘sing’]; [+high], [+front])

As we saw in chapter 6, the Sy representations for *sing* and *sang* are as in (3). (For simplicity, I suppress the higher T^0 layer, since it contains no morphemic indices that would affect the present discussion.)

(3) a. *sing*

$$\begin{bmatrix} V^0 & \\ \text{tense:} & \text{pres} \\ \text{Lex:} & \text{‘sing’} \end{bmatrix}$$

b. *sang*

$$\begin{bmatrix} V^0 & \\ \text{tense:} & \text{past} \\ \text{Lex:} & \text{‘sing’} \\ \text{Func:} & \text{irreg.past} \end{bmatrix}$$

The only move we need to make in order to specify the phonological information of the irregular past is to allow the first parameter of the OVERLAPS schema (and the other phonomorphemic schemata of chapter 8) to be filled by a combination of morphemic indices rather than by just one index.

(4) OVERLAPS ([Lex: ‘sing’, Func: irreg.past]; [+low], [+front])
Abbreviation: $_{\text{sing,i.p.}}$([+low] ● [+front]), or $_{\text{sing,i.p.}}$(*æ*)

Now, whenever there is a Sy node that bears *both* [Lex: ‘sing’] and [Func: irreg.past], the Ph morph spelling out that node must contain a low front vowel.

If we wanted, we could put together a “complete” phonological specification for the irregular past tense, parallel to that of the base form in (1).

(5) Phonomorphemic constraints for ‘sang’ (unnecessary version):

$_{\text{sing,i.p.}}$(COR ● [+cont])
$_{\text{sing,i.p.}}$([+low] ● [+front])
$_{\text{sing,i.p.}}$(DOR ● [+nas])

But this is not actually necessary. The phonomorphemic constraints in (1) that are sensitive only to the lexemic index [Lex: 'sing'] will apply to the past tense structure in (3b) just as much as they will apply to the present tense structure in (3a). There is no need for the irregular past constraints in (5) to repeat the demands that the morph contain an *s* and an *ŋ*. The irregular past morph will automatically be subject to these demands when it submits to the constraints in (1). The only phonological properties that need to be specified for the combination [Lex: 'sing', Func: irreg.past] are those that you don't get for free from the constraints for [Lex: 'sing'] alone, namely the requirement for a low front vowel in (4).

The analysis of *sang* highlights some of the advantages of not assuming that the phonological content of a lexical entry must be representationally coherent. If the form of a past tense cannot be completely predicted from the form of its present tense, many morphological approaches have no alternative but to fully list the representations of both present and past, as if the relation were one of pure suppletion. With morphemic constraints, the constraints for the irregular past tense need to specify *only* that information which differs from the present tense. Sometimes this differing information can interpreted as a coherent representation (e.g., as a floating low feature), but this is not always the case. Similarly, there is also no need for the information common to all forms of the lexeme to be interpretable as a coherent underlying representation.[2]

In a way, the constraint $_{\text{sing,i.p.}}$(*æ*) can be seen as a sort of lexical "diacritic": the past tense of 'sing' is weird in having an [æ] where you wouldn't expect one. But it is quite unlike a usual diacritic in an important sense. An ordinary diacritic needs a separate mechanism for affecting the outcome of a derivation or an evaluation, to cause the result to come out differently than if the diacritic were not present. There needs to be some sort of interpreter which watches out for diacritics in the input and has the power to reach into the grammar and turn off or trigger a rule (or reach into OT's Eval and re-rank some constraints, or perform some other exceptional action).[3] A "diacritical" phonomorphemic constraint, on the other hand, needs no extra mechanism to interpret it. The constraint $_{\text{sing,i.p.}}$(*æ*) is made out of the same schemata as ordinary constraints, is ranked at a single place in the hierarchy like ordinary constraints, assesses violation marks to candidates in the same way that ordinary

[2] This would suggest that the common phonomorphemic constraints for the lexeme 'sing' should say nothing about the vowel [ɪ], a consequence I am deliberately glossing over in the text. There are a couple of possible ways of implementing a solution. One is to say that the base form *sing* also bears a functional index, so that the present tense representation should in (3) should actually have an additional feature such as [Func: base]. There would then be a phonomorphemic constraint such as $_{\text{sing,base}}$(*ɪ*) sensitive to the combination [Lex: 'sing', Func: base], and the phonomorphemic constraints for plain [Lex: 'sing'] would mention only those properties that all forms of the lexeme had in common, namely $_{\text{sing}}$(*s*) and $_{\text{sing}}$(*ŋ*). This solution would require the appropriate extra intra-syntactic constraints of the kind discussed in chapter 6, to make sure that the feature [Func: base] ends up on all the nodes it is supposed to. Another possible solution would be to say that the common phonomorphemic constraints for [Lex: 'sing'] *do* specify the vowel [ɪ] but that this is overridden in a Paninian fashion by the more specific phonomorphemic constraint for the past tense: $_{\text{sing,i.p.}}$(*æ*) $\gg$ $_{\text{sing}}$(*ɪ*). In order for this to work, there would need to be other constraints to rule out candidates like *[sæŋɪ]* where both required vowels appear, perhaps a constraint that the 'sing' morph be monosyllabic.

[3] Needless to say, a working diacritic interpreter has very seldom actually been built, either in generative phonology or OT, though see Zonneveld (1978).

constraints do. In MOT, exceptional cases are handled by the same kinds of constraints as the general cases — the “exceptional” constraints are just more narrowly focussed and higher ranked.

This example from English shows one particular way of getting “overlapping exponence” from a Sy node bearing two morphemic indices. The crucial property of this example is that the lexemic and the functional indices *act jointly* in determining the phonological content of the node’s morph — that is, there is at least one phonomorphemic constraint sensitive to the presence of both features simulataneously. The next section illustrates a slightly different situation, one where the lexemic and the functional indices are acting independently of each other, each with separate phonomorphemic constraints that end up constraining the shape of the same morph.

11.2 Yawelmani

We turn now to a brief analysis of verbal templatic morphology in Yawelmani, the principles that determine which template will be used in which verb, and (the part relevant for the subject of this chapter) the “phonological content” of the templates themselves. This section is based heavily on the analysis of Archangeli (1984, 1991) of the data in Newman (1944). Before turning to the analysis itself, I give a quick overview of the templatic system of Yawelmani.

11.2.1 The templatic morphology of the verb

Yawelmani verbs use three templates, defined in prosodic terms by Archangeli (1991) as syllable, heavy syllable, and foot:

(6) a. σ
b. $\sigma_{\mu\mu}$
c. $(\sigma_{\mu}\ \sigma_{\mu\mu})$ = Iamb

The first “template” is essentially the absence of any templatically imposed prosodic or segmental requirments. When a root is subject to the σ template, its segments are simply syllabified as optimally as possible by the usual syllabification constraints of Yawelmani, which allow CV, CVC, and CVV syllables (see Archangeli, 1997).

About half of the suffixes of Yawelmani impose templates on their base. Some examples of template imposing suffixes are:

(7)			
	-*(ʔ)iixoo*	‘consequent auxiliary’	imposes σ
	-*(ʔ)aa*	‘continuative’	imposes $\sigma_{\mu\mu}$
	-*wsel*	‘reflexive/reciprocal adjunctive’	imposes Iamb

In addition to their prosodic effect, the $\sigma_{\mu\mu}$ and Iamb templates also cause the vowel of the heavy syllable to be non-high.

The effects of templates can be illustrated using three biconsonantal and three triconsonantal verb roots:

(8)

caw	'shout'	*ʔamc*	'be near'
cum	'destroy'	*diyl*	'guard'
hoy	'name'	*bint*	'ask

The forms of these six verbs with the three suffixes of (7) is given in (9). The consequent auxiliary and continuative forms are followed by a second suffix, *-hin* 'aorist'.

(9)

	root segments	consequent auxiliary *-(ʔ)iixoo*	continuative *-(ʔ)aa*	reflexive/reciprocal *-wsel*
'shout'	caw	ca.w'ee.xoo.hin	caa.w'aa.hin	ca.waw.sel
'destroy'	cum	cu.m'oo.xoo.hin	coo.m'aa.hin	cu.mow.sel
'name'	hoy	ho.y'ee.xoo.hin	hoo.y'oo.hin	ho.yow.sel
'be near'	ʔamc	ʔam'.cee.xoo.hin	ʔam'.caa.hin	ʔa.maa.ciw.sel
'guard'	diyl	diy'.lee.xoo.hin	dey'.laa.hin	di.yee.liw.sel
'ask'	bint	bin'.tee.xoo.hin	ben'.taa.hin	bi.nee.tiw.sel

About half of Yawelmani suffixes, such as *-hin* 'aorist', impose no template at all on their bases. Before such a suffix, roots will surface with their own lexically idiosyncratic preferred template (what Archangeli (1984) called their "default" template).

(10)

	root segments	preferred template	aorist *-hin*
'shout'	*caw*	σ	*caw.hin*
'destroy'	*cum*	$\sigma_{\mu\mu}$	*c'om.hun*
'name'	*hoy*	Iamb	*ho.yoo.hin*
'be near'	*ʔamc*	σ	*ʔa.mic.hin*
'guard'	*diyl*	$\sigma_{\mu\mu}$	*dee.yil.hin*
'ask'	*bint*	Iamb	*bi.net.hin*

Note that the non-high vowel requirements of the $\sigma_{\mu\mu}$ and Iamb templates continue to be respected when the template is the verb's default one.

11.2.2 Analysis: Morphosyntax

Let us assume that a template is the phonological reflex of a functional morphemic index.

(11)

σ	[Func: grade1]
$\sigma_{\mu\mu}$	[Func: grade2]
Iamb	[Func: grade3]

The grade "morphemes" have no inherent meaning. They are analogous to the different kinds of stem proposed for Latin by Aronoff (1994), as discussed further in section 11.3.1.

A suffix's selection of a particular grade of the stem can be formalized using the GOVERNS schema.

(12) *Suffixes subcategorizing for particular templates:*
GOVERNS ([Func: ‘consequent aux’], [Func: grade1]) ‘cons.aux’⁀grade1
GOVERNS ([Func: ‘continuative’], [Func: grade2]) ‘contin.’⁀grade2
GOVERNS ([Func: ‘refl/recip adj.’], [Func: grade3]) ‘r/r adj’⁀grade3

No such GOVERNS constraints would exist for neutral suffixes like *-hin* ‘aorist’.

A verb stem’s preference for its default template can be formalized with the usual implicational cooccurrence constraints:

(13) [Lex: ‘shout’] → [Func: grade1]
[Lex: ‘destroy’] → [Func: grade2]
[Lex: ‘ask’] → [Func: grade3]

Since template-imposing suffixes get their way without regard to the preferences of the verb stem, constraints like those in (12) must outrank stem-preference constraints like those in (13).

I will assume that the continuative form of the stem ‘ask’ has the structure in (14).

(14)
[Asp^0 / asp: continuative]
[V^0 / Lex: ‘ask’ / Func: grade2] [Asp^{-1} / asp: continuative / Func: ‘continuative’]

The [Func: grade2] on the stem’s node is required by the subcategorization constraint of the continuative in (12). The following tableau shows how these constraints interact to give the structure in (14). As usual, the abbreviation 💡→ [ask],[contin] represents the collection of constraints on the semantics/syntax interface that will not allow deletion of either morphemic index in order to avoid the intra-syntactic constraint conflict.

(15)

	Sy	💡→[ask],[contin]	‘contin.’⁀grade2	‘ask’→grade3
	[ask, grade1] [contin]		*!	*
☞	[ask, grade2] [contin]			*
	[ask, grade3] [contin]		*!	
	[ask] [contin]		*!	*
	[ask, grade3] [ ]	*!		

In the absence of template-imposing suffixes, the weaker stem-preference constraints like [Lex: ‘ask’]→[Func: grade3] will be satisfied.

(16)

	Sy	💡→[ask],[aor]	‘contin.’⌒grade2	‘ask’→grade3
	[ask, grade1] [aor]			*!
	[ask, grade2] [aor]			*!
☞	[ask, grade3] [aor]			
	[ask] [aor]			*!
	[ask, grade3] [ ]	*!		

11.2.3 Analysis: Phonology

Phonologically, the [grade2] and [grade3] functional indices have both prosodic and segmental consequences.

The phonomorphemic constraints sensitive to [Func: grade2] will demand that the associated morph begin with a heavy syllable and that the vowel of that syllable be [−high]. The prosodic requirement can be formulated as (17a) using an alignment constraint as in chapter 9. Using the No-Variables method of chapter 8, the segmental requirement can be formulated as (17b), where $\acute{\mu}$ stands for a mora that is head of a foot.

(17) *Phonomorphemic constraints for the second grade:*
  a. Prosodic: ALIGN ([Func: grade2], Left; $\sigma_{\mu\mu}$, Left)
  b. Segmental: $_{\text{grade2}}(\ \acute{\mu} \blacktriangleright [-\text{high}]\ )$

For concreteness, let’s assume that the phonological “content” of the ‘ask’ lexeme is enforced by the following No-Variables constraints:

(18) a. $_{\text{ask}}(\ \text{b} \prec \text{n}\ )$
  b. $_{\text{ask}}(\ \text{n} \prec \text{t}\ )$
  c. $_{\text{ask}}(\ \mu \blacktriangleright [+\text{front}])$

Given a Sy representation with the nodes [Lex: ‘ask’, Func: grade2] and [Func: contin.], some of the candidates for the surface form are given in (19), together with the crucial constraints violated by each.[4]

(19)
ben.taa	the actual surface form
bin.taa	violates (17b)
be.ni.taa	violates (17a)
bi.nee.taa	violates (17a)
bee.ni.taa	violates some syllabification constraint (e.g., *μ)
bnee.taa	violates some syllabification constraint (e.g., *COMPLEXONSET)
ban.taa	violates (18c)
bee.naa	violates (18b)

[4] In this analysis, we will ignore the glottalization induced by the continative suffix.

The actual surface form, *ben.taa* does violate some constraints of Yawelmani. For example, it contains a mid vowel rather than a less marked high vowel. But the constraints violated by *ben.taa* must be less important than the morphemic constraints of (17) and (18).

The phonomorphemic constraints sensitive to the [Func: grade3] index are almost identical, differing only in that they demand an iamb rather than a simple heavy syllable.

(20) *Phonomorphemic constraints for the third grade:*
 a. Prosodic: ALIGN ([Func: grade3], Left; Iamb, Left)
 b. Segmental: $_{\text{grade3}}(\ \acute{\mu} \blacktriangleright [-\text{high}]\ )$

What should we represent the phonological "content" of the [grade1] index? It turns out that the surface form of the sequence of [Lex:'ask', Func: grade1] and [conseq.aux.], *bin.xee.too*, is completely predictable from the phonomorphemic constraints of 'ask' and [Func: conseq.aux.] and the general syllabification constraints of Yawelmani. Some candidates are:

(21)

bin.tee.xoo	actual surface form
ben.tee.xoo	needlessly violates *[−high, −low]
bi.nii.tee.xoo	needlessly violates $*\sigma$ and $*\mu$
bi.ni.tee.xoo	needlessly violates $*\sigma$
bi.nee.xoo	violates (18b)

All this suggests that the [Func: grade1] index has no inherent phonomorphemic constraints of its own that outrank the broader well-formedness constraints of Yawelmani. We don't even need to specify, as Archangeli (1991) did ¡¡¡CHECK¿¿¿, that the template for [Func: grade1] is a syllable — the syllable will happen anyway given the normal syllabification constraints of the language.

Notice that, even though there are no phonomorphemic constraints that care about the presence or absence of [Func: grade1], we cannot just dispense with it. We cannot simply say that the consequent auxiliary form of 'ask' has no grade at all. It is true that the phonological shape of *binteexoo* is left to non-morphemic constraints, but this delegation of authority itself is contrary to the wishes of the [Lex: 'ask'] index, which prefers to have the grade 3 iambic template in the absence of any template imposed from the outside (as we can see in the aorist form *bi.net.hin*). Whatever lack of phonological effects the [Func: grade1] index may have, it must be at least real enough to be imposed from outside and therefore prevent the default occurrence of [Func: grade3] in the consequent auxiliary form of 'ask'.

The [Func: grade1] index, then, is an example of the second predicted kind of "zero-morpheme". There are "real zero-morphemes" that don't really exist, i.e., there is no morphemic index at all in the node of the Sy tree where we might expect one. Then there are "accidental zero-morphemes" like [Func: grade1], which exist as a morphemic index in the Sy tree but, because of the feebleness or complete absence of phonomorphemic constraints that care about them, have no spell-out effects on the Ph representation.

A note on intermediate phonological representations

My analysis of the [−high] vowel requirement in the second and third grades is quite different from the traditional generative analysis. Since Kuroda (1967), the alternation between high and mid vowels has usually been attributed to a phonological rule that lowers all long vowels. Many of these putative long vowels exist only at an abstract intermediate stage of a generative derivation.

For example, the continuative form of 'guard', [dey'laahin], would have an underlying representation of /diyl-(ˀ)aa-hin/. This would be transformed into [diiyl-(ˀ)aa-hin] by a template mapping process or its equivalent. The long vowel would then be lowered, giving [deeyl-(ˀ)aa-hin]. The long vowel would then, conveniently, shorten, resulting in [deyl-(ˀ)aa-hin]. On the other hand, in the consequent auxiliary form of 'guard', [diy'leexoohin], the /i/ vowel of the stem would remain high because it never gets lengthened during the derivation.

The vowel-lowering rule of the traditional generative analysis requires some idiosyncratic and some systematic exceptions — there are indeed long high vowels in Yawelmani that never get lowered. Nevertheless, vowel-lowering in Yawelmani has often been held up as an example of a process that absolutely requires intermediate representations (e.g., Goldsmith, 1993; Lakoff, 1993), and would therefore be incompatible with a purely mono-stratal OT framework.

Fortunately, there are other possible analyses. Now that phonology recognizes the importance of prosodic constituents, we need no longer characterize the vowels that undergo the rule as being long — we can characterize them as vowels in heavy syllables (with the heaviness due to either vowel length or a coda consonant). Specifically, it seems that the lowering will only happen within a heavy syllable which is required by the $\sigma_{\mu\mu}$ or Iamb templates of the second or third grade. The [−high] feature borne by vowels in this environment is therefore more accurately seen as a part of the morpho-phonological information of these two templatic "morphemes" (the way *a* is part of the information of the Arabic broken plural morpheme), rather than as an across-the-board rule of general Yawelmani phonology. In sum, Yawelmani vowel-lowering would appear to provide no evidence in favour of a multi-stratal phonology.

11.3 Elaboration

11.3.1 Connections

In section 11.2.2, I compared the analysis of the different Yawelmani templates with the different kinds of stem proposed by Aronoff (1994) for Latin verbs.

Latin verbal morphology involves three different forms of the stem for each verb. The "third" stem, traditionally called the supine, is used for the perfect passive and for the active future infinitive and participle — a collection of categories that has no semantic features in common that set it apart from the other categories of Latin. The various suffixes are alike only in their morphologically idiosyncratic selection of the third form of the stem, rather than one of the other two. While the second form of the stem can be seen as somehow realizing the category of the perfect, the third and the first (default) forms of the stem cannot be given any consistent semantic interpretation.

As we saw, the situation is similar in Yawelmani. There are no semantic criteria that can set apart the suffixes that impose an iambic template from the other suffixes, or even the suffixes that impose any template at all from the suffixes that don't. Whether a template is imposed, and if so which one, are purely arbitrary morphological facts that must be learned about each suffix, similar to the way a Latin speaker would have had to simply learn which suffixes selected for the third form of the verb stem. (In passing, we might describing the effects of template imposition as resulting in different kinds of stems is faithful to Newman's original way of describing the alternations: *-wsel* attaches to the "strong" stem, others to the "weak" stem or "zero" stem, etc.)

It seems likely that pretty much any morphological analysis that relies on different forms of the stem (e.g., Zwicky (19xxx), the other analyses in Aronoff (1994)) can be recast straightforwardly into MOT using the Yawelmani strategy of having both a lexemic and a functional index on the same Sy node, where the functional index is subcategorized for by a particular suffix by means of a GOVERNS constraint.

Chapter 12

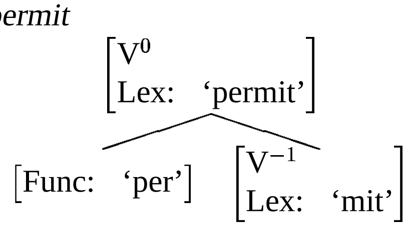
Overlapping exponence III: mother-daughter

12.1 What we need

Until now, we have been concentrating on spell-out constraints that are sensitive to the presence of morphemic indices in the terminal nodes of the syntactic representation. We have been assuming that the yield of higher nodes in the syntactic tree is predictable based on the yields of the terminal nodes they dominate, for example, by alignment constraints enforcing a concatenation or a near concatenation of the yields of their daughters.

It is not logically necessary, however, for the non-terminal nodes of a morphosyntactic tree to be so uninterestingly predictable. Specifically, it is not logically necessary that morphemic indices only occur on the terminal nodes. I have already suggested that the word *permit* has a structure like:

(1) *permit*



In this chapter, we look at some of the benefits that such "recursive" morphemic indices can offer to a declarative theory of morphology. Specifically, we will see how they help us analyze compounds, (potentially cyclic) derivational morphology, and perhaps idioms.

12.2 Implementation

We will require a node to dominate another node using the DOMINATES schema of chapter 6:

(2) DOMINATES(X,Y) — abbreviation: X▶Y
All nodes satisfying the description X must immediately dominate some node satisfying the description Y.

If a node needs to dominate two daughter nodes, this can be done by two constraints of the form in (2). If there is no evidence that these two constraints must be ranked at different places in the hierarchy, I will often abbreviate them as a single constraint:

(3) Mother ▶ Daughter_1, Daughter_2

This is in fact the same notation as traditional phrase structure rules of the form VP → V NP. The ▶ symbol is used instead of → in order to avoid confusion with the way we have been using it so far, to represent logical implication within a single node (i.e., X→Y means "If node N has X then node N has Y").[1]

12.2.1 Compounds

The internal structure of a compound can be required using the DOMINATES schema.

(4) [Lex: 'football'] ▶ [Lex: 'foot'], [Lex: 'ball']

This is interpreted as requiring every node which bears the lexemic index [Lex: 'football'] to dominate a daughter which bears the lexemic index [Lex: 'foot'] and a daughter which bears [Lex: 'ball'].

When it comes to determining the phonological yield of a non-terminal node with a lexemic index, morphemic constraints need to be framed only for those aspects of the pronunciation which are not predictable from the pronunciations of the daughters and from the construction. There need to be no more phonomorphemic constraints for [Lex: 'football'], for example. The optimal phonological representation is fully predictable from the yields of [Lex: 'foot'] and [Lex: 'ball'] and from the general constraints on the noun compound construction in English (e.g., alignment constraints placing the head to the right, prosodic constraints on the stress of compounds).

But there are also cases, especially in derivational morphology, where the form of the whole is not fully predictable from the form of its parts. We turn to such cases in the next section.

12.2.2 Derivational morphology

Derivational morphology creates new lexemes. The starting point is usually a simpler lexeme (as in *good* → *goodness*), but many languages also allow the initial creation of lexemes based on bound non-lexemic elements known as roots (as in *"pi"* → *piety* or *"infl"* → *inflate*).

[1]Though the constraint abbreviations have a form similar to traditional phrase structure rules, they must not be seen as implying a derivation in time. As in GPSG, phrase structure rules should be seen merely as "node admissibility conditions".

The structure of many derived lexemes looks almost exactly like that of a compound, though the head may have the bar level of an affix rather than a word. For example, the English word *goodness* could have a structure like the following.

(5) *goodness*

$$\begin{bmatrix}\text{N}^0 & \\ \text{Lex:} & \text{‘goodness’}\end{bmatrix}$$

$$\begin{bmatrix}\text{Adj}^0 & \\ \text{Lex:} & \text{‘good’}\end{bmatrix} \quad \begin{bmatrix}\text{N}^{-1} & \\ \text{Func:} & \text{‘-ness’}\end{bmatrix}$$

This structure could be enforced by a constraint like:

(6) [Lex: ‘goodness’] ▶ [Lex: ‘good’], [Func: ‘-ness’]

Not all cases of derivational morphology necessarily involve recursive indices. Especially affixation that is fully productive and both semantically and phonologically transparent is unlikely to involve a higher lexemic index. While *goodness* needs its own “lexical entry” because of its partial unpredictability (e.g., the possibility of using it as an interjection), most other nouns derived with *-ness* do not need to be listed in the lexicon.[2] *Happiness* would therefore have a structure like:

(7) *happiness*

$$\begin{bmatrix}\text{N}^0\end{bmatrix}$$

$$\begin{bmatrix}\text{Adj}^0 & \\ \text{Lex:} & \text{‘happy’}\end{bmatrix} \quad \begin{bmatrix}\text{N}^{-1} & \\ \text{Func:} & \text{‘-ness’}\end{bmatrix}$$

But there are also cases, especially in derivational morphology, where the form of the whole is not predictable from the form of its parts, and the combination of the daughters has to carry some additional information which does not belong to any of them individually. In this case, the lexemic index of the non-terminal node can contribute unpredictable information, in the form of phonomorphemic constraints which are sensitive to its presence.

For example, the phonology of the English lexeme *infallible* is completely predictable from the phonologies of its pieces, *in* and *fallible*, and from general constraints on their combination. On the other hand, the phonology of the lexeme *infinite* is almost, but not quite, predictable its pieces. Stress unexpectedly goes on the first syllable, and the vowels of the second half are different from what they are when *finite* stands alone.

(8) *infinite*

$$\begin{bmatrix}\text{Adj}^0 & \\ \text{Lex:} & \text{‘infinite’}\end{bmatrix}$$

$$\begin{bmatrix}\text{Adj}^{-1} & \\ \text{Func:} & \text{‘in-’}\end{bmatrix} \quad \begin{bmatrix}\text{Adj}^0 & \\ \text{Lex:} & \text{‘finite’}\end{bmatrix}$$

[2] Anshen and Aronoff (1988) present evidence that the *-ness* words could *not* have been listed for most of the recent history of English.

The lexeme [Lex: 'infinite'] is contributing information of its own not found in its daughters — or rather, constraints sensitive to [Lex: 'infinite'] are contributing information over and above that contributed by constraints sensitive to [Func: 'in-'] and [Lex: 'finite']. Cheating slightly, let's say that part of this information takes the form of a constraint requiring left-alignment of a dactyl foot (σ́σ̆σ̆):

(9) ALIGN ([Lex: 'infinite'], Left; Dactyl, Left)

This constraint must outrank the constraints responsible for the stress pattern of *finite* and *infallible*. There must also be some phonomorphemic constraints sensitive to [Lex: 'infinite'] that will result in the vowel quality [ɪ], which must outrank those sensitive to [Lex: 'finite'] that usually result in [aj]s. Apart from this, nothing else needs to be specified — all the consonants, for example, can "piggy-back" on the constraints for the daughters.

This kind of solution avoids many of the problems inherent in earlier approaches to morphology. It is necessary neither for the combination to have its own complete underlying representation (massive redundancy) nor for the daughter "morphemes" to carry in all their incarnations information which is relevant only in this particular combination. Recursive indices make it possible to capture the idiosyncrasies of the combination without denying the presence of the parts and the contributions they make in perfectly predictable ways.

Recursive indices also allow us to avoid one of the weaknesses of the more extreme word-syntax approaches when dealing with forms like *inflate*. In a number of ways, *inflate* acts just like it ends with the derivational suffix *-ate*. In a pure Item-and-Arrangement approach, the only way to account for this behaviour is to say that the word contains the morpheme *-ate*, which commits one also to giving morphemic status to the rest of the word (i.e., *infl* or *in* and *fl* are also morphemes). With recursive indices in MOT, however, there is no need for all the morphological information in the word to come from sister formatives. We can account for the *-ate* behaviour of [Lex: 'inflate'] by saying that it "contains" (i.e., dominates a node with) [Func: '-ate'] without also committing ourselves to the existence of a node or nodes for the remainder of the word. Instead, the rest of the information in the word (e.g., the phonological content of [ɪnfl]) can be handled by phonomorphemic constraints which are sensitive directly to the non-terminal node with [Lex: 'inflate']. The resulting morphosyntactic representation and its spell-out relations with Ph would look like Figure 12.1.

English has a number of derivational dominance constraints involving *-ate*, one of which enforces the dominance relation in figure 12.1. For example:

(10)	[Lex: 'inflate']	▶	[Func: '-ate']
	[Lex: 'navigate']	▶	[Func: '-ate']
	[Lex: 'frustrate']	▶	[Func: '-ate']
	[Lex: 'educate']	▶	[Func: '-ate']

-ate itself would have the phonomorphemic constraints abbreviated in (11). The higher lexemic indices [Lex: 'inflate'] and [Lex: 'navigate'] would have the phonomorphemic constraints abbreviated in (12).

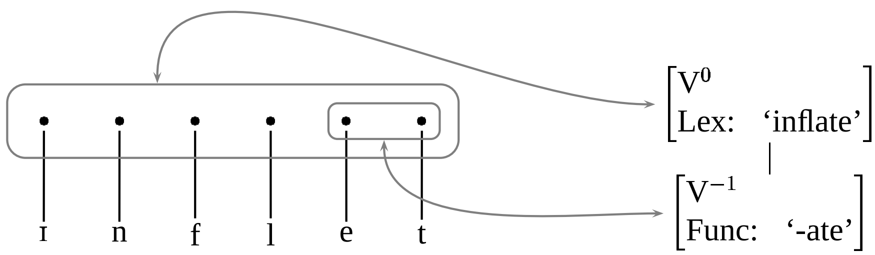


Figure 12.1: Spell-out relations for *inflate*

(11) $_{\text{-ate}}$(e ≺ t)

(12) $_{\text{inflate}}$(ɪ ≺ n ≺ f ≺ l)
$_{\text{navigate}}$(n ≺ æ ≺ v ≺ ɡ)

Finally, we need some way of ensuring that the morph for *-ate* ends up at the end of the morph for *inflate*, not at the beginning or in the middle. This is one of the situations alluded to in section 9.1 where we crucially need mother-alignment rather than sister-alignment, since the node with [Func: ‘-ate’] has no sister.

(13) ALIGN ([Func: ‘-ate’], Right; Mother, Right)

12.2.3 Conversion

It is possible that conversion also involves recursive indices. If this is so, the structure for the English noun *love*, which is converted or “zero-derived” from the verb *love*, would look as follows:

(14) [cat: N
Lex: ‘love$_N$’]
|
[cat: V
Lex: ‘love$_V$’]

[Lex: ‘love$_N$’] would serve as the focal point for Se/Sy interface constraints for any idiosyncratic semantic properties of *love*$_N$. But there is no reason for [Lex: ‘love$_N$’] to have any phonomorphemic constraints — all aspects of the lexeme’s phonology can be delegated to the constraints for the lower [Lex: ‘love$_V$’].

(Another possibility for conversion, hinted at in chapter 5, is that there is a single lexemic index whose node disobeys its category constraints, for example, [Lex: ‘love$_V$’, cat: N], which violates [Lex: ‘love$_N$’] → [cat: V]. The analysis of head operations later in this chapter will ignore this possibility and assume that conversion uses recursive indices.)

12.2.4 Idioms

12.3 Examples

12.3.1 Head operations on compounds

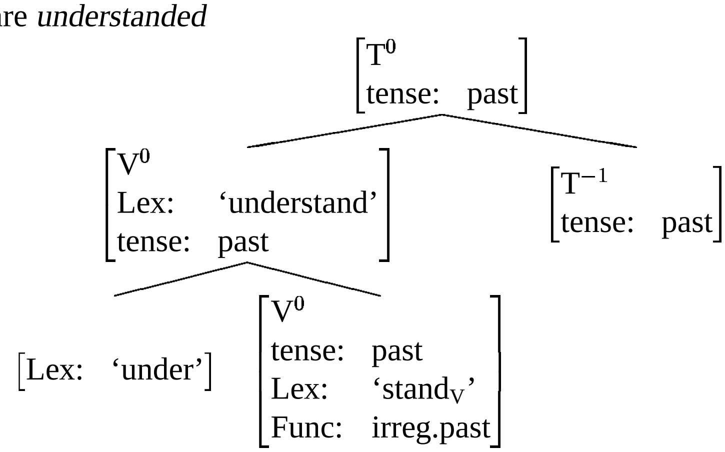
One of the challenges facing a morphological theory is to explain when and why the irregularity of a head survives in the behaviour of a compound verb. For example, the past tense of *understand* is not **understanded* but *understood*. Cases like this where an inflectional feature is realized irregularly on the head rather than regularly on the compound as a whole are known as **head operations** (cf. Hoeksema, 1985; Aronoff, 1988). Matters are made more complicated by the fact that head operations don't occur in every situation. For example, when the noun lexeme GRANDSTAND$_N$ is converted to the verb lexeme GRANDSTAND$_V$, the past tense form is the regular *grandstanded* rather than the "head-operated" form **grandstood*.

Those cases where head operations do exist can be easily handled by feature percolation. Assume that the compound *understand* is the result of the result of the following constraint.[3]

(15) [Lex: 'understand'] ► [Lex: 'under'] [Lex: 'stand$_V$']

The correct surface form of the past tense is given in (16). Using a process metaphor to describe what is going in (16), the tense feature has percolated from the T^{-1} node to the T^0 node, and from there down to the the compound verb node with [Lex: 'understand'] and to the lower verb node with [Lex: 'stand$_V$']. This has triggered the insertion of the a [Func: irreg.past] index on the lower verb, in accordance with the kinds of constraints we saw in section 6.3.1. The presence of the [Func: irreg.past] index prevents the presence of the regular [Func: '-ed'] index on the T^{-1} node.

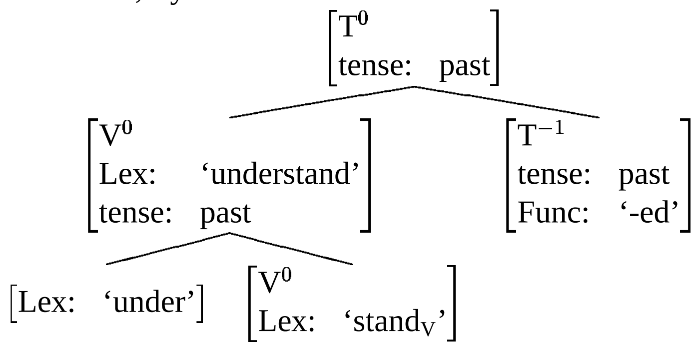
(16) bare *understanded*



[3]The lower *stand* node will get the correct V^0 category by the kinds of lexemic constraints discussed in chapter 5.

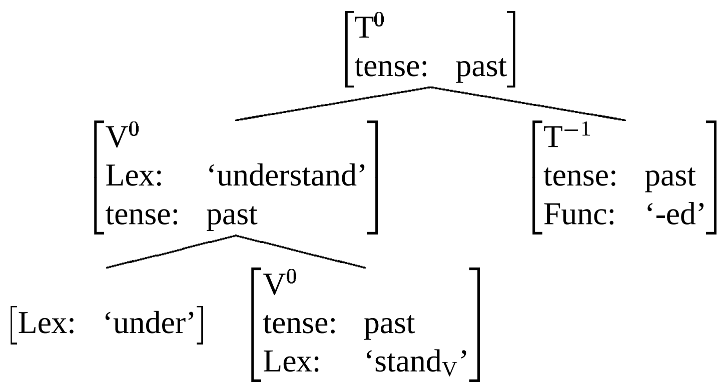
Some close competitor candidates are given in (17), (18), and (19). In (17), the node of the compound verb has the feature [tense: past] but this has not percolated down to the lower verb node with [Lex: 'stand$_V$']. We might expect this to be a violation of the PERCOLATE constraint.

(17) *understanded*, try 1



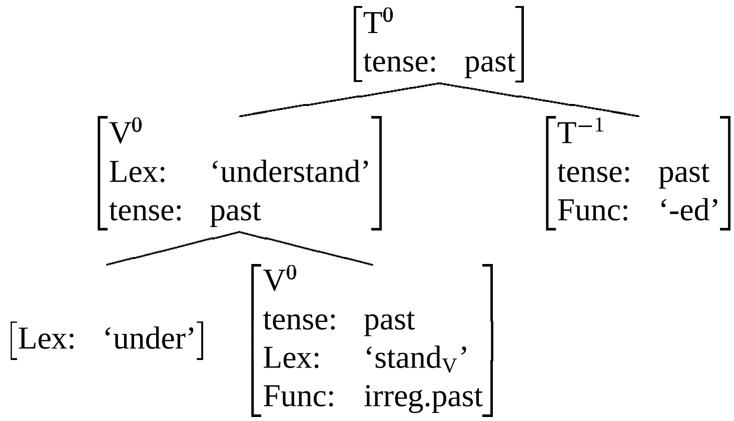
In (18), the tense feature has percolated down to the lower verb node, but there is no [Func: irreg.past]. We might expect this to be a violation of the constraint [Lex: 'stand$_V$', tense: past] → [Func: irreg.past], as discussed in section 6.3.1.

(18) *understanded*, try 2



In (19), the [Func: irreg.past] index appears on the lower verb, but there is also an overt regular tense suffix [Func: '-ed'] on the T^{-1} node. We would expect this to be a violation of the NOTGOVERNS (-ed, irreg.past) constraint, also discussed in section 6.3.1.

(19) *understooded*



The constraints involved in the evaluation for *understood* are summarized in (20). We know from section 6.3.1 that (20a) and (20c) must both outrank (20d).

(20) a. [Lex: ‘stand$_V$’, past] $\rightarrow$ [Func: irreg.past]
b. PERCOLATE ([tense: past])
c. NOTGOVERNS ([Func: ‘-ed’], [Func: irreg.past])
d. [T^{-1}, past] $\rightarrow$ [Func: ‘-ed’]

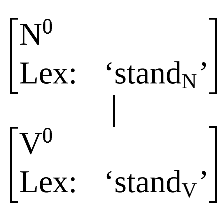
(21) Selecting *understood*

Sy	stand$_V$,past$\rightarrow$ irreg.past	PERCOLATE	-ed$\not\curvearrowright$irreg.past	T^{-1},past$\rightarrow$-ed
understanded1		*!		
understanded2	*!			
understooded			*!	
☞ *understood*				*

Now we turn to the question of why the same kind of head-operation does not happen with *grandstand*, making a past tense form of *grandstood*. We follow Pinker and Prince’s (1988) idea that *grandstand* contains a noun which acts as a “barrier” to the percolation of the past tense feature.

The compound noun *grandstand* is made of the adjective *grand* and the noun *stand*$_N$. Following the discussion of 12.2.3, let us assume that the noun *stand*$_N$ has the conversion struction in (22).

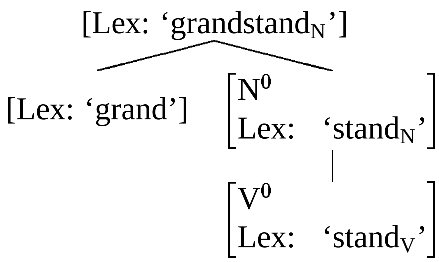
(22)



grandstand$_N$ would then look like (24), which we may assume results from a constraint like (23).

(23) [Lex: ‘grandstand$_N$’] ► [Lex: ‘grand’], [Lex: ‘stand$_N$’]

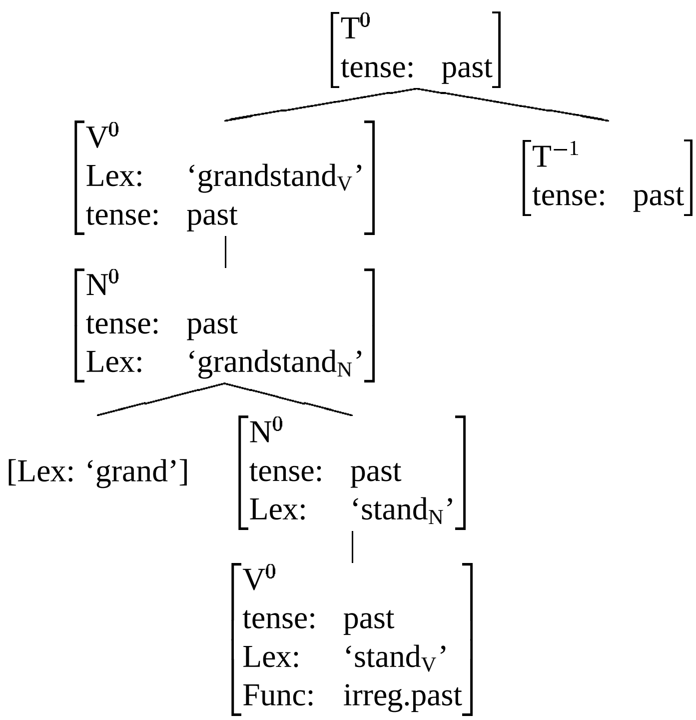
(24)



The verb *grandstand*$_V$ comes from yet another conversion, which would add another [cat: V, Lex: ‘grandstand$_V$’] node to the top of (24).

Now in order for the past to be *grandstood*, the feature [tense: past] would have had to percolate from the highest V^0 of [Lex: ‘grandstand$_V$’] all the way down to the lowest [Lex: ‘stand$_V$’], resulting in the syntactic structure in (25).

(25)



The major problem with this is that intermediate N^0 nodes have the feature [tense: past], in violation of our usual expectations that nouns do not have tense. We can formulate this as the constraint:

(26) *[cat:N, tense:X]

As we saw in section 3.3.4, for such constraints to be operative at all, they must outrank the corresponding PERCOLATEALL constraints.

The most intense competition is thus between (25) and the correct surface form, *grand-standed*, where the tense feature does not percolate below the highest V^0 node. The evaluation can be summarized in tableau (27).

(27)

	Sy	*[N,tense]	PERCOLATE (tense)	[stand$_V$,past] →[irreg.past]
☞	[grand [[stand]]] ed		*	
	[grand [[stood]]]	*!		

As seen in (27), the influence (and even the ranking) of the irregularity inducing [stand$_V$, past] → [irreg.past] constraint is irrelevant.

12.3.2 Truncatory morphology

Constraints like [Lex: 'inflate'] ▶ [Func: '-ate'] are in principle violable, and indeed the differing patterns of violation allow us to see that not every constraint of the form X▶[Func: '-ate'] is ranked at the same position in the hierarchy. In a pattern which Aronoff (1976) analyzed as "truncatory" morphology, English *-ate* has a habit of failing to appear before the suffix *-able*. But this does not hold for all lexemes.

(28)

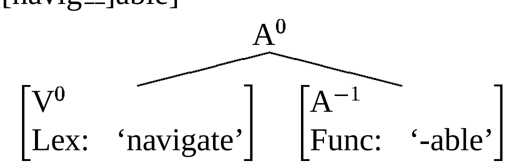
*navigatable	navigable
*negotiatable	negotiable
inflatable	*inflable

We can express the typical "truncation" of *-ate* by *-able* using the kind of non-cooccurrence constraint introduced in section 6.2.1:

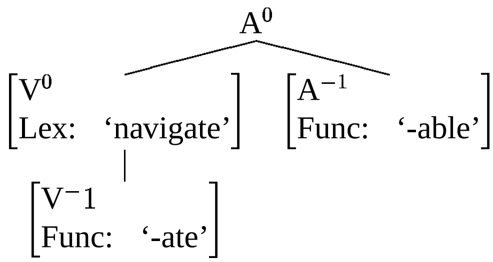
(29) NOTGOVERNS ([Func: '-able'], [Func: '-ate'])
abbreviation: -able↛-ate

This constraint does not prevent the lexeme *navigate* from combining with the suffix *-able*, but it does prevent the node for *navigate* from dominating a node with [Func: '-ate']. The next few examples give a few of the more promising candidates for the word *navigable*.

(30) [[navig_]able]



(31) [[navig[ate]]able]



(32) [__ able]

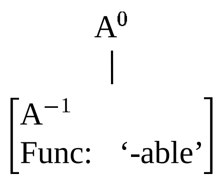


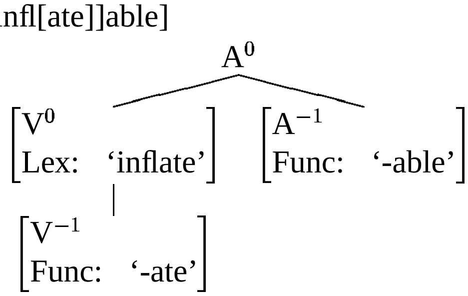
Tableau (33) shows how the grammar/lexicon chooses candidate (30), which has [Func: '-able'] and [Lex: 'navigate'] but no [Func: '-ate']. The fullest candidate (*navigateable*) violates the NOTGOVERNS constraint. The Se/Sy interface constraints are strong enough that leaving out either [Lex: 'navigate'] or [Func: '-able'] is not a viable option. The requirement that [Lex: 'navigate'] dominate [Func: '-ate'] is the weakest constraint of the bunch, so it is the one that gives way.

(33)

	Sy	💡↔ [Lex:'navigate'] [Func:'-able']	-able↷̸-ate	navigate▶-ate
☞	[[navig_]able]			*
	[[navig[ate]]able]		*!	
	[_ able]	*!		
	[[navig[ate]]_]	*!		

The situation is different when the semantics requires the presence of both [Lex: 'inflate'] and [Func: '-able']. In this case, the winning candidate *does* have the [Func: '-ate'] index:

(34) [[infl[ate]]able]



This suggests that -able↷̸-ate must be lower ranked than [Lex: 'inflate'] ▶ [Func: '-ate'].

(35) [Lex: ‘inflate’] ▶ [Func: ‘-ate’] ≫
-able⌒-ate ≫
[Lex: ‘navigate’] ▶ [Func: ‘-ate’]

The following tableau shows how the correct candidate is chosen:

(36)

	Sy	[Lex:‘inflate’] ↔[Func:‘-able’]	inflate▶-ate	-able⌒-ate
	[[infl_]able]		*!	
☞	[[infl[ate]]able]			*
	[_ able]	*!		
	[[infl[ate]]_]	*!		

12.4 Elaboration

12.4.1 Connections

GPSG

Sign Based Morphology, Orgun (1996)

Anderson (1992) on historical vs. representational treatments of derivation — cf. syntactic trees.

12.4.2 Better domination schemata?

I have been vague about the order of elements should be interpreted in abbreviated schemata like:

(37) [Lex: ‘football’] ▶ [Lex: ‘foot’], [Lex: ‘ball’]

If (37) is really just an abbreviation of two DOMINATES constraints, then there is no implication of linear order at all. I have assumed that there are always going to be independent constraints that will result in the correct ordering of the two daughters in an abbreviated schema, for example, the constraint that the head of a compound be on the right or the constraint that the X^{-1} head of an X^0 constituent should be on the right.

But independent principles might not always be enough. For example, without any reference to semantics, there is no way of telling that the head of *football* is *ball* rather than *foot*. A complete theory will need some way of requiring a particular linear order where necessary. One way would be with alignment constraints. For example, (37) might be an abbreviation of three constraints rather than two:

(38) [Lex: ‘football’] ▶ [Lex: ‘foot’]
[Lex: ‘football’] ▶ [Lex: ‘ball’]
ALIGN ([Lex: ‘football’], Right; [Lex: ‘ball’], Right)

Another way would be to use constraint schemata that can explicitly state what the head of a construction should be:

(39) HASHEAD ([Lex: ‘football’], [Lex: ‘ball’])
HASDAUGHTER ([Lex: ‘football’], [Lex: ‘foot’])

Bibliography

Anderson, John M. and Colin J. Ewen (1987); *Principles of Dependency Phonology*; Cambridge University Press.

Anderson, Stephen R. (1992); *A-Morphous Morphology*; Cambridge: Cambridge University Press.

Anshen, Frank and Mark Aronoff (1988); "Producing morphologically complex words;" *Journal of Linguistics* 26, 641–655.

Archangeli, Diana (1984); *Underspecification in Yawelmani phonology and morphology*; Ph.D. thesis; MIT; published by Garland, 1988.

Archangeli, Diana (1991); "Syllabification and prosodic templates in Yawelmani;" *NLLT* 9, 231–283.

Archangeli, Diana (1997); *Optimality Theory: an introduction to linguistics in the 1990s*; chapter 1, pp. 1–32; in Archangeli and Langendoen (1997).

Archangeli, Diana and D. Terence Langendoen (eds.) (1997); *Optimality Theory: an overview*; London: Blackwell.

Archangeli, Diana and Douglas Pulleyblank (1994); *Grounded Phonology*; MIT Press.

Aronoff, Mark (1976); *Word formation in generative grammar*; MIT Press.

Aronoff, Mark (1988); "Head operations and strata in reduplication: a linear treatment;" *Yearbook of Morphology* 1, 1–16.

Aronoff, Mark (1994); *Morphology by itself*; MIT Press.

Baker, Mark (1985); "The Mirror Principle and morphosyntactic explanation;" *LI* 16, 373–416.

Beard, Robert (1995); *Lexeme-Morpheme Base Morphology*; Albany: State University of New York Press.

Bernhardt, Barbara Handford and Joseph P. Stemberger (1997); *Handbook of phonological development from the perspective of constraint-based nonlinear phonology*; Academic Press.

Bird, Steven (1990); *Constraint-based phonology*; Ph.D. thesis; University of Edinburgh.

Bird, Steven (1995); *Computational phonology: a constraint-based approach*; Cambridge University Press.

Boersma, Paul (1998); *Functional Phonology: Formalizing the interaction between articulatory and perceptual drives*; Ph.D. thesis; University of Amsterdam; published by Holland Academic Graphics.

Bresnan, Joan (ed.) (1982); *The mental representation of grammatical relations*; Cambridge, MA: MIT Press.

Bresnan, Joan and Samuel A. Mchombo (1995); "The Lexical Integrity Principle: evidence from Bantu;" *NLLT* 13, 181–254.

Bybee, Joan L. (1985); *Morphology: a study of the relationship between form and meaning*; John Benjamins.

Carstairs, Andrew (1987); *Allomorphy in Inflexion*; London: Croom Helm.

Carstairs-McCarthy, Andrew (1991); "Inflection classes: two questions with one answer;" in Plank (1991).

Carstairs-McCarthy, Andrew (1994); "Inflection classes, gender, and the Principle of Contrast;" *Language* 70, 737–788.

Chomsky, Noam (1981); *Lectures on Government and Binding*; Dordrecht: Foris.

Chomsky, Noam and Morris Halle (1968); *The Sound Pattern of English*; MIT Press.

Clements, George N. and Samuel Jay Keyser (1983); *CV Phonology*; Cambridge, MA: MIT Press.

Coleman, John (1998); *Phonological representations: their names, forms, and powers*; Cambridge University Press.

Di Sciullo, Anna Maria and Edwin Williams (1987); *On the definition of word*; MIT Press.

Fulmer, Sandra L. (1991); "Dual-position affixes in Afar: an argument for phonologically driven morphology;" in *Proceedings of the 9th West Coast Conference on Formal Linguistics*; pp. 189–203.

Fulmer, Sandra L. (1997); *xxx*; Ph.D. thesis; University of Arizona; Tucson.

Gazdar, Gerald, Ewan Klein, Geoffrey Pullum, and Ivan Sag (1985); *Generalized Phrase Structure Grammar*; Oxford: Blackwell.

Goldsmith, John (1993); "Harmonic phonology;" in *The last phonological rule*, (ed.) John Goldsmith; pp. 21–60; Chicago: University of Chicago Press.

Golston, Chris (1996); "Direct Optimality Theory: representation as pure markedness;" *Language* 72, 713–748.

Grimshaw, Jane (1997); "Projection, heads, and optimality;" *LI* 28, 373–422.

Hale, Kenneth and Samuel Jay Keyser (eds.) (1993); *The view from building 20: essays in linguistics in honor of Sylvain Bromberger*; MIT Press.

Hall, Christopher J. (1992); *Morphology and mind: a unified approach to explanation in linguistics*; London: Routledge.

Halle, Morris and Alec Marantz (1993); "Distributed Morphology and the pieces of inflection;" in Hale and Keyser (1993).

Hammond, Michael (1988); "Templatic transfer in Arabic broken plurals;" *Natural Language and Linguistic Theory* 6, 247–270.

Hammond, Michael (1995); "There is no lexicon!" University of Arizona.

Harris, James W. (1991a); "The exponence of gender in Spanish;" *Linguistic Inquiry* 22, 27–62.

Harris, James W. (1991b); "The form classes of Spanish;" *Yearbook of Morphology* 4, 65–88.

Hayes, Bruce (1989); "Compensatory lengthening in moraic phonology;" *LI* 20, 253–306.

Hockett, Charles (1954); "Two models of grammatical description;" *Word* 10, 210–231.

Hoeksema, Jack (1985); *Categorial morphology*; New York: Garland.

Inkelas, Sharon (1993); "Nimboran position class morphology;" *NLLT* 11, 559–624.

Jackendoff, Ray (1997); *The architecture of the language faculty*; MIT Press.

Jackendoff, Ray S. (1975); "Morphological and semantic regularities in the lexicon;" *Language* 51, 639–671.

Kayne, Richard (1994); *The antisymmetry of syntax*; MIT Press.

Koopman, Hilda (1984); *The Syntax of Verbs: From Verb Movement Rules in the Kru Languages to Universal Grammar*; Dordrecht: Foris.

Kuroda, S.-Y. (1967); *Yawelmani Phonology*; MIT Press.

Lakoff, George (1993); "Cognitive phonology;" in *The last phonological rule*, (ed.) John Goldsmith; pp. 117–145; Chicago: University of Chicago Press.

Lieber, Rochelle (1989); "On percolation;" *Yearbook of Morphology* 2, 95–138.

Lieber, Rochelle (1992); *Deconstructing morphology: word formation in syntactic theory*; University of Chicago Press.

Matthews, P.H. (1972); *Inflectional morphology: a theoretical study based on aspects of Latin verb conjugations*; Cambridge University Press.

McCarthy, John J. (1989); "Linear order in phonological representation;" *LI* 20, 71–99.

McCarthy, John J. and Alan S. Prince (1986); "Prosodic morphology;" Unpublished ms.

McCarthy, John J. and Alan S. Prince (1990a); "Foot and word in prosodic morphology: the Arabic broken plurals;" *NLLT* 8, 209–282.

McCarthy, John J. and Alan S. Prince (1990b); "Prosodic morphology and templatic morphology;" in *Perspectives on Arabic linguistics: papers from the second symposium*, (eds.) Mushira Eid and John J. McCarthy; pp. 1–54; Amsterdam: John Benjamins.

McCarthy, John J. and Alan S. Prince (1993a); "Generalized alignment;" in *Yearbook of Morphology 1993*, (eds.) Geert Booij and Jap van Marle; pp. 79–153; Dordrecht: Kluwer.

McCarthy, John J. and Alan S. Prince (1993b); *Prosodic Morphology I: constraint interaction and satisfaction*; Technical report; University of Massachusetts, Amherst and Rutgers University.

McCarthy, John J. and Alan S. Prince (1994); "Two lectures on prosodic morphology;" handouts and lecture transcripts from the OTS/HIL Workshop on Prosodic Morphology.

McCarthy, John J. and Alan S. Prince (1995); "Faithfulness and reduplicative identity;" in *Papers in Optimality Theory*, (eds.) Jill Beckman, L. Walsh Dickey, and S. Urbanczyk; volume 18 of *University of Massachusetts Occasional Papers in Linguistics*; pp. 252–384; Amherst: GLSA.

McDonough, Joyce (1990); *Topics in the phonology and morphology of Navajo verbs*; Ph.D. thesis; University of Massachusetts, Amherst.

Menn, Lise and Brian MacWhinney (1984); "The repeated morph constraint;" *Language* 60, 519–541.

Nespor, Marina and Irene Vogel (1986); *Prosodic phonology*; Dordrecht: Foris.

Newman, Stanley (1944); *Yokuts language of California*; number 2 in Viking Fund Publications in Anthropology; New York: Viking Fund.

Noyer, Rolf (1992); *Features, positions and affixes in autonomous morphological structure*; Ph.D. thesis; MIT; Cambridge, MA.

Orgun, Cemil Orhan (1996); *Sign-Based Morphology and Phonology with special attention to Optimality Theory*; Ph.D. thesis; University of California, Berkeley.

Ouhalla, Jamal (1991); *Functional projections and parametric variation*; London: Routledge.

Payne, David L. (1981); *The phonology and morphology of Axininca Campa*; Arlington, TX: Summer Institute of Linguistics.

Pinker, Steven and Alan S. Prince (1988); "On language and connectionism: Analysis of a parallel distributed processing model of language acquisition;" *Cognition* 28, 73–194.

Plank, Frans (ed.) (1991); *Paradigms: the economy of inflection*; Berlin: Mouton de Gruyter.

Pollard, Carl and Ivan A. Sag (1987); *Information-based syntax and semantics, volume 1: fundamentals*; volume 13 of *CSLI Lecture Notes*; Stanford: CSLI.

Pollard, Carl and Ivan A. Sag (1994); *Head-Driven Phrase Structure Grammar*; Chicago: University of Chicago Press.

Pollock, Jean-Yves (1989); "Verb movement, Universal Grammar, and the structure of IP;" *LI* 20, 365–424.

Prince, Alan S. and Paul Smolensky (1993); *Optimality Theory: constraint interaction in generative grammar*; Technical report; Rutgers University and University of Colorado, Boulder.

Pullum, Geoff and Arnold Zwicky (xx); "...phonology-free syntax;" *xx* xx, xx.

Rice, Keren (1993); "The structure of the Slave (northern Athabaskan) verb;" in *Phonetics and Phonology 4: Studies in Lexical Phonology*, (eds.) Sharon Hargus and Ellen M. Kaisse; pp. 145–171; San Diego: Academic Press.

Rice, Keren (1998); "Slave;" in *Handbook of Morphology*, (eds.) Andrew Spencer and Arnold M. Zwicky; pp. xx–xx; London: Blackwell.

Russell, Kevin (1993); *A constraint-based approach to phonology and morphology*; Ph.D. thesis; University of Southern California.

Russell, Kevin (1995); "Morphemes and candidates in optimality theory;" University of Manitoba [ROA].

Russell, Kevin (1997); *Optimality Theory and morphology*; chapter 4, pp. 102–133; in Archangeli and Langendoen (1997).

Russell, Kevin (1999); “The constraint hierarchy is the lexicon: or how to break Moroccan Arabic plurals;” University of Manitoba.

Sadock, Jerold M. (1991); *Autolexical Syntax*; Chicago: University of Chicago Press.

Sagey, Elizabeth (1986); *The representations of features and relations in non-linear phonology*; Ph.D. thesis; MIT; Cambridge, MA.

Saxon, Leslie (1986); *The syntax of pronouns in Dogrib: some theoretical consequences*; Ph.D. thesis; University of California, San Diego.

Scobbie, James M. (1991); *Attribute value phonology*; Ph.D. thesis; University of Edinburgh; published by Garland.

Selkirk, Elisabeth O. (1982); *The syntax of words*; MIT Press.

Selkirk, Elisabeth O. (1984); *Phonology and syntax: the relation between sound and structure*; MIT Press.

Selkirk, Elisabeth O. (1995); “The prosodic structure of function words;” in *Papers in Optimality Theory*, (eds.) Jill Beckman, L. Walsh Dickey, and S. Urbanczyk; volume 18 of *University of Massachusetts Occasional Papers in Linguistics*; Amherst: GLSA.

Spencer, Andrew (1992); “Nominal inflection and the nature of functional categories;” *Journal of Linguistics* 28, 313–341.

Spring, Cari (1990); *Implications of Axininca Campa for prosodic morphology*; Ph.D. thesis; University of Arizona.

Steele, Susan (1995); “A theory of morphological information;” *Language* xxx, xxx.

Stemberger, Joseph Paul (1981); “Morphological haplology;” *Language* 57, 791–817.

Steriade, Donca (1988); “Reduplication and syllable transfer in Sanskrit and elsewhere;” *Phonology* 5, 73–155.

Stump, Gregory T. (1991); “A paradigm-based theory of morphosemantic mismatches;” *Language* 67, 675–725.

Stump, Gregory T. (1993); “On rules of referral;” *Language* 69, 449–479.

Tranel, Bernard (1994); “French liaison and elision revisited: a unified account within Optimality Theory;” University of California, Irvine. [ROA-15].

Truckenbrodt, Hubert (1999); “On the relation between syntactic phrases and phonological phrases;” *LI* 30, 219–255.

Walther, Markus (1995); "A strictly lexicalized approach to phonology;" in *Proceedings of DGfS/CL'95*, (eds.) James Kilbury and Richard Wiese; pp. 108–113; Deutsche Gesellschaft für Sprachwissenschaft, Sektion Computerlinguistik.

Walther, Markus (1997); *Deklarative prosodische Morphologie – constraintbasierte Analysen und Computermodelle zum Finnischen und Tigrinya*; Ph.D. thesis; Philosophische Fakultät der Heinrich-Heine-Universität Düsseldorf.

Zonneveld, Wim (1978); *A formal theory of exceptions in generative phonology*; Lisse: Peter de Ridder Press.

Zwicky, Arnold M. (1992); "Some choices in the theory of morphology;" in *Formal grammar: theory and implications*, (ed.) Robert Levin; pp. 327–371; Oxford University Press.