TRANSDERIVATIONAL IDENTITY:
PHONOLOGICAL RELATIONS BETWEEN WORDS

A Dissertation Presented

by

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ABSTRACT

TRANSDERIVATIONAL IDENTITY

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This dissertation develops the hypothesis that morphologically-related words are required to be phonologically identical by ranked and violable constraints. Pairs of surface forms are linked by a transderivational or output-to-output (OO) correspondence relation. Through ranking, constraints on the OO-correspondence relation may force a derived word to deviate from the canonical surface patterns of the language in order to be more like its output base. This theory obviates the traditional analysis that deviant phonology in complex words is the product of cyclic derivation. Given transderivational relations, cyclic effects are produced by constraint interaction in nonprocedural Optimality Theory.

Cyclic effects are better understood as misapplication identity effects, similar to the over- and underapplication phenomena observed in reduplicated words. Phonological processes may overapply (take place where they are not properly conditioned) or underapply (fail to apply where properly conditioned) to achieve surface identity of paradigmatically-related words. Constraints that demand identity in paradigms interact directly with phonological markedness constraints and input-output faithfulness requirements. When OO-correspondence constraints take precedence, phonology misapplies.

Three case studies are presented. The Austronesian language Sundanese shows an overapplication pattern, and Tiberian Hebrew demonstrates underapplication identity effects. In both cases, paradigmatic identity is achieved at the cost of greater markedness in surface forms. Both of these languages also show that paradigmatic identity is sacrificed when it

would produce too marked a structure, providing support for the claim that OO-correspondence constraints are ranked in a fixed, monostratal grammar.

The study of English paradigms presents a theory of phonological classhood. Two arbitrarily-defined classes of affixed words participate in different transderivational identity effects. Each affix class triggers a distinct OO-correspondence relation governed by its own set of faithfulness constraints. All class-specific phonological behavior follows from the ranking of the two sets of OO-correspondence constraints.

In this tranderivational theory, phonology is sensitive to morphology because phonological faithfulness relations hold over paradigmatically-related words. There are no cycles or levels of derivation. Complex words, like simplex words, are derived in a parallel grammar, without any intermediate stages.

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CHAPTER 1

PHONOLOGICAL RELATIONS BETWEEN WORDS

1.1 Introduction and Overview

Morphologically-related words tend to be phonologically similar. In some cases related words are similar just because they share a morpheme and are generated from the same underlying form. For example, *cat* and *cats*, which are related by plural affixation, are phonologically identical (to the extent that they are) because both contain the root with the underlying representation /kæt/, and both are derived by the English grammar.

In other cases, phonological similarities in related words cannot be explained simply by appeal to a shared underlying form, because achieving identity entails violating regular phonotactic patterns of the language. The morphological difference between two words – e.g., the presence or absence of an affix – makes it so that a phonological alternation is expected in one word but not in the other. Nevertheless, the two words are identical in some relevant part; one word mimics the other, and thereby violates an otherwise true generalization about the language. Put differently, a phonological process observed in the language at large MISAPPLIES so that related forms are more alike in segmental or featural content or in prosodic organization. The phonological process may OVERAPPLY (take place where it is not conditioned) or UNDERAPPLY (fail to occur where it is conditioned) to increase identity of related words.[1]

Consider an example of identity-driven misapplication in English phonology. Certain consonant clusters are not permitted to surface tautosyllabically, as shown by *condemn*, *thumb* and *sign*. That these words end in clusters in underlying form is demonstrated by related words like *condemnation*, *Thumbelina* and *signature*, where the unpredictable clusters surface in a heterosyllabic parse. In a certain set of suffixed words, cluster simplification applies where it is not expected to: in *condemning*, *thumbing* and

1 The terms under- and overapplication come from Wilbur (1973), who analyzes similar patterns in reduplicated words (see §2.4 below).

signer, one of the root-final consonants is lost, even though both consonants could surface in a heterosyllabic parse. This overapplication of cluster simplification increases identity of morphologically-related words; deleting a consonant from both words makes pairs like *condemn*   *condemning*, *thumb*   *thumbing* and *sign*   *signer* more alike.[2]

A second English example involves stress. Certain complex words, such as *orìginálity* or *arìstocrátic*, bear stress on the second syllable, even though stress is not expected in that position. In simplex words of similar shape (three light syllables before the main stress), secondary stress appears on the first syllable of the word: *Lòllapalóoza*, *Tàtamagóuchee*, *àbracadábra*. The expected leftward alignment of secondary stress underapplies in *orìginálity* and *arìstocrátic*, and the peninitial vowel bears stress. This non-canonical stress placement is driven by identity considerations: *orìginálity* bears stress on its second vowel because the corresponding vowel bears stress in the related base *oríginal*. By failing to conform to the regular secondary stress pattern, *orìginálity* resembles *oríginal* in prosodic structure.

These misapplication identity effects cannot be attributed to a shared underlying representation because they involve mimicry of DERIVED phonological properties. In the cluster simplification case, the suffixed word *signer* copies a predictable property of its base *sign*: the deletion of a consonant. Clearly, the fact that both *sign* and *signer* are generated from the UR /saygn/ does not explain the surface similarity of the two words. If the suffixed word *signer* were merely generated from the UR /saygn + ər/, there would be no account of its loss of the /g/, since clusters are simplified only if they must be tautosyllabic.[3] In fact, the overapplication of deletion in *signer* suggests that this word is not "generated

2 Not all pairs of related words achieve the same degree of identity. In *condemn*   *condemnation*, normal application of cluster simplification makes the pair non-identical. I argue in §5 that the distinction between class 1 and class 2 affixation in English correlates with the degree of phonological identity observed in each type of paradigm.

3 It might be proposed that *sign* and *signer* are derived by distinct subgrammars of English, so that *signer* is subject to principles that simplify heterosyllabic clusters, while *sign* and *signature* show only tautosyllabic consonant deletion. This subgrammar notion has been exploited in serial-derivational theories like Lexical Phonology and serialist Optimality Theory. I will argue explicitly against subgrammar theory, showing that it is highly stipulative and leads to significant loss of generalization.

from" the UR /saygn/ at all, but from the surface word *sign*, which shows predictable loss of the underlying /g/.

The stress case similarly suggests a phonological relation between two derived words. English stress is (by and large) predictable, and predictable properties are assigned by the grammar, rather than attributed to underlying representation. The foot structure of *oríginal* and *orìginálity* therefore cannot come from the underlying root these words have in common – indeed, initial stress on *órigin* shows that the underlying foot structure in /ɔrɪǰɪn/, if any, is not respected by the English grammar. Non-canonical peninitial stress on *orìginálity* is induced not by the UR, but by the related word *oríginal* (in which stress accords with canonical English patterns). To emphasize: it is the surface form of *oríginal*, where predictable stress feet appear, that influences secondary stress placement in *orìginálity*.

This dissertation develops a theory of phonological relations between words. Misapplication patterns are studied to show that identity of morphologically-related words is enforced directly by the phonological grammar. Constraints defined over transderivational (output-to-output or OO) correspondence relations state identity requirements on pairs of words, or PARADIGMS, constructed by morphological derivation (e.g., *cat*   *cats, origin*   *original, sign*   *signer*). As primitive elements of the grammar, the paradigmatic identity constraints interact directly with constraints that impose phonotactic patterns. When paradigmatic identity takes precedence, canonical patterns are disobeyed to achieve identity of related words.

This proposal is an extension of the Correspondence Theory of faithfulness (McCarthy & Prince, 1995) in Optimality Theory (Prince & Smolensky, 1993). The leading idea of Correspondence Theory is that all types of grammatical faithfulness are regulated in the same way, by ranked and violable constraints on correspondence relations. Corresponding strings can stand in various types of relations: they may be related as underlying and surface form (input and output) or as a reduplicant and its base or, as argued

here, as a pair of output words. In each type of relation, identity is enforced by a set of faithfulness constraints. Thus multiple sets of faithfulness constraints, proper to different types of linguistic relations, coexist in the grammar, interacting with one another and with the hierarchy of phonological markedness constraints (see §1.2 and §1.3 below on Optimality and Correspondence Theory).

My central claim is that identity of words in paradigms is required by the phonological grammar, in the same way that the grammar demands identity in input-output or base-reduplicant pairs: by violable constraints on a correspondence relation. When OO-Identity constraints on a transderivational (output-output) relation take precedence over markedness requirements or faithfulness to the underlying form, phonological processes misapply. When OO-Identity constraints are dominated, phonology applies as expected, and identity of paradigmatically-related words is sacrificed.

One of the results of this proposal, which I dub Transderivational Correspondence Theory (TCT), is that it eliminates intermediate stages in word formation, and supports the strong claim of parallelism in an Optimality grammar (Prince & Smolensky, 1993). In TCT, the unit of evaluation is a paradigm, and the paradigmatically-related words are available to the phonology at the same time. This is a departure from the traditional analysis of over- and underapplication patterns as the product of CYCLIC DERIVATION, in which one word is an intermediate stage in the derivation of the other. The idea is that phonological rules apply in cycles, to successively larger morphological constituents of a complex word (Chomsky & Halle, 1968), and rules can appear to be improperly conditioned (overapplied) or unexpectedly blocked (underapplied) at the end of the final cycle. In the cyclic derivation of *orìginálity*, stress rules apply to the constituent *oríginal* before they apply again to the full word, and the stress assigned to the antepenultimate syllable of *oríginal* is preserved by the rules of the later cycle.[4] There is, therefore, no need for a rule that places peninitial

[4] Later cycles do not always preserve the output of earlier cycles; for example, the stress assigned on the *órigin* cycle is not preserved in *oríginal*.

stress on *orìginálity*, which is good, because the English stress rules would assign initial stress to this word (cf. *Lòllapalóoza*). Instead, the peninitial stress on *orìginálity* is a residue of the (regular) stress on *oríginal*. Thus, the fact that *orìginálity* escapes initial secondary stress is simply a by-product of the serial derivation of this word.[5]

Transderivational relations are not incompatible with serialism, but both produce the same result – identity of related words – so it makes sense to eliminate one in favor of the other. I argue throughout this thesis that the constraint-based transderivational system improves on serial analyses, both conceptually and empirically. One argument is that the transderivational analysis goes straight to the heart of the matter, and focuses directly on identity of morphologically-related words. There is nothing epiphenomenal about identity in paradigms; it is enforced by principles of grammar.

I will also argue that TCT is less stipulative than cyclic theory. For example, it has been noticed since the introduction of the cycle, that cycles of rules apply only to full words, and not to smaller morphological constituents (Brame, 1974; Kiparsky, 1982a; Inkelas, 1989). "Cyclic effects" occur only in words that are derived from another word, and not in words built by affixation to a bound root (such as *electric, conceive, impeach*). Serial theories require some extra stipulation to prevent rules from cycling on bound roots; familiar proposals include the (Revised) Alternation Condition (Kiparsky 1968) and the Strict Cycle Condition (Kean, 1974; Mascaró, 1976; Kiparsky, 1982a; Cole, 1995). In TCT, the fact that bound roots are not cyclic domains follows from the basic premises of the theory. Cyclic effects are misapplication identity effects, in which a complex word mimics its output base (as demanded by high-ranking OO-correspondence constraints). Since a word built from a bound root has no output base (**electr, *ceive, *peach*), it can never show misapplication or "cyclic" effects.[6]

5 In addition, the rule that assigns word-initial secondary stress has to be "turned off" before the class of words like *orìginálity* is derived.

6 Another restriction on cyclic rule application, known as the Strong Domain Hypothesis (Borowsky, 1986 citing unpublished work by Kiparsky), holds that rules can be "turned off" but not "turned on" in the course of a derivation. SDH effects also fall out naturally in the TCT framework, from general principles of constraint ranking (see §5.7).

Another argument that will receive some attention in following chapters is that TCT is typologically more restrictive than cyclic theory. Because all words are evaluated against the same hierarchy of constraints, the parallel theory puts a limit on how deviant the deviant phonology of complex words can be. The non-canonical surface patterns observed in paradigms and the canonical patterns of the language are generated by the same grammar. All words are evaluated against the same fixed ranking, so they are restricted in the ways they can differ. Serial theories, in contrast, leave open the possibility that cycles or levels of derivation differ in any or all ways, and can produce wildly various surface patterns in different classes of words, including patterns that are unlikely to be attested in natural language. These and other arguments against the serial or cyclic approach are set out in more detail in following chapters.

The transderivational alternative to cyclic theory is not new. In the generative framework,[7] Harris (1973) argues for a paradigm-based analysis of certain Spanish phenomena, Hock (1973) proposes a theory of synchronic analogy in an analysis of Sanskrit forms, and Chung (1983) presents a transderivational analysis of stress and segmental phonology in Chamorro. Hooper/Bybee's (1976, 1985) theory of lexical networks is similar in spirit, as is Leben & Robinson's (1977) theory of Upside Down Phonology. There are also connections between transderivational theory and Aronoff's (1976) word-based morphology, in that the word unit plays a prominent role in both frameworks. More recently, Burzio (1994 *et. seq.*) articulates a theory of anti-allomorphy effects which foreshadows many of the ideas presented in this dissertation.

With the development of Optimality Theory (OT) and its notion of parallel derivation, and particularly since the Correspondence Theory of faithfulness was introduced, the transderivational approach to word formation has received a good deal of attention. Transderivational analyses have been offered by Benua (1995), McCarthy (1995), Itô,

7 The structuralist Word-and-Paradigm tradition of morphophonological analysis is clearly related to transderivationalist ideas, and there are also obvious connections between synchronic transderivational theories and the notion of analogy in language change (see Hock (1973) for discussion).

Kitigawa & Mester (1995), Kraska-Szlenk (1995), Kenstowicz (1996, 1997), Kager (1995), Buckley (1995), Verhijde (in prep.), Flemming (1995), Wilson (1996), Steriade (1996), Archangeli (1996), Crosswhite (1996); Levy (1997ab), and Bakovic (1997), among others.[8]

The transderivational model proposed in this thesis is laid out in §2. In brief, I claim that morphological derivation (affixation, truncation, ablaut, etc.) is mirrored by a phonological faithfulness relation between the derived output and an output base. Each output is also related to an input or underlying form, as in (1).

(1) Transderivational Relations

		OO-correspondence		
	[kæt]	→	[kæts]	
IO-correspondence	↑		↑	***IO-correspondence***
	/kæt/		/kæt + s/	

OO-correspondence relations link words two at a time, in SUBPARADIGMS. Identity constraints on the OO-correspondence relation compete with IO-correspondence constraints and markedness constraints in a fully parallel derivation of paradigms.

The TCT proposals are developed in three case studies, which are previewed briefly in (2). In each case, phonology misapplies to achieve identity of a related pair of words.

(2) Case Studies

§3 Sundanese (Robins 1957; Cohn 1990) Progressive nasal assimilation overapplies in infixed plurals: [ɲ-ãl-ĩãr] 'seek (pl)'. Oral consonants are expected to block nasal spread (compare [ŋũliat] 'stretch'), but the oral consonant of the plural infix fails to do so. The root vowels in the plural word [ɲ-ãl-ĩãr] are nasal because the corresponding vowels in the related singular base [ɲĩãr] are predictably nasalized by progressive harmony. Other affixed words show normal application of nasal harmony: [gəde g-um-ə̃de] 'big/be conceited'. Thus not all affixation paradigms are identical in vocalic nasality; affixed words mimic their bases' vowels, except when this would put an oral vowel in a post-nasal context. This context-sensitive overapplication pattern shows that OO-Identity and IO-Faith constraints are ranked in a fixed markedness hierarchy.

§4 Tiberian Hebrew (Prince, 1975) Epenthesis and post-vocalic spirantization underapply in certain morphologically truncated words, producing complex syllable margins [yišb] 'let him take captive' and post-vocalic stops [šāmaʕat] 'you (f.sg) heard'. Epenthesis and spirantization underapply because they are not conditioned in the related base words [yišbē] 'take captive', [šāmaʕtī] 'I heard'. Other truncated words show identity-disrupting normal application of epenthesis and spirantization [yixtōβ kəθōβ] 'write/write!'. Thus mis-application is sensitive to morphological category; phonology underapplies in jussives, and applies normally in imperatives. I propose that the two classes of truncation show different surface patterns because they are subcategorized by distinct OO-correspondence relations.

§5 English (Chomsky & Halle, 1968; Kiparsky 1982; Borowsky 1986, among others) Two classes of affixed words exhibit different misapplication effects. Words with class 1 affixes show identity-driven misapplication of secondary stress footing [*oríginal* *orìginálity*], while words with class 2 affixes show misapplication of main stress [*óbvious* *óbviousness*] as well as a variety of segmental processes, including word-final cluster simplification [*dam<n>* *dam<n>ing*]. Developing the theory of phonological classhood introduced in §4, I propose that the two arbitrarily-defined classes of English affixes are subcategorized by distinct OO-correspondence relations. I argue that affix classes are defined solely in terms of these misapplication identity effects.

[8] See also Orgun's (1995, 1997) declarative theory of cyclicity effects, and Raffelsiefen's (1992, 1993) nonconfigurational model of base recognition.

The case studies show that all types of phonology can misapply – a derived word can mimic its base in features (nasalization in Sundanese), segmentism (epenthesis in Tiberian Hebrew) or prosodic structure (English stress footing). The misapplying alternations can be contrastive (English cluster simplification) or allophonic (Hebrew spirantization). Also, misapplication identity effects occur in paradigms constructed by any type of morphological derivation; the languages analyzed here illustrate truncatory and affixation paradigms, but identity effects also occur in ablaut (Benua, 1997a) and compounding (see, e.g., Mohanan, 1982, 1986).

The remainder of this chapter introduces some basic relevant notions of Optimality Theory (§1.2) and Correspondence Theory (§1.3). In §2, the transderivational model is introduced. Following the case studies in §§3-5, the main points of the thesis are reviewed and some residual issues are addressed in §6.

1.2 Optimality Theory

Optimality Theory (Prince & Smolensky, 1993) holds that a grammar is a hierarchy of universal well-formedness constraints. From a given input, a set of candidate outputs is generated and evaluated against a language-particular ranking of the constraints. The candidate output that best-satisfies the ranking, by violating the fewest lowest-ranked constraints, is selected as the optimal or actual surface form.

A full discussion of Optimality Theory (OT) is obviously not possible or necessary here. This section summarizes some of the fundamental concepts and conventions of OT, and then turns to two aspects of the theory that are particularly relevant to my proposals: parallelism of derivation (§1.2.1) and the theory of inputs and lexical forms (§1.2.2).

Constraint interaction is the core of OT. Constraints impose a variety of goals, and when the goals conflict, one takes precedence over another. The schematic example in (3) demonstrates the interaction of a markedness constraint, which demands a certain well-formed structure, with faithfulness constraints that militate against deviation from lexical forms. The markedness constraint is ONSET, which requires syllable onsets, and the faithfulness constraints are MAX and DEP, which prohibit deletion and insertion, respectively.[9] In tableaux, constraints are arranged in order of rank from left to right. The input or lexical form appears in the upper left corner, and candidate outputs are displayed in the cells below. Only three of the most likely candidate outputs generated from the hypothetical input /iba/ are considered in (3), although many others could (and should) be imagined.[10]

9 Faithfulness constraints are introduced in more detail in §1.3 below.

10 With *Freedom of Analysis*, the generator function can pair an input with a potentially infinite set of output representations. All suboptimal outputs violate constraints that are ranked higher than the constraints violated by an optimal form. Inviolable or hard constraints may limit the pool of possible linguistic structures, and hence limit the candidate set. Tesar & Smolensky (1993, 1996) develop an algorithm by which the learner can further limit the candidate set to the most competitive forms.

(3) Constraint Evaluation ONSET, DEP >> MAX

/iba/		ONSET	DEP	MAX
a.	i.ba	*!		
b.	yi.ba		*!	
c. ☞	ba			*

In this grammar, candidate (c) *ba* is the optimal form. Fully faithful realization of the vowel-initial input violates the syllable structure constraint, and this high-ranking ONSET violation is fatal to candidate (a). Candidates (b) and (c) avoid an ONSET violation by being unfaithful to the input: candidate (b) satisfies ONSET by epenthesizing a glide and violating DEP, and candidate (c) avoids ONSET violation by deletion, which violates MAX. Because ONSET and DEP dominate MAX, the MAX-violator (c) is the optimal output. It is more harmonic to delete a vowel from the input /iba/ than to tolerate an onsetless syllable or to epenthesize an onset consonant.

A constraint ranking is established by conflict. The example in (3) demonstrates two rankings, ONSET >> MAX and DEP >> MAX, by comparison of the actual word with other possible realizations of the input. Domination can also be established by transitivity. If a different input-output pair in the hypothetical language in (3) demonstrates a conflict and ranking between ONSET and another constraint C, such that C dominates ONSET, then by transitivity C dominates MAX. Domination is strict, so that multiple violations of some constraint cannot override a single violation of a higher-ranked constraint.[11] In the two-dimensional tableaux, constraints that cannot be ranked with respect to one another are displayed in arbitrary order. Established rankings are represented by the domination sign (>>) and thicker grid lines in tableaux. Violations that are fatal to the relevant candidate are marked with an exclamation point (!), and the pointing hand (☞) draws attention to the optimal form. Cells that assess irrelevant violation of crucially dominated constraints are shaded.

11 But see Smolensky (1995) on local conjunction, especially self-conjunction of constraints.

OT is a radical departure from traditional rule-based generative phonology. It is non-procedural – constraints state output targets only, and repairs fall out of the ranking. There is no step-wise derivation of surface forms (but see below). Moreover, because it is non-procedural, OT predicts consistency among the surface forms of a language. If a grammar is a constraint hierarchy rather than a rule set, multiple processes in a language should work toward the same target structures, those enforced by the highest-ranked constraints. Observed consistencies in a phonological system, which have been described as rule conspiracies (Kisseberth, 1971) duplication (Kenstowicz & Kisseberth, 1977, 1979) or persistence (Myers, 1991a), follow naturally from the idea that a grammar is a static hierarchy of constraints (see Prince & Smolensky, 1993; McCarthy & Prince, 1993a; McCarthy, 1997a). Rule-based theory does not make the same prediction. Without additional stipulation, a rule-based grammar is free to contain any set of rules. Rules can produce intermediate stages that are illict in the system, or surface forms that are inconsistent with one another. Nothing in rule-based theory requires the various processes in a language to conform to the same patterns, so conspiracies are unexpected.

1.2.1 Parallelism

OT derivations take place in parallel, without intermediate stages. Priority among competing goals is modelled as ranking priority of constraints, rather than temporal ordering of rules. Parallelism of derivation is a fundamental part of OT, in that candidates sets are generated and evaluated simultaneously against the constraint ranking. Prince & Smolensky (1993) take the parallelism notion further, and make the strong claim that grammar is parallel. Derivations are one-step mappings from an input to a set of *fully-formed* output representations.

Full parallelism of grammar is not an entailment of OT. Derivations could take place in serially-ordered stages, each consisting of a one-step mapping from an input to an optimal output form. This kind of serial elaboration of OT has been proposed (see

McCarthy & Prince 1993a; Black, 1993; Inkelas, 1994; Kenstowicz, 1995). Serialism is introduced into OT to explain the class of cases known as cyclic effects: an output, with its predictable phonology derived by one constraint ranking, functions as the input to a later level of derivation, which has a different constraint ranking. Serial OT recapitulates the core of the rule-based analysis of paradigmatic identity effects: *orìginálity* doesn't conform to the canonical pattern of leftward secondary stress because the word *oríginal* is derived first, and (by promoting faithfulness constraints) the later level of derivation preserves the peninitial stress.

As mentioned, I argue against serialism and for a fully parallel theory of grammar, without intermediate stages of any kind. The core of my proposal is that constraints evaluate *subparadigms*, or pairs of words, like *oríginal* *orìginálity*. The unit of evaluation is the subparadigm, and both members are available for evaluation by the constraints. There is no sense in which the less complex word is derived first. Some of the arguments against serialism have already been noted; namely, that TCT is less stipulative and more typologically-restricted than cyclicity, and it is also more appealing conceptually, in that it directly regulates identity in related words. In addition, the parallel theory makes the correct predictions about relations between underlying and surface forms. In a cyclic analysis, a morphologically-complex word loses its link to the underlying representation. The input to *orìginálity* is the derived output *oríginal*, and not the underlying root. A direct link to underlying representatation is often crucial, however, and it is naturally available in the parallel theory. These arguments are developed in following chapters.

1.2.2 Inputs and Underlying Forms

OT recognizes two levels of derivation – inputs and outputs. An output is a structure that minimally violates the language-particular constraint ranking. The definition of an input is not quite as obvious. Most OT work assumes the traditional view that each morpheme of a language is assigned an underlying representation, based on the system of contrasts in the language, and allomorphy is derived from this unique UR by the phonological grammar.[12] But unlike rule-based theory, OT provides a formal framework for deriving the underlying inventory of morphemes. Underlying forms are derived from surface forms by principles of grammar (Prince & Smolensky, 1993:§8).

Roughly, constraints fall into two groups, markedness constraints and faithfulness constraints.[13] Both state output targets. Markedness constraints penalize certain structures or features, such as onsetless syllables or ATR low vowels. They can be context-sensitive, stating bans on a feature in some position or sequence (e.g., "no gutturals in codas" or "no post-vocalic stops"), or context-free, penalizing any occurence of a feature or feature combination (e.g., "no labials" or "no nasal vowels"). The markedness constraints state output targets in an obvious way. Faithfulness constraints are also output-oriented; they require outputs to be just like their inputs (see §1.3 on faithfulness theory).

All OT constraints are restrictions on output representations. It is of course logically possible to state constraints on underlying representations, as rule-based theories make use of morpheme structure constraints (MSC's) and other tools, including language-particular underspecification. But this leads to the duplication problem: the similarity between MSC's and the surface patterns produced by rules is unexplained (see Kenstowicz & Kisseberth, 1977, 1979). With its strict output orientation, OT obviates the duplication problem. Apparent restrictions on underlying forms (the putative MSC's) reflect the same generalizations that surface forms do, because both outputs and inputs are determined by the grammar, as set out shortly below.

[12] Obviously, only phonologically-predictable allomorphy is derived by the phonological grammar. Suppletive allomorphy (*go/went*), including partial suppletion like the vowel changes in *compel/compulsion*, *repel/repulsion*, etc. is not predictable, and has to be encoded underlyingly.

[13] Whether a given constraint enforces markedness or faithfulness is not always clear. For instance, a constraint that requires edges of morphological and phonological constituents to coincide (McCarthy & Prince, 1993b) could be a markedness constraint, since it dictates a certain structural alignment, or a faithfulness constraint, since it requires an edgemost element to be faithfully realized as edgemost (see §4.3.3 on ALIGN and ANCHOR constraints). Moreover, it is possible to imagine other kinds of constraints besides markedness and faithfulness, such as anti-faithfulness constraints ("be different from the input").

Another fundamental premise of OT is that phonological constraints are supplied by universal grammar. Language-particular patterns result from permutations in ranking of the universal output constraints (see Prince & Smolensky, 1993 and McCarthy & Prince 1993a on factorial typology). The only difference between languages, and the only thing that a language learner needs to master, is the ranking of universal output constraints.[14]

From these two basic assumptions – that constraints state output targets only, and that the re-ranking of universal constraints defines the typological space – it follows that the pool of possible inputs is universal. Very simply, OT does not have the tools to restrict input forms, so inputs must be universal. Any possible input structure, fed into a language-particular grammar, gives rise to an output that is well-formed in that language.[15] Since language-particular assumptions about inputs cannot be stipulated, they have to be deduced from the language's surface patterns. This is the *Richness of the Input* principle (Prince & Smolensky, 1993:191ff.).[16]

Because language-particular restrictions on inputs cannot be stated, OT distinguishes POSSIBLE INPUTS, which are drawn from the universal pool of possible linguistic structures, from the UNDERLYING REPRESENTATIONS of the morphemes of a particular language. The pool of possible inputs to a grammar is universally unrestricted or rich. The underlying forms of a particular language are derived from its surface representations, by examining the system of surface contrasts.

[14] This may be too strong. For example, work on constraint conjunction (Smolensky, 1994, 1997; Fukazawa & Miglio, 1997; Itô & Mester, 1997) proposes that the mechanism of conjunction (the "&" operator) is part of UG, but constraints are selected for conjunction on a language-particular basis. Constraints keyed to particular morphemes can also be seen as language-specific, but in a similarly limited sense. I argue below that morpheme-specific phonological patterns are produced by the rank of the faithfulness constraints relevant to the morpheme or morpheme class at hand – the strong claim is that *the only constraints that can refer to particular morphemes are faithfulness constraints*. I assume that the framework of faithfulness (correspondence relations and their attendant constraints MAX, DEP, IDENT[F], etc.) is innate. The task of the learner is to look for links between correspondence relations and the language's morphemes (see §6).

[15] Prince & Smolensky (1993:47) propose that a given input may not be paired with any overt output. An input may be uninterpreted by the grammar, so that its optimal output is the null parse (see also McCarthy & Prince, 1993a:§7).

[16] Prince & Smolensky actually refer to this as the *Richness of the Base* – its name is changed here so that the term *base* can refer exclusively to the output base of an OO-correspondence relation.

If some phonological property is contrastive in some context, the language learner can deduce that this property is designated in the underlying representations of that language. For example, contrastive obstruent voicing in English *pat/pad/bat/bad* provides evidence that obstruent voicing is fixed in underlying representations, and that faithfulness to underlying voicing is more important than avoiding marked laryngeal features in obstruents (by the ranking Faith[vce] >> *[obstr-vce]). The arbitrary distribution of voicing in obstruents in surface forms must, logically, be specified in underlying representations of English morphemes.

Predictable properties, on the other hand, cannot be fixed in underlying representations by logical deduction, because predictable phonology is a matter of markedness, not faithfulness. For example, nasals are voiced in English because a markedness constraint against voiceless nasals is high-ranking, and not because all nasals happen to be underlyingly voiced. High-ranking markedness ensures that nasals are voiced in optimal outputs. Therefore, it makes no difference whether inputs have voiced or voiceless nasals in them. Inputs are unrestricted, so voiceless nasals from the universal pool of inputs may be presented to the English grammar, but the ranking of *[nas-vcls] >> Faith[vce] excludes voiceless nasals from optimal English words.

Since nasal voicing is predictable, several possible inputs converge on the same output representation. For instance, the underlying form of a word like *man* could contain either voiced or voiceless nasals – the possible inputs /man/, /m̥an/, /man̥/ and /m̥an̥/ converge on the same voiced output [man], due to high-ranking markedness against voiceless nasals. Prince & Smolensky (1993:191ff.) propose that speakers resolve this indeterminacy by *Lexicon Optimization* (see also Itô, Mester & Padgett, 1995). Speakers use the grammar to select the best underlying form. The possible input that entails the fewest, lowest-ranked violations in the mapping to the actual output is chosen as the lexical representation.

By Lexicon Optimization, the fully voiced input /man/ is the optimized underlying representation of this morpheme, since no constraint violations are incurred in the mapping to the voiced output [man], whereas other possible inputs incur violation of Faith[vce]. This Faith[vce] violation is low-ranking and irrelevant in the selection of the optimal output, but it nevertheless works to exclude voiceless sonorants from the underlying representations of English morphemes.[17]

To sum up, underlying forms of morphemes are not stipulated in OT, but derived from the surface evidence. Contrastive properties are logically deduced to be part of underlying representations, while noncontrastive properties may be fixed in underlying representations by making use of the constraint heirarchy, by Lexicon Optimization. I have rehearsed Prince & Smolensky's theory both to make clear my assumptions about inputs and lexical forms, and because the *Richness of the Input* principle plays an important role in the transderivational proposal. In particular, *Richness of the Input* means that misapplication identity effects in paradigms can only be produced by constraints that compare two surface representations.

When a predictable or allophonic alternation misapplies to preserve identity in a paradigm, it is clear that input-output (IO) faithfulness constraints are not responsible. Misapplication of allophony has to be forced by high-ranking output-output (OO) identity constraints. Noncontrastive features cannot be fixed in inputs; as just discussed, OT lacks the tools. Thus, inputs are rich in predictable properties, and faithfulness to these rich input specifications is necessarily low-ranking, below the markedness constraints that determine the surface allophony. It follows that the markedness violations entailed by misapplication in paradigms is not forced by low-ranking IO-Faith constraints. Moreover, logically, the distribution of noncontrastive features is reliable only in surface representations, where it is enforced by markedness constraints. When a word deviates from canonical phonological

[17] This is just one version of Lexicon Optimization offered by Prince & Smolensky. In another version, a *SPEC constraint penalizes feature specifications, so that the voiceless input is selected as the optimal underlying form. See §3.5 for more on Lexicon Optimization.

patterns to mimic its base's predictable features, it is being faithful to the base's output representation, where the predictable features are fixed by output constraints. I return to this argument in following chapters.

It has been my goal in this section to lay out some of the fundamental principles of OT, focusing in particular on its claim of parallelism of derivation and its theory of inputs and underlying forms. The former is crucial because it is a central motivation of my proposal – if paradigmatic identity is enforced by transderivational identity relations, serial word formation is obviated. The theory of inputs and underlying forms is also important, because it requires differentiation of faithfulness constraints on different types of relations – specifically, it demands a distinction between input-output faithfulness and faithfulness between related outputs. The next section presents some introductory discussion of the faithfulness constraints themselves.

1.3 Correspondence Theory

The conflict between markedness and faithfulness constraints is at the heart of OT. Unrestrained, markedness constraints would reduce all utterances to the least-marked structures *ba* or *ti*. Faithfulness constraints counterbalance markedness requirements. The Correspondence Theory of faithfulness (McCarthy & Prince, 1993a, 1994ab, 1995) holds that candidate sets are provided with correspondence relations between elements in related strings.

(4) Correspondence
Given two related strings S_1 and S_2, correspondence is a relation R between elements of S_1 and elements of S_2. Segments α (an element of S_1) and β (an element of S_2) are referred to as correspondents of one another if $\alpha R \beta$.

Correspondence is simply a relation between segments in pairs of strings; it can be thought of as coindexation of related elements.[18] Correspondence governs all types of linguistics

[18] Following McCarthy & Prince, I assume that correspondent elements are segments, as stated in (4), although nothing in my core proposal crucially relies on this. McCarthy & Prince suggest that correspondence relations may hold between other kinds of elements, such as features or prosodic units, and others have pursued this suggestion (Lamontagne & Rice, 1995; Lombardi, 1995b; Causley, 1997ab).

relations – the S_1 and S_2 of the definition in (4) may be related as an input-output pair, or as base and reduplicant, or as a pair of output words.

Correspondence between two elements does not guarantee identity of those elements. Correspondent identity is enforced by ranked and violable constraints. Each variable dimension of the representation is governed separately, by a separate faithfulness constraint. The constraints in (5) demand complete and exclusive correspondence between strings. MAX requires every segment in the base S_1 to have a correspondent in the related S_2, prohibiting deletion. DEP penalizes insertion – any segment in S_2 without a correspondent in S_1 violates the DEP constraint.

(5) Stringwise Faithfulness
MAX "Every segment in S_1 has a correspondent in S_2."
DEP "Every segment in S_2 has a correspondent in S_1."

Correspondent segments are required to be identical in feature composition by IDENT[F] constraints, which separately govern all phonological features. Through ranking, they force correspondent segments to be identical.

(6) Featural Faithfulness
IDENT[F] "Correspondent segments are identical with respect to feature F."

Every possible deviation from perfect identity is regulated by a separate constraint. In addition to MAX, DEP and IDENT[F] constraints, CONTIGUITY constraints ("no skipping" and "no intrusion") require contiguous elements to have contiguous correspondents, LINEARITY penalizes metathesis and UNIFORMITY prohibits coalescence/breaking (see McCarthy & Prince 1995: Appendix A). Other faithfulness constraints will be introduced as they come up in specific analyses.

Under Correspondence Theory, deletion and epenthesis are literal. The foundational OT work, Prince & Smolensky (1991, 1993) and McCarthy & Prince (1993a), assumed a different model of faithfulness, which has come to be known by the names of its anti-

Correspondence between features addresses some apparent problems with enforcing featural identity through segments, but it also raises its own questions, such as how associations between features and segments are regulated.

deletion and anti-epenthesis constraints PARSE and FILL. Under PARSE-FILL faithfulness, elements cannot be deleted or inserted. Instead, deletion is understood as underparsing of material by segmental or prosodic structure (PARSE violation), and epenthesis is characterized as overparsing, or unfilled prosodic structure (FILL violation). PARSE-FILL faithfulness respects the principle of *Containment*, which requires output representations to literally contain input structures. With Containment, OT is essentially a single-level theory of grammar. Underlying forms are required to encode a language's system of contrasts and to account for phonologically-conditioned allomorphy, but there is no need to look back at the input representation to assess satisfaction of the faithfulness constraints, because all input information is literally contained in the output representation.

Correspondence Theory makes OT a two-level theory. Input and output are separate strings, and faithfulness between them is assessed via the correspondence relation provided by the candidate generator. There are several differences between Correspondence Theory and the PARSE-FILL theory of faithfulness. For example, Correspondence Theory explains why deleted material, which under PARSE-FILL's Containment principle must be present-but-unparsed, has no effect on outputs (e.g., in assessment of alignment). By allowing literal insertion of segments, Correspondence Theory also explains how epenthetic segments (which are filled in post-phonologically under Containment) can spread their features onto neighboring segments. The two theories also differ in their characterizations of linear order violations (metathesis) and failures of biuniqueness (coalescence and diphthongization). McCarthy & Prince (1995) offer discussion of these and other points of comparison.

1.3.1 Differentiating Faithfulness: IO and BR Correspondence Relations

For present purposes, the most important difference between PARSE-FILL faithfulness and Correspondence Theory is that the latter recognizes different types of faithfulness relations. Correspondence relations were initially posited by McCarthy &

Prince (1993a) to model identity (or the lack of identity) in the reduplicative "copying" relation. Noting the parallels between base-reduplicant identity and input-output faithfulness, McCarthy & Prince (1995) propose a generalized Correspondence Theory, modelling every type of faithfulness relation in the same way, through correspondence relations. All kinds of linguistic relations are subject to the same general system of correspondent identity constraints.

Different types of correspondence relations hold in different domains. Output forms are related to their input or underlying forms by an input-output (IO) correspondence relation, while reduplicants are related to their bases by a base-reduplicant (BR) correspondence relation. Each relation is associated with its own separate, and separately-rankable, faithfulness constraints. IO-correspondence is governed by the *IO-Faith* constraints IO-MAX, IO-DEP, IO-IDENT[F], and identity of a reduplicant and its base is evaluated by *BR-Identity* constraints BR-MAX, BR-DEP, and BR-IDENT[F].

A simple example from Balangao reduplication demonstrates that IO-Faith and BR-Identity constraints are distinct from one another (McCarthy & Prince, 1994ab). Balangao words freely admit coda consonants, except in reduplicants – syllable codas are minimized in reduplicative copies. Less-than-total copying of the base occurs in the reduplicated words in (7) in order to avoid coda consonants.

(7) Balangao Reduplication

/maN-RED-tagtag/	ma-tag.ta-tag.tag	'running everywhere'
/ma-RED-taynan	ma-tay.na-tay.nan	'repeatedly to be left behind'

This pattern is produced by ranking two different types of faithfulness constraints, IO-Faith and BR-Identity, in different positions in the Balangao grammar. Specifically, two MAX constraints, IO-MAX and BR-MAX, have different rank with respect to the syllable-structure constraint NOCODA ("syllables do not have coda consonants").

If codas are permitted in the general case, IO-MAX must outrank NOCODA in Balangao. Tableau (8) shows how a monomorphemic word like *tagtag* 'run' gets an optimal faithful parse, despite the entailed violation of NOCODA.

(8) Balangao IO-MAX >> NOCODA

/tagtag/	IO-MAX	NOCODA
a. ta.ta	**!	
b. tag.ta	*!	*
c. ☞ tag.tag		**

Candidates (a-b) each fail to realize some input material, and are suboptimal because IO-MAX outranks the markedness constraint against codas. It is better to realize all input segments and satisfy IO-MAX than to avoid a coda consonant, as in optimal (c).

In reduplication, codas are more marked, and the full base *tagtag* is not copied in the reduplicated form. Instead, the base's final consonant fails to correspond to reduplicant material, in violation of BR-MAX, so that a NOCODA violation is avoided. It is more harmonic to minimize codas in reduplication than to achieve complete copying, because NOCODA >> BR-MAX.[19]

(9) Codas are Minimized in Reduplication NOCODA >> BR-MAX

/RED-tagtag/	NOCODA	BR-MAX
a. ☞ <u>tag.ta</u>-tag.tag	***	*
b. <u>tag.tag</u>-tag.tag	****!	

IO-MAX, which governs the relation between outputs and inputs or lexical forms, and BR-MAX, which relates reduplicants and bases, have different rank with respect to NOCODA. They are formally distinct constraints.

IO-Faith and BR-Identity constraints are ranked in the same constraint hierarchy. In analysis of a variety of cases, McCarthy & Prince demonstrate that BR-Identity and IO-Faith constraints can come into conflict and be ranked with respect to one another, so that

19 The reduplicant is forced to have one coda consonant by dominant BR-CONTIGUITY, which requires contiguous segments to have contiguous correspondents.

faithfulness to the input can take precedence over reduplicative identity, and vice versa. These direct conflicts between IO-Faith and BR-Identity are clear evidence that BR-Identity and IO-Faith coexist in the same grammar. Other evidence comes from cases that show that reduplicants and bases are generated simultaneously, in parallel. Discussion of parallelism in reduplication is postponed until §2.4, where reduplicative identity effects and paradigmatic identity effects are compared.

McCarthy & Prince (1993, 1994ab, 1995) explore in detail the patterns that result from various permutations of IO-Faith, BR-Identity and markedness constraints. These include the *emergent unmarkedness* ranking of IO-Faith >> M >> BR-Identity exemplified in Balangao, in which the different rank of two types of faithfulness forces unmarked structure (open syllables) to emerge in a special morphological domain (reduplicated words). Other possible rankings of the three constraint types produce other patterns, including identity-preserving *over-* and *underapplication* of phonology, and identity-disrupting *normal application*. These reduplicative patterns resemble very closely the paradigmatic misapplication phenomena that are analyzed in this dissertation, so I put off discussion of them until the theory of transderivational correspondence relations is introduced in §2.

1.3.2 Differentiating Faithfulness: Roots and Affixes

In addition to the fundamental distinction between IO and BR faithfulness relations, McCarthy & Prince (1994b) propose that faithfulness is relativized to the basic morphological types root and affix. Universally, faithfulness to root material takes precedence over faithfulness to affixal material: Root-Faith >> Affix-Faith.

The Root-Faith >> Affix-Faith ranking means that affixal material is relatively unmarked with respect to root material. All else being equal, roots admit greater contrasts than affixes. This follows from the emergent unmarkedness ranking logic: given a hierarchy Root-Faith >> M >> Affix-Faith, structures that are marked with respect to a phonological constraint M can surface in roots, by Root-Faith >> M, but M-violating structures cannot surface in affixes, because M >> Affix-Faith. A straightforward demonstration of the Root-Faith >> Affix-Faith ranking comes from Turkish, in which fewer, less-marked vowels appear in affixes than are permitted to surface in roots. Beckman (1997) analyzes similar cases.[20]

The Root-Faith/Affix-Faith distinction cross-cuts all types of correspondence relations. Thus, IO-Faith constraints fall into two types, IO_{Root}-Faith and IO_{Affix}-Faith, and BR-correspondence constraints are similarly divided. As set out in §2 below, transderivational OO-correspondence constraints are also bifurcated into Root-Faith and Affix-Faith constraints.

1.3.3 Differentiating Faithfulness: Distinct Correspondences of the Same Type

Urbanczyk (1995, 1996) shows that a language may make use of more than one correspondence relation of the same type. In her study of reduplication in the Salish language Lushootseed, Urbanczyk argues that each of two reduplications invokes a distinct BR-correspondence relation.

One of Urbanczyk's arguments involves reduplicant shape. Two Lushootseed reduplications pattern differently: distributive reduplication copies the initial CVC of the base [bəd-bədaʔ] 'children', while diminutive reduplication is CV, without a coda [č̓a-č̓aləs] 'little hand'. Because they show different surface patterns, the two reduplications must be subject to different BR-correspondence constraints. The BR-MAX constraint proper to distributive reduplication, BR_{DIST}-MAX, outranks NOCODA, allowing distributive reduplicants to have coda consonants, while a distinct BR-MAX constraint on diminutive

20 For Beckman, the distinction between Root-Faith and Affix-Faith is a subcase of a broader phenomenon of Positional Faithfulness. Prominent positions (roots, stressed syllables, initial syllables) admit greater contrasts because special faithfulness constraints are keyed to prominent positions, and these positional faithfulness constraints are higher-ranked than nonspecific faithfulness constraints.

reduplication, BR_{DIM}-MAX, is lower-ranked, so that dominant NOCODA prevents more extensive copying.

(10) Two Reduplicants in Lushootseed (Urbanczyk, 1995)

a. CVC Distributive Reduplication BR_{DIST}-MAX >> NOCODA

/RED_{DIST}-bədaʔ/	BR_{DIST}-MAX	NOCODA
a. ☞ bəd-bədaʔ	**	**
b. bə-bədaʔ	***!	*

b. CV Diminutive Reduplication NOCODA >> BR_{DIM}-MAX

/RED_{DIM}-č̓aləs/	NOCODA	BR_{DIM}-MAX
a. č̓al-č̓aləs	**!	**
b. ☞ č̓a-č̓aləs	*	***

On this theory, there are no reduplicative templates (McCarthy & Prince, 1994b). Invariant reduplicant shape derives from constraint interaction – specifically, from the ranking of faithfulness constraints on the relevant BR-correspondence relation with respect to the markedness hierarchy. Because the two reduplicants in Lushootseed have different shapes, they must be subject to distinct faithfulness requirements. Two BR-MAX constraints, each proper to a different reduplicative correspondence relation, coexist in the Lushootseed grammar.[21]

Stated more generally, Urbanczyk's proposal is that morpheme-specific phonological behavior is produced by morpheme-specific faithfulness relations. The general mechanism of faithfulness, correspondence, is available in universal grammar. Lushootseed speakers see that the two reduplicants conform to different phonological patterns, and learn that each reduplicant is associated with a distinct BR-correspondence relation.

21 Urbanczyk also demonstrates that BR_{DIM}-Identity and BR_{DIST}-Identity are part of the same Lushootseed hierarchy by showing that the two reduplicants influence one another in double reduplications. The outer reduplicant in a double reduplication both triggers misapplication in the inner reduplicant and copies it. This pattern cannot be produced serially without excessive stipulation, and Urbanczyk argues that the two reduplicants are generated in parallel and evaluated against the same constraint ranking.

The idea that multiple correspondence relations of the same type can coexist in a grammar plays a major role in the transderivational theory developed here. Building on Urbanczyk's results, I propose that different types of OO-correspondence relations are keyed to different types of morphological derivation, producing morpheme-specific or class-specific phonological behavior. English provides a particularly clear example of class behavior. Two sets of English affixes are associated with distinct surface patterns. Both classes participate in transderivational identity effects, demonstrating that OO-correspondence relations govern both class 1 and class 2 paradigms. But the identity effects are different in each class – paradigms constructed by class 2 affixation show misapplication of primary stress (*óbvious* *óbviousness*) and segmental alternations like cluster simplification (*dam<n>* *dam<n>ing*), while paradigms constructed by class 1 affixation show misapplication of nonprimary stress only (*orìginal* *orìginálity, dam<n>* *damnation*). The two classes of paradigms are governed by distinct sets of OO-Identity constraints proper to distinct OO-correspondence relations (see §5).

Urbanczyk ultimately attributes the differences between diminutive and distributive reduplication in Lushootseed to morphological types: distributive reduplicants are roots and have canonical CVC root shape, while diminutive reduplicants are canonical CV affixes. Given the Root-Faith >> Affix-Faith meta-ranking of Generalized Template Theory, it follows that BR_{DIST}-correspondence constraints rank higher in the grammar than the BR_{DIM}-correspondence constraints on truly affixal reduplication.

No similar morphological connection can be made in paradigmatic cases. In the English case, two distinct OO-correspondence relations are associated with two sets of *affixal* morphemes, and moreover, these sets are arbitrarily defined – no etymological or morphosyntactic properties correlate with English affix classhood. I conclude that it is simply the selection of an OO-correspondence relation that distinguishes affix classes in English, and that all correlates of affix classhood follow from the rank of two separate sets of OO-Identity constraints.

This proposal is easily extended to class-specific patterns in monomorphemic words. For example, Fukazawa (1996) presents a correspondence-based analysis of sublexicons in Japanese, in which the different surface patterns observed in Yamato, Sino-Japanese, Mimetic and Foreign vocabulary follow from the rank of constraints on four distinct IO-correspondence relations (cf. Itô & Mester, 1995). Verhijde (in prep.) pursues a similar analysis of non-derived environment blocking (NDEB) in Sanskrit and other languages, and Burzio (1997ab) has independently suggested a similar analysis of NDEB effects in English.

Recognition of distinct correspondence relations of the same type is a natural extension of Correspondence Theory. The leading idea of Correspondence Theory is that different types of faithfulness relations, holding between different types of stringwise pairs (input-output, base-reduplicant, etc.), coexist in a grammar. Recognizing distinct relations within one type is a logical next step. This proposal is developed in more detail in the analyses of Tiberian Hebrew truncations (§4) and English affixation (§5).

1.3.4 Summary: Articulated Faithfulness Theory

Correspondence Theory is an articulated theory of faithfulness relations, in which distinct types of faithfulness requirements compete with one another (and with markedness constraints) in the determination of well-formed output structures. Correspondence Theory is readily extended to explain the phonology of words in paradigms. "Cyclicity" phenomena are the visible evidence of a third basic type of correspondence relation: an output-output or OO-correspondence relation between morphologically-related words. This transderivational extension of Correspondence Theory is set out below.

CHAPTER 2

TRANSDERIVATIONAL CORRESPONDENCE THEORY

2.1 Transderivational Correspondence Theory (TCT)

In an early exposition of Correspondence Theory, McCarthy & Prince (1994b) suggest that correspondence relations hold not only between input-output and base-reduplicant pairs, but also between independent words. This dissertation develops that suggestion into Transderivational Correspondence Theory (TCT). The core of the proposal is that words in a paradigm are required to be phonologically identical by constraints on an identity relation between two surface words. This is a transderivational or output-output (OO) correspondence relation, linking words across their individual input-output mappings. The related words are evaluated simultaneously, in parallel, against the constraint hierarchy. Through ranking, OO-correspondence constraints produce misapplication effects – or "cyclic" effects – without a cyclic derivation.

Related words are required to be identical by OO-correspondence constraints, and they are also required, by constraints on an IO-correspondence relation, to be faithful to their underlying forms. This complex of relations is represented schematically in (11).

(11) Transderivational (Output-Output) Correspondence

OO-correspondence

[root_i] → [root_i + affix]

IO-correspondence ↑ ↑ ***IO-correspondence***

/ root / / root + affix /

Each output word is linked to an input by an IO-correspondence relation, and the two words are related to each other by a transderivational OO-correspondence relation. Through these relations each word is evaluated for faithfulness to its input by IO-Faith constraints (IO-MAX, IO-DEP, IO-IDENT[F], etc.) and the two outputs are compared by OO-Identity constraints (OO-MAX, OO-DEP, OO-IDENT[F], etc.). The two types of faithfulness requirements are distinct and separately rankable. IO-Faith and OO-Identity constraints

coexist in the hierarchy, and interact with one another and with a fixed ranking of markedness constraints.

When a derived word and its base differ in some way relevant to a phonological process observed in the language, permuting the ranking of IO-Faith and OO-Identity with respect to markedness constraints produces one of three patterns: *overapplication*, in which the process applies where it is not phonologically conditioned; *underapplication*, in which the process is conditioned but fails to apply; and *normal application*, in which the process applies always and only where it is properly conditioned. In §2.4, each pattern is introduced, together with the ranking that generates it. But first §2.2 explains how correspondence-governed paradigms are defined, and §2.3 discusses how they are evaluated by constraints.

2.2 Phonological Paradigms

Transderivational OO-correspondence relations are the phonological reflex of a morphological relation between two words. All types of morphological derivation are mirrored by a transderivational correspondence relation; affixation, truncation, reduplication, ablaut, consonant mutation, mapping to a template, compounding, or any other type of word formation requires an OO-correspondence relation between the derived word and an output base.[22] Although I adopt an item-and-arrangement approach to word formation, my proposals are also consistent with an item-and-process view (see, e.g., Hockett, 1954; Anderson, 1992). It makes no difference whether affixes are objects or operations, as long as morphological derivation is concomitant with a phonological identity relation.

The identity relation triggered by morphological derivation holds between the derived word and an output base. The base is the independent word identified with the string that undergoes morphological derivation; in affixation, the base is the word identified

[22] In compounding, the derived word has two output bases. Compounding is not analyzed in this thesis, but see Allen (1975) on Welsh, Mohanan (1982, 1986) on Malyalam and Duanmu (1995) on Chinese for examples of transderivational identity effects in compounding.

with the string adjacent to the affix. A precise definition is difficult to formulate, because the relevant base can be identified only with respect to a specific derived word. For example, the base can be morphologically simplex (as in *sign* *signer*) or complex (as in *original* *originality*). Often, the base is the word that is minimally less morphologically complex than the derived word, so that the base consists of a subset of the derived word's morphemes. But this kind of subset relation does not always hold. An obligatorily-inflected word can serve as the base of another inflected word, and the base's inflection is neither morphologically nor phonologically present in the derived word.[23] Given these kinds of cases, there can be no formal requirement of a morphological subset relation between the derived word and its base.

The base of an OO-correspondence relation is a licit output word, which is both morphologically and phonologically well-formed. Morphological well-formedness constraints are important. In inflectional languages, morphology requires OO-correspondence relations to hold between two fully-inflected words (and it also prevents the base's inflection from appearing in the derived form). In derivational systems, the fact that the base must be morphologically well-formed entails that bound roots are not cyclic domains. The minimal domain of phonology is the word.[24] The base of an OO-correspondence relation is also phonologically well-formed, in that it conforms to the language's canonical surface patterns. This is not a definitional characteristic of the base, however, because maximal base harmony is entailed by the recursive evaluation of paradigms performed by the grammar, as set out in §2.3 below.

Every affix or morphological operation requires a transderivational relation to be established between the derived output and an output base. To formalize this, I adopt the

[23] Cases in which an obligatorily-inflected word functions as the base of an OO-correspondence relation are discussed in §4.2 and §6.3. The base's inflectional morphology is not present in the derived word (in either its input string or its output form), but it can nevertheless affect the derived word's surface phonology by altering neighboring stem segments in the base.

[24] Compare this result with the proposal in Kiparsky (1982a) that the minimal domain of rule application is the *lexeme*, a category that includes both full words and a special subset of bound roots – those that can be made into full words by obligatory inflection.

familiar subcategorization frames of Lieber (1980). In addition to their segmental content (if any), affixal morphemes are supplied with a subcategorization frame that specifies idiosyncratic information about the affix, such as its selectional restrictions, and whether it is a prefix or a suffix. I propose that the affix's subcategorization frame also specifies the OO-correspondence relation that links the affixed output in a paradigmatic identity relation. This provides a direct connection between morphological derivation and phonological identity relations, preventing identity relations between randomly-selected words. Because of their link with morphological subcategorization frames, OO-correspondence relations compare a morphologically-derived word and its base, and not other kinds of word pairs. Subcategorization also provides a ready explanation of phonological class behavior: individual affixes may be subcategorized by distinct OO-correspondence relations (see §1.3.3 above and §§4-5 below).

Each affix or morphological operation invokes an OO-correspondence relation. Consequently, phonological paradigms are constructed as a linear array, as in (12). In a multiply-affixed word like *orìginálity*, each affix triggers an OO-correspondence relation between the affixed output and an output base. The resulting linear paradigm reflects the increasing complexity of morphological structure.

(12) Multiple Affixation

origin	***OO-Identity*** →	original	***OO-Identity*** →	originality
↑		↑		↑
/ origin /		/ origin + al /		/ origin + al + ity /

With each affix triggering an OO-relation, words in an extended paradigm are related two at a time, in SUBPARADIGMS, and paradigmatic identity is evaluated in a strictly local way. The goodness of correspondence between *orìginálity* and its base *oríginal* is reckoned separately from the goodness of correspondence between *oríginal* and its base *órigin*. This is a useful result, since paradigmatic identity is observed in only one of these pairs – *orìginálity* mimics the stress feet of its base *oríginal*, but *oríginal* is not faithful to the footing of *órigin*. The linear phonological paradigms built by subcategorization are local, in the sense that a derived word is linked to its base only.

With these linear and local paradigms, TCT predicts the phenomena attributed to *bracket erasure* in cyclic theories (e.g., Chomsky & Halle, 1968; Pesetsky 1979; Kiparsky 1982a). Bracket erasure is the mechanism that erases morphological brackets after each cycle of phonological rules, thereby preventing the derivation of a multiply-affixed word from making crucial reference to the derived phonology of embedded constituents. By the time phonology applies on the outermost cycle of *orìginálity*, bracket erasure has rendered the initial cycle on *órigin* indistinguishable from the intermediate cycle on *oríginal*. In effect, multiply-affixed *orìginálity* cannot rely on information contained in *órigin* if that information is not also present in *oríginal* (for example, word-initial stress). TCT explains bracket erasure effects differently. *Orìginálity* is not phonologically related to the unaffixed word *órigin*, so *orìginálity* cannot mimic the stress pattern in *órigin* – it can only be influenced by the stress of its base *oríginal*. The derived phonology of embedded constituents is not available because OO-correspondence relations link only the most morphologically-similar words in local subparadigms.[25]

Paradigms could be constructed in a different way, as non-linear arrays. The paradigm in (12) could be conceived of as in (13) (see Burzio, 1994, 1996, 1997a; Hooper/Bybee, 1976, 1988).

(13) Nonlinear Paradigmatic Relations (words with the same root)

origin

original ------------------ originality

In this web of relations, all words that contain the same root are phonologically linked, so any word can exert influence over any other word in the web. This model therefore does not predict bracket erasure effects. In general, a non-linear theory of paradigms is faced

[25] Although the phonology of embedded constituents is not available to a multiply-affixed word, the complete morphological structure is accessible from the input string. This makes it possible to violate bracket erasure with respect to morphological information, as when an affix selects for a base that contains another specific affix (see Williams, 1981; Fabb, 1988; Hammond, 1991; among others).

with the task of sorting out how the relations in the web interact with one another, to determine which words can exert influence over which other words.[26]

In a non-linear model, phonological relations can connect all words that contain the same root, as in (13), or all words that contain the same affix, as in (14).

(14) Nonlinear Paradigmatic relations (words with the same affix)

sanity

brevity ------------------ obesity

Burzio (1994) proposes that all words that contain the same affix are related phonologically, at least in their corresponding affixal portions (see also Wilson, 1996), and Kenstowicz (1996) makes a similar claim. If all instantiations of an affix are related in surface form, then misapplication identity effects should occur in affixal material. One realization of an affix should be able to violate canonical phonological patterns in order to be more like another realization of the affix in a different word.

The linear model of paradigms that I propose does not permit misapplication in affixes. OO-correspondence relations are triggered by morphological derivation, and relate the derived output with an output base, and not with other similarly derived words. Identity relations holds in paradigms like *sane* *sanity* and *obese* *obesity*, but not between the two derived words *sanity* and *obesity*. It follows that there can be no "cyclic effects" in affixal material like *-ity*. Cases purported to show identity-driven misapplication in affixes are given different analyses in §6.2.

Throughout this thesis I use the the word "paradigm" to denote a linear construction like the one in (12). More specifically, I refer to SUBPARADIGMS, the pairs of words linked by an OO-correspondence relation, and EXTENDED PARADIGMS involving more than one OO-correspondence relation. This is the notion of paradigm that is phonologically relevant.

[26] In Bybee's lexical networks, the relative strength of the relations in a web is determined by semantic criteria or by word frequency.

Characterizations of a paradigm as "all words built from root X" or "all words that contain affix Y" may be useful to morphology, but they have no formal status in phonology.

2.3 Evaluation of Paradigms

2.3.1 Recursive Evaluation

Words in a phonological paradigm are evaluated in parallel against a recursive constraint hierarchy. The language-particular heirarchy is duplicated, and the recursions are ranked with respect to one another. The optimal form of each word in the paradigm is determined by one of the recursions of the constraints, so that the base is evaluated against a higher-ranked recursion, and the derived word is evaluated against a lower-ranked recursion of the hierarchy. This recursive evaluation mechansim enforces the "bottom-up" character of word formation by restricting misapplication identity effects to the derived word in subparadigm.

To show how the recursive system works and why I propose it, it is helpful to have a real example at hand. Consider an identity effect involving morphological truncation in English described by Kahn (1976).[27] In paradigms like *L[æ]rry* *L[æ]r*, the truncated diminutive satisfies an OO-Identity constraint by violating a phonotactic constraint against tautosyllabic *ær* sequences. All other English words must have a back low vowel before a tautosyllabic *r* (*c[a]r*, *h[a]rd*), and not a front one (**c[æ]r*, **h[æ]rd*). Neutralization of the *a/æ* contrast before tautosyllabic *r* fails to apply, or underapplies, to preserve identity in the *L[æ]rry* *L[æ]r* paradigm.

For present purposes, the phonotactic constraint that drives neutralization is called *ær]$_\sigma$.[28] This constraint must outrank input-output faithfulness: *ær]$_\sigma$ >> IO-IDENT[BK] prevents any possible input from giving rise to an optimal output with a tautosyllabic *ær* sequence (*c[a]r*, **c[æ]r*). Truncated words violate *ær]$_\sigma$ in order to respect identity with

27 According to Kahn, the misapplication effect described here occurs in English dialects that maintain a *Mary* *marry* *merry* distinction.

28 This constraint is just a brute-force convenience. A more refined understanding of *a/æ* neutralization would probably relate it to the dorsality of English bunched *r*.

the base – the nickname is *L[æ]r*, not **L[a]r*, because the base name *L[æ]rry* has a front vowel. My proposal is that a dominant OO-Identity constraint forces violation of *ær]$_\sigma$, blocking neutralization in the truncated word. The ranking is (15).

(15) OO-IDENT[BK] >> *ær]$_\sigma$ >> IO-IDENT[BK]

Optimal paradigms are selected by recursions of this ranking. Evaluation of candidates is represented in complex tableaux like (16). Candidates are subparadigms, represented discontinuously across the tableau. In paradigm (a), both words have a back vowel. In candidates (b) and (c), the related words have different vowels. Candidate (d) is the optimal paradigm with two front vowels. Because the OO-Identity constraint is at the top of the hierarchy, it is more harmonic to achieve identity than to obey the phonotactic constraint.

(16) Recursive Evaluation

	candidate (a)	L[a]rry L[a]r	*overapplication*
	candidate (b)	L[a]rry L[æ]r	*"backwards" application*
	candidate (c)	L[æ]rry L[a]r	*normal application*
☞	candidate (d)	L[æ]rry L[æ]r	*underapplication*

Ranking: OO-IDENT[BK] >> *ær]$_\sigma$ >> IO-IDENT[BK]

Recursion (A) / Recursion (B)

/læri/	OO-ID	*ær]$_\sigma$	IO-ID	>>	/læri - TRUNC/	OO-ID	*ær]$_\sigma$	IO-ID
a. la.ri			*!		a'. lar			*
b. la.ri			*!		b'. lær	*	*	
c. læ.ri					c'. lar	*!		*
d. ☞ læ.ri					d'. ☞ lær		*	

The truncatory diminutive morphology triggers an OO-correspondence relation and a recursion of the constraint hierarchy, and each word in the subparadigm is evaluated against one of the recursions. The base is evaluated by the dominant recursion, so paradigms with non-canonical phonology in the base are eliminated. Paradigms (16a) and (16b) are ruled out by the violation of IO-IDENT[BK] incurred by *L[a]rry*, the base common to them.[29]

29 The underlying form of the base *Larry* must have a front [æ] because backness is contrastive before heterosyllabic *r* (cf. *sorry*). I assume that low vowels contrast in backness in the general case, which means that IO-IDENT[BK] is dominated only by context-sensitive constraints like *ær]$_\sigma$. All other conflicting markedness constraints, in particular context-free bans on each vowel or feature combination (**æ* or **a*),

The choice between the remaining candidates falls to the lower-ranked recursion of the constraints, where OO-Identity is decisive. Paradigm (16c) is optimal in spite of its *ær]$_{\sigma}$ violation.

By taking into account *where* in a paradigm constraint violations are incurred – in the base or in the derived word – recursive evaluation makes paradigmatic underapplication possible. Without it, underapplication of phonology in the derived word would be ruled out in favor of overapplication in the base. In (16a), overapplication of the [æ]-to-[a] change[30] in the base of the paradigm satisfies both OO-Identity and markedness, and violates only IO-Faithfulness. And since IO-Faith has to rank below *ær]$_{\sigma}$ to drive the canonical neutralization pattern, overapplication is expected to win. Recursive evaluation ensures that it does not. The IO-Faith violation incurred by the base in (16a) is more costly, because it is higher-ranked, than the *ær]$_{\sigma}$ violation in the derived word in the optimal paradigm (16b).

Underapplication requires a low-ranking constraint to compel violation of a dominant one. Recursive evaluation resolves this paradox by invoking a second order of evaluation of paradigms, differentiating (through ranking) the violations incurred by each member. Thus, a lower-ranked constraint can compel violation of a higher-ranked one if and only if the lower-ranked constraint is violated in a word with RANKING PRIORITY in a subparadigm. The idea is that the base is morphologically prior to or less-complex than the derived word, so it is endowed with ranking priority, and subjected to a higher-ranked recursion of the constraints. The base is therefore maximally harmonic, satisfying the language-particular ranking as best it can by conforming to canonical surface patterns.[31] Since the base has to show canonical phonology, high-ranking OO-Identity can be only

rank lower than IO-Faith. Thus, it is IO-IDENT[BK] that requires a front vowel in *Larry*, as shown in (16).

30 The procedural terminology over- and underapplication gets in the way here. I do not claim that there is a productive [a]-to-[æ] process in English. Rather, a contrast between [a] and [æ], observed in open syllables, is neutralized in syllables that are closed by [r], as demanded by *ær]$_{\sigma}$. While it is accurate to say that the *ær]$_{\sigma}$ constraint underapplies in the diminutive *L[æ]r*, in that it has no effect in that word, it is difficult to characterize the overapplication candidate other than by reference to an [æ]-[a] alternation.

31 The base of an OO-correspondence relation can show non-canonical phonology if it is itself morphologically-complex, and its deviant features increase identity with its output base.

satisfied by misapplying phonology in the paradigm's derived word. Underapplication *L[æ]rry* *L[æ]r* is optimal, even though it violates a dominant constraint, because overapplication **L[a]rry* *L[a]r* violates the PRIORITY OF THE BASE generalization enforced by the recursive evaluation.

Another way to resolve the ranking paradox in underapplication is to re-rank constraints, so that some part of the English grammar forces low vowel neutralization by the ranking *ær]$_{\sigma}$ >> IO-IDENT[BK] (hence *c[a]r*, **c[æ]r*), while another part of the grammar, relevant to truncated words, has the opposite ranking and no neutralization (*L[æ]r*, **L[a]r*). The idea that multiple grammars coexist in one language is familiar from cyclic and stratal theories like Lexical Phonology (Pesetsky 1979; Kiparsky, 1982, 1985b; Mohanan 1982, 1986; Borowsky, 1986, 1993), as well as from OT subgrammar theories (McCarthy & Prince, 1993a; Inkelas, 1994; Kenstowicz, 1995; Itô & Mester, 1995; Kiparsky, 1997). But note that distinguishing between levels or subgrammars (by constraint re-ranking or otherwise) is by itself insufficient to model the base-priority asymmetry in paradigms. The levels or subgrammars also have to be chained together in serial order.

In a re-ranking analysis of misapplication, serialism has two functions. First, when misapplication involves mimicry of a phonologically-predictable property, as in the English stress case *oríginal* *orìginálity*, the derived word has to be related to a form that has already undergone some phonological derivation. This entails (at least) two derivational steps. Serialism also enforces the PRIORITY OF THE BASE generalization. The base is derived first in a bottom-up construction of the complex word, and the base's derivation cannot look ahead to anticipate later events. It follows that the less-complex base can never copy the phonology of the derived word.

Recursive evaluation supplants serialism's "no look-ahead" function (its other job, relating outputs, is assigned to the OO-Identity constraints). Identity relations between words are asymmetrical – the base can never copy the derived word – because each word is evaluated individually, and violations in the base are more costly than violations in the derived word. There is no need to invoke a serial derivation, so I propose that words are evaluated in parallel by OO-Identity (and other) constraints. This has the added benefit of obviating the other leg of the serial analysis: re-ranking. A parallel theory is necessarily monostratal, with fixed constraint ranking, so only a limited variety of patterns can be produced in the same language. By allowing constraints to re-rank, subgrammar theory makes much broader typological predictions. These and other points of comparison between TCT and serial theory are developed throughout this thesis.

Recursion of the constraint ranking is limited only by morphological complexity. In multiple affixation, each affix triggers an OO-correspondence relation and a recursion of the ranking. Tableau (17) shows evaluation of the extended paradigm *origin original originality* against constraints that govern stress placement in English (see §5.2). Affixation of *-al* triggers one OO-correspondence relation and a recursion of the constraints, and further affixation of *-ity* triggers another relation and another, lower-ranked recursion. Each word in the extended paradigm is evaluated against a recursion of the constraints. (Tableau (17) appears as (156) in §5.2, and its content is explained there.)

(17) Multiple Affixation, Multiple Recursion

	OO-Identity		***OO-Identity***	
origin	→	original	→	originality
↑		↑		↑
/origin/		/ origin + al /		/ origin + al + ity /

Recursion (A)

/origin/	NONFINAL	ALIGN-R	OO-IDENT	ALIGN-L	IO-IDENT	>>
a. o (rí.gin)	*!			*		
b. (ó.ri) gin		*				
c. (ó.ri) gin		*				
d. ☞ (ó.ri) gin		*				

Recursion (B)

>>	/origin+al/	NONFINAL	ALIGN-R	OO-IDENT	ALIGN-L	IO-IDENT	>>
	a'. o (rí. gi) nal		**		*		
	b'. (ó.ri) gi nal		***!				
	c'. o (rí. gi) nal		**	*	*		
	d'. ☞ o (rí. gi) nal		**	*	*		

Recursion (C)

>>	/origin+al+ity/	NONFINAL	ALIGN-R	OO-IDENT	ALIGN-L	IO-IDENT
	a''. o (rì. gi) (ná.li) ty		**		*	
	b''. (ò.ri) gi (ná.li) ty		**			
	c''. (ò.ri) gi (ná.li) ty		**	**!		
	d''. ☞ o (rì gi) (ná.li) ty		**	*	*	

Each output is evaluated individually against the constraint hierarchy, so that in (17) ALIGN violations in *orìginálity* are assessed separately from ALIGN violations in *oríginal* or *órigin*. Recursion allows a similarly local assessment of candidates by faithfulness. Each token of the IO-Faith constraint in (17) evaluates the word in its recursion, and each token of the OO-Identity constraint compares just two words: the derived word in its recursion and its output base. In an extended paradigm like (17), two subparadigms (*órigin oríginal* and *oríginal orìginálity*) are assessed independently by the OO-Identity constraint (here a constraint demanding faithfulness to prosodic organization, ANCHOR-FT). Thus, recursion functions as a bookkeeping device, keeping track of which words in which paradigms violate which constraints. It also models strict locality in paradigms, facilitating separate evaluation of each minimally-distinct pair of words.

Note briefly that OO-Identity constraints are vacuously satisfied by simplex words. This follows from the hypothesis that identity relations are established by morphological derivation. A simplex word like *origin* contains no affix, so no OO-correspondence relation is triggered between *origin* and any output base. In effect, an OO-Identity constraint cannot be violated in the topmost recursion of a paradigmatic tableau. This technical point is not relevant in the cases introduced so far (where OO-Identity is optimally satisfied), but it is important in certain cases in which non-identical paradigms are optimal (see, e.g., §3.4 below).

Recursive evaluation of paradigms is one way to enforce the asymmetrical and strictly local character of word formation without recourse to "no look-ahead" serial derivations. With recursion built into the grammar's evaluation mechanism, I predict that the priority of the base generalization holds universally (the few cases purported to show identity-driven noncanonical phonology in the base of an OO-correspondence relation are examined in §6.4). The grammar enforces the asymmetrical, bottom-up character of word formation by subjecting the base to a dominant recursion of constraints. As discussed, recursion is essential in underapplication, where it rules out the overapplication alternative. Therefore further discussion of the recursive system, and the beginnings of a comparison with the serial alternative, appear in the introduction to underapplication in §2.4.

2.3.2 The Phonology of Affixes

So far I have ignored the fact that words in a paradigm are not completely identical. Obviously, morphological derivation makes corresponding words different. In affixation, related words are not identical because the affix's segments have no correspondents in the base.

(18)

OO-Identity

[obvious] → [obviousness]

IO-Faith ↑ ↑ ***IO-Faith***

/ obvious / / obvious + ness /

The suffix -*ness* is pronounced, and not pronounced as *ba*, because the affixed word *obviousness* is related by IO-correspondence to the input /obvious + ness/, which contains the lexical form of the affix. The affix is required to be faithfully realized in the output by IO-Faith constraints, as set out below.

Because affixal segments in a derived word have no correspondents in the base, affixation violates OO-DEP. This OO-DEP constraint clearly has to be low-ranking in the general case, since affixation is common. McCarthy & Prince's (1994b) proposal that faithfulness to affix material is regulated separately from faithfulness to roots, and that Root-Faith >> Affix-Faith, is relevant here. It is an OO_{Affix}-DEP constraint that is crucially dominated in affixation paradigms. In tableau (19), IO_{Affix}-MAX dominates and forces violation of OO_{Affix}-DEP.

(19) Affixation Violates OO_{AFX}-DEP

Constraints:

IO_{Affix}-MAX "Every affixal segment in the input has an output correspondent."

OO_{Affix}-DEP "Every affixal segment in the derived word has a base correspondent."

Candidates:

candidate (a) obvious obvious

☞ candidate (b) obvious obviousness

Recursion (A)

/obvious/	IO_{AFX}-MAX	OO_{AFX}-DEP	>>
a. obvious			
b. ☞ obvious			

Recursion (B)

>>	/obvious + ness/	IO_{AFX}-MAX	OO_{AFX}-DEP
	a'. obvious	***!	
	b'. ☞ obviousness		***

The only difference between the candidates in (19) is in whether or not the affix gets pronounced. In paradigm (a), the input affix is not supplied with output correspondents, and IO_{AFX}-MAX is fatally violated. The optimal candidate (b) satisfies IO_{AFX}-MAX at the expense of the lower-ranked OO-Identity constraint. Reversing the ranking in (19) would prevent the affix from surfacing, so it is possible that an OO_{AFX}-DEP >> IO_{AFX}-MAX ranking is responsible for zero morphology, or nonaffixation in morphologically-complex words.

There is another way that affixation can be forced to violate paradigmatic identity constraints. Samek-Lodovici (1993), McCarthy & Prince (1995), Gnandesikan (1997) and Benua (1997a), among others, employ a MORPHDIS constraint, which requires strings with distinct morphological content to be distinct phonologically. MORPHDIS plays a role when morphological derivation, such as a floating feature morpheme, produces a highly-marked output (see Benua (1997a) on ablaut in Javanese, and Gnandesikan (1997) on Celtic consonant mutations; see also Zoll (1996) for a different theory of floating features). Failure to realize the affix (19a) is a MORPHDIS violation, since non-realization of *-ness* makes the adjective and the derived noun phonologically indistinguishable. It is possible, then, that the ranking MORPHDIS >> OO_{Affix}-DEP forces affixes to surface.

Whether affixes are forced to appear by IO_{Affix}-MAX or MORPHDIS, they typically do surface, and segments in an affixed word have no base correspondents. Affixation is made possible by the constraint ranking, by crucial domination of OO_{Affix}-DEP.

As mentioned earlier, one of the entailments of TCT is that misapplication or "cyclic" effects do not occur in affixal material. Misapplication is forced by OO-Identity constraints, and affixes are typically not in an OO-correspondence relation, so misapplication in affixes is impossible. Traditional serial analyses of word-formation makes the same prediction in a different way, by assuming that phonological rules do not

cycle on affixes by themselves; cycles affect roots or root-affix combinations only.[32] Cases alleged to show identity-driven misapplication of phonology in affixes are discussed in §6.2, where I argue that they cannot be produced by OO-Identity requirements in TCT but fall to other kinds of analyses.

2.4 Misapplication and Other Surface Patterns

When paradigmatically-related words differ in structure, such that a phonological process is conditioned in one word but not in the other, interactions of OO-Identity, IO-Faith and markedness constraints can produce three different patterns. Two of these preserve identity: OVERAPPLICATION (application of the process where it is not conditioned) and UNDERAPPLICATION (failure of the process where it is conditioned). A third disrupts identity of related words: in NORMAL APPLICATION, the process applies just where it is conditioned, affecting one word in the subparadigm but not the other, and paradigmatic identity is not achieved.

The over- and underapplication terminology comes from Wilbur's (1973) analysis reduplicative misapplication patterns (see also Aronoff, 1976; Shaw, 1976; Carrier, 1979; Marantz, 1982; Odden & Odden, 1985; Kiparsky, 1986; Mester, 1986; Steriade, 1988a; Schlindwein, 1991; and especially McCarthy & Prince (1995), who coin "normal application"). Wilbur's terms are somewhat unfortunate in the context of a nonprocedural theory like OT, but they are well-known from the reduplication literature, so I use them here as descriptive terms.

Over- and underapplication patterns within a reduplicated word are similar to the "cyclic effects" in paradigms – both involve disobedience to canonical patterns in a special morphological domain. Both are traditionally assumed to follow from rule-ordering: phonology takes place before, or fails to take place after, a morphological operation like

32 Like certain roots and stems, affixes are morphologically bound, and therefore are not legitimate domains of phonological rule application. But see Borowsky (1986), who proposes that English *-ing* goes through level 1 rules to derive its velar nasal.

reduplicative copying or affixation. Building on McCarthy & Prince's work, I show in this section that reduplicative and paradigmatic misapplication identity effects are similar but not identical phenomena, and that neither is the product of derivational ordering. Misapplication identity effects are produced in parallel by constraint interaction.

2.4.1 Overapplication

In overapplication, a phonological process applies where it is not conditioned to preserve identity of related strings. The Austronesian language Sundanese provides a simple case of overapplication in a paradigm (see §3). Sundanese has progressive nasal harmony. Vowels and vowel sequences that follow nasal consonants are nasalized, and all other vowels are oral. Supralaryngeal oral consonants block nasal harmony [ŋãtur] 'arrange', [ŋũliat] 'stretch', except in one circumstance. When the plural morpheme (realized as [-ar-] or [-al-]) is infixed after a root-initial nasal, it fails to block nasal spread. Nasalization overapplies in [ɲ-ãl-ĩãr] 'seek (pl)', nasalizing vowels in a non-nasal context.

(20) Sundanese Paradigmatic Overapplication

	OO-Identity	
[ɲĩãr]	→	[ɲ-ãl-ĩãr]
↑		↑
/ɲiar/		/ar + ɲiar/

Nasal harmony applies in the infixed word, where it is not conditioned, because nasal harmony is properly conditioned in the base. Corresponding vowels in the two words are in different environments and are expected to differ in nasality, but do not, because paradigmatic identity takes precedence over the nasal spread constraints.

Overapplication is produced by the constraint ranking in (21). A phonological process occurs generally in the language because a markedness (M) constraint outranks IO-Faith constraints. The process overapplies in paradigms because an OO-Identity constraint is highly-ranked in the grammar, as high as the alternation-inducing M constraint.

(21) Overapplication OO-Identity, M >> IO-Faith

To see this ranking in action, consider an overapplication pattern in reduplicated words.

Reduplicative overapplication is formally parallel to overapplication in paradigms; it is produced by the same constraint interaction (with BR-Identity high-ranked, instead of OO-Identity). McCarthy & Prince (1995) analyze overapplication of progressive nasal harmony in Madurese. Madurese has the same complementary distribution of oral and nasal segments as Sundanese – nasality spreads from primary nasal consonants onto following vocoids. In reduplicated words like [ỹãt-nẽỹãt] 'intentions', nasal assimilation overapplies, and the prefixed reduplicant is nasalized even though it is not post-nasal. McCarthy & Prince's Madurese analysis is sketched briefly here, and laid out in more detail in §3, where it is applied to the nearly identical Sundanese pattern.[33]

Allophonic alternations are produced by the interaction of two markedness constraints: one demands the more-marked allophone in a specific context, and the other demands the less-marked allophone in the general case. In Madurese, a context-sensitive markedness constraint *NVORAL ("no oral vocoids after nasal segments") forces nasal vocoids by banning less-marked oral ones from a specific environment. Ranked above a context-free markedness constraint against nasal vocoids, *VNAS, the *NVORAL constraint demands nasality. Nasal vocoids surface only in post-nasal context, which means that *VNAS dominates the IO-Faith constraint IO-IDENT[NAS].[34] The hierarchy that produces the canonical complementary distribution of oral and nasal vocoids in Madurese (and Sundanese) is *NVORAL >> *VNAS >> IO-IDENT[NAS].

In overapplication, preserving identity of reduplicant and base forces nasal vocoids to appear in a non-nasal context. BR-Identity forces *VNAS violation, as in (22).

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[33] The differences are (i) Madurese tolerates nasalized glides and not Sundanese does not, and (ii) overapplication of nasalization occurs within a reduplicated Madurese word (by high-ranking BR-Identity), and between two separate Sundanese words (by high-ranking OO-Identity).

[34] This Markedness >> IO-Faithfulness ranking must hold, because allophonic nasality cannot be fixed in input forms (see Prince & Smolensky, 1993:191ff. and §1.2.2 above on the *Richness of the Input*). Rich inputs may present either allophone without regard to context, and IO-Faith is low-ranking.

(22) Madurese Reduplicative Overapplication BR-Identity, M >> IO-Faith

/RED - neyat/	BR-IDENT[NAS]	*NV$_{ORAL}$	*V$_{NAS}$	IO-IDENT[NAS]
a. yat-nẽyat		*!		
b. ☞ ỹãt-nẽỹãt			*****	*****
c. yat-nẽỹãt	*!		***	***

The optimal candidate (22b) satisfies both BR-Identity and the top-ranked markedness constraint by overapplying nasal spread. The underapplication candidate (22a) also satisfies BR-Identity, but it fatally violates high-ranking *NVORAL. Candidate (22c) is the normal application candidate, where nasalization affects all and only post-nasal vocoids. Normal application fares better on *VNAS than optimal (22b) does, but it fatally violates dominant BR-IDENT[NAS].

When BR-Identity is high-ranking in a grammar, as high as an alternation-inducing markedness constraint, overapplication of phonology in reduplicated words is optimal. Overapplication in paradigms is formally similar: an OO-Identity constraint, ranked as high as the phonology-inducing markedness constraint, produces overapplication of nasalization in Sundanese paradigms like the one in (20), [ɲĩãr ɲãlĩãr]. Paradigmatic overapplication is demonstrated in detail in §3.

(23) Overapplication
in reduplication BR-Identity, M >> IO-Faith
in paradigms OO-Identity, M >> IO-Faith

2.4.2 Normal Application

Identity of related strings is not always achieved. Normal application of the phonology can disrupt identity in both reduplicated words and in paradigms. McCarthy & Prince (1995) provide actual examples of identity-disrupting normal application in reduplication, but to simplify this discussion (24) shows a hypothetical language Madurese' in which reduplicative identity is sacrificed to the canonical nasal harmony pattern. As in real Madurese, the base's vocoids are post-nasal and their correspondents in the reduplicant

are not, but here nasalization applies normally, always and only where it is properly conditioned, and the optimal base-reduplicant pair is not identical.

(24) Madurese' Normal Application M >> BR-Identity, IO-Faith

/RED - neyat/	*NVORAL	*V$_{NAS}$	BR-IDENT[NAS]	IO-IDENT[NAS]
a. yat-nẽyat	*!			
b. ỹãt-nẽỹãt		***!**		*****
c. ☞ yat-nẽỹãt		***	*	***

Normal application results when faithfulness ranks below the phonology-inducing markedness constraints. In (24), both IO-IDENT[NAS] and BR-IDENT[NAS] are dominated by the markedness constraint against nasal vocoids. Therefore, nasal vocoids appear only when forced by *NVORAL – that is, nasal vocoids appear in post-nasal context, and nowhere else.

Normal application in paradigms works the same way. OO-Identity is dominated by markedness, and paradigmatic identity is not achieved. In Sundanese, for example, identity-disrupting normal application occurs when an affix introduces a nasal segment: corresponding vowels in the paradigm [dɤhɤs d-um-ɤ̃hɤ̃s] 'approach (a superior)' are not identical, because nasal spread is more important. OO-IDENT[NAS] is violated under domination by the top-ranked markedness constraint *NVORAL, and paradigmatic identity is sacrificed (see §3.4).

(25) Normal Application
in reduplication M >> BR-Identity, IO-Faith
in paradigms M >> OO-Identity, IO-Faith

Summing up, reduplicative and paradigmatic identity relations produce the overapplication and normal application patterns in the same way, through the same constraint interactions. The only difference is in which type of faithfulness constraints are relevant.

2.4.3 Underapplication and Back-Copying

Like overapplication, underapplication of a phonological process leads to identity in reduplicated words and in paradigms. In underapplication, an alternation fails to apply where it is properly conditioned. In the underapplication candidate (24a), nasalization fails to occur in the final syllable of the base, even though it is in post-nasal context, because nasalization is not conditioned in the corresponding reduplicant. Underapplication is the most complicated and most interesting of the patterns, in part because it shows a difference between reduplicative and paradigmatic identity relations.

Underapplication of a process entails violation of the markedness constraint that drives the process – in (24a), underapplication violates high-ranking *NVORAL. Overapplication better satisfies the constraints: (24b) satisfies both BR-Identity and the top-ranked M constraint. Logically, then, overapplication is more harmonic than underapplication, and should always be preferred. For underapplication to win, something has to rule out the overapplication option.

In reduplication, underapplication occurs relatively infrequently because it requires a special configuration of constraints (see McCarthy & Prince, 1995:§5). BR-Identity has to be joined at the top of the hierarchy by a markedness constraint C, which prohibits (over)application of the process in the reduplicated word. This C cannot block the process in the general case; it has to become relevant, and force M-violation, only in reduplication. McCarthy & Prince point to constraints like the OCP and template-like constraints on reduplicative morphology to rule out overapplication. In Akan, for example, a palatalization process (k --> tç /__ɪ) underapplies in reduplicated words like [kɪ-kaʔ] 'bite' because BR-Identity must be satisfied (*tçɪ-kaʔ) and overapplication is prohibited by an OCP constraint on palatal features (*tçɪ-tçaʔ). Thus, underapplication is not simply a response to a high-ranking BR-Identity constraint. It requires the combined effort of BR-Identity and a particular type of markedness constraint, which blocks phonology in reduplicated environments only. The reduplicative underapplication ranking is (26).

(26) Reduplicative Underapplication C, BR-Identity >> M >> IO-Faith

Underapplication in paradigms is formally different. Paradigmatic underapplication does not require any special circumstances; it is a straightforward response to high-ranking OO-Identity constraints. The English truncation case shows underapplication: the expected backing of a low vowel before a tautosyllabic *r* fails to apply in the diminutive form *L[æ]r* because low-vowel backing is not properly conditioned by the base *L[æ]rry*.[35]

(27) Underapplication

OO-Identity

L[æ]rry → L[æ]r

↑ ↑

/ L[æ]rry / / L[æ]rry + TRUNC$_{DIM}$ /

The constraint against tautosyllabic [ær] sequences is violated by the truncated word in (27). The markedness constraint has no effect – it underapplies – because an OO-Identity constraint is dominant (see tableau (16)). In paradigmatic underapplication, OO-Identity conflicts with and forces violation of an alternation-inducing M constraint.

(28) Paradigmatic Underapplication OO-Identity >> M >> IO-Faith

The English underapplication ranking blocks neutralization: *L[æ]rry* *L[æ]r* satisfies OO-IDENT[BK] at the cost of a *ær]$_\sigma$ violation. The question is what rules out the competing paradigm *L[a]rry* *L[a]r*, which manages to satisfy both OO-Identity and *ær]$_\sigma$ by overapplying phonology in the base.

McCarthy & Prince's theory of reduplicative underapplication does not translate to the paradigmatic cases, because no markedness constraint can block application of a phonological process in one of the the members of a paradigm without blocking it in all words. Markedness constraints govern individual words. Co-membership in a paradigm does not violate markedness; for example, the OCP is not violated if two separate words contain the same feature. Elements in separate words can interact only if those words coexist in a phonological phrase, not if they coexist in a phonological paradigm. Thus, insofar as there are no paradigm-specific markedness constraints, anything that blocks

35 Recall the disclaimers in fn. 30 about the use of procedural terminology in this description.

(over)application of a process in a paradigm will block its application across the whole language.

I propose that overapplication in the paradigm's base is ruled out, and underapplication in the derived word is ruled in, by recursive evaluation of paradigms. Consider again the two candidates from tableau (16) that satisfy OO-Identity. Overapplication in *L[a]rry L[a]r* violates only low-ranking IO-Faith, while the optimal underapplication paradigm *L[æ]rry L[æ]r* violates dominant $*ær]_\sigma$. Overapplication fails because it incurs a fatal violation in the dominant recursion of constraints.

(29) The Recursive Hierarchy

	overapplication	(a)	L[a]rry L[a]r
☞	underapplication	(b)	L[æ]rry L[æ]r

Ranking: OO-IDENT[BK] >> $*ær]_\sigma$ >> IO-IDENT[BK]

Recursion (A)

/læri/	OO-ID	$*ær]_\sigma$	IO-ID
a. la.ri			*!
b. ☞ læ.ri			

>>

Recursion (B)

/læri - TRUNC/	OO-ID	$*ær]_\sigma$	IO-ID
a'. lar			*
b'. ☞ lær		*	

The key is the locus of the misapplication effect. Phonology misapplies in the base in the failed paradigm, while misapplication occurs in the derived word in the optimal one. Underapplication wins because overapplication in the base is impossible. The base must show maximally-harmonic ("canonical") phonology, because it is evaluated by a dominant recursion of the constraints. Recursion makes underapplication possible without contravening the $*ær]_\sigma$ >> IO-IDENT[BK] ranking. The lower-ranked constraint compels violation of the higher-ranked one only because IO-IDENT[BK] is violated in a dominant recursion of constraints. As mentioned earlier, I take the PRIORITY OF THE BASE generalization to be inviolable in paradigms, and build it into the architecture of the grammar by way of recursive evaluation.

Reduplicated words, unlike paradigms, can violate base priority, and the base of reduplication can copy phonology that is properly conditioned only in the reduplicant.

McCarthy & Prince refer to this as BACK-COPYING and analyze several examples. These include the well-known Tagalog case in which the prefix /paŋ/ triggers nasal substitution in both the reduplicant and the base: [pa-mu-mutul] < /paŋ + RED + putul/. Nasal substitution is properly conditioned only between the prefix and the adjacent reduplicant. The process applies in the base simply to preserve BR-Identity. For expository purposes, I abbreviate the constraints that produce nasal substitution adjacent to prefixes like /paŋ/ as NAS-SUB. This constraint has dominate IO-IDENT[NAS] to force the canonical substitution pattern. BR-IDENT[NAS] also dominates IO-Faith, producing overapplication in (30b).[36]

(30) Tagalog back-copying overapplication BR-Identity, **M** >> IO-Faith

/paŋ + RED + putul/	BR-IDENT[NAS]	NAS-SUB	IO-IDENT[NAS]
a. pa pu putul		*!	
b. ☞ pa mu mutul			**
c. pa mu putul	*!		*

Comparing this tableau with the Madurese case in (22) shows that the grammar is indifferent to where in the reduplicated word the misapplication occurs. In Tagalog unexpected phonology appears in the base, while a formally similar ranking makes the reduplicant misbehave in Madurese. BR-Identity constraints can induce noncanonical phonology in either string, whichever better satisfies the constraints. In Tagalog and Madurese, the winner is more harmonic (markedness-satisfying) overapplication. Thus, reduplicative identity is a two-way street, and either string in a BR-Identity relation can influence the other. This fits with the null hypothesis about an identity relation: it should be symmetrical. Faithfulness constraints in Correspondence Theory reflect the expectation of symmetry in the correspondence relation: they demand that two related elements are alike, and not that one element defers to the other.

36 In assessing IO-Faith violations in (30) I assume that both the base-initial and the reduplicant-initial consonant correspond to the underlying root's oral /p/ (as well as to the underlying prefix's final nasal; i.e., this is coalescence). Alternatively, the reduplicant's segments could correspond to base material only (and not to the input). This would change the IO-Faith violations in (30) but not the overapplication result.

The symmetry demonstrated by back-copying confirms that reduplicated words are derived in parallel. In a parallel theory it is natural that the base can determine features of the reduplicant and the reduplicant can determine features of the base, because the two strings are generated and evaluated simultaneously. Serial-derivational theories, in contrast, do not predict back-copying: a reduplicant is assigned its segmentism by its base, so the base must be generated first. Patterns in which the base's phonology is influenced by the reduplicant require some additional explanation.[37]

In further support of parallelism, McCarthy & Prince discuss cases like Malay, where the reduplicant both triggers and copies an alternation in the base (1995:§3.6). Like the Austronesian languages mentioned earlier, Malay has progressive nasal harmony. In (31), prefixing a reduplicant triggers nasalization on the base-initial syllable, and the reduplicant copies this nasalization in an overapplication identity effect.[38]

(31)	Malay	/RED - waŋi/	w̃ãŋ̃ĩ-w̃ãŋ̃ĩ	'very fragrant'
		/RED - haməә/	hãmə̃-hãmə̃	'germs'
		/RED - aŋan/	ãŋãn-ãŋãn	'ambition'

This pattern is difficult to model with serial derivation. Any ordering of nasal spread with reduplicative copying produces incorrect results. In (32a) copying precedes nasalization, and the nasal spread rule fails to affect the reduplicant's first syllable. In (32b) copying follows nasalization, and nasalization applies twice in a cyclic derivation, but again the wrong form is produced. Both of the simple serial hypotheses ("copy first" or "copy second") incorrectly generate normal application of nasal spread.

[37] For example, the Tagalog reduplicant could be infixed in a cyclic derivation. Nasal substitution would apply first to the prefix-base combination, and apply again on a later cycle after the reduplicant is infixed. Note, however, that there is no apparent reason why the reduplicant would infix in this case, since infixation of a CV reduplicant in a consonant-initial stem like [pamutul] does not improve its harmony (see McCarthy & Prince, 1993a on prosodically-driven reduplicative infixation).
[38] If the reduplicant is suffixal, then Malay is a case of back-copying overapplication, similar to Tagalog.

(32) The Failure of Serialism in Malay Reduplication

a. Copy first		b. Copy second		c. Copy twice?	
UR	/RED - waŋi/	UR	/RED - waŋi/	UR	/RED - waŋi/
copy	waŋi-waŋi	nasalize	waŋ̃ĩ	copy	waŋi-waŋi
nasalize	waŋ̃ĩ-w̃ãŋ̃ĩ	copy	waŋ̃ĩ-waŋ̃ĩ	nasalize	waŋ̃ĩ-w̃ãŋ̃ĩ
		nasalize	waŋ̃ĩ-w̃ãŋ̃ĩ	**copy?**	w̃ãŋ̃ĩ-w̃ãŋ̃ĩ
SR	*waŋ̃ĩ-w̃ãŋ̃ĩ	SR	*waŋ̃ĩ-w̃ãŋ̃ĩ	SR	w̃ãŋ̃ĩ-w̃ãŋ̃i

To get overapplication the derivation in (32c) is required: first reduplicative copying, then nasal spread, and then another copying-like operation, which nasalizes the reduplicant's first syllable. This second copying procedure is remarkably different from the first one, however, in that no segments are actually copied; only nasalization is transferred.

The difficulty for the serial analysis of Malay is that two different features of the reduplicant are called on at different stages of the derivation. To put it informally, the nasal /...ŋ̃ĩ/ half of the reduplicant has to trigger nasalization in the base before the oral /wa.../ half of the reduplicant copies it. The serial analysis of this pattern is clumsy at best, but in a parallel analysis the problems fall away: Malay shows a simple overapplication identity effect, produced by the same ranking that generates overapplication of nasal spread in Madurese. With BR-Identity at the top of the ranking, the overapplication candidate (33b) is optimal.

(33) Malay overapplication BR-Identity, **M** >> IO-Faith

/RED - waŋi/	BR-IDENT[NAS]	*NV$_{ORAL}$	*V$_{NAS}$	IO-IDENT[NAS]
a. waŋ̃ĩ-waŋ̃ĩ		**!	**	**
b. ☞ w̃ãŋ̃ĩ-w̃ãŋ̃ĩ			******	******
c. waŋ̃ĩ-w̃ãŋ̃ĩ	*!		****	****

Back-copying in Tagalog and Malay (and other languages) is strong support for the hypothesis that reduplication is parallel, without intermediate stages. Any case in which the reduplicant dictates some property of its base is evidence that the strings are symmetrically related. In part this follows from the nature of reduplication, because at the same time that the reduplicant influences the base, the base has to dictate properties of the reduplicant (otherwise the pattern would not be reduplicative copying).

However, the argument that "symmetry demonstrates parallelism" actually has two subparts. First, a reduplicant and its base are available simultaneously because they are treated as a unit by the grammar. They comprise a word. Second, the strings are available at the same time because the grammar makes no distinction between violations incurred by the base and violations incurred by the reduplicant. All violations are tallied equivalently, and misapplication can occur in either of the related strings.

Words in paradigms behave differently. Paradigmatic relations are asymmetrical, in that the base can influence the derived word, but the derived word never influences the base. Recursive evaluation enforces the base's priority by distinguishing violations incurred in the base from those incurred in the derived word, and assigning greater cost to the base's violations. Thus one of the arguments supporting parallelism in reduplication does not go through in paradigms: the grammar does distinguish the locus of constraint violation in paradigms, and there is no two-way street in misapplication effects. But the other argument for parallelism holds: paradigms are treated as units by the grammar. The paradigm's members are separate words, but there are primitive elements of grammar that make reference to subparadigm units: the OO-Identity constraints. Logically, both members of the subparadigm must be available for evaluation at the same time, in the same way that inputs and outputs are simultaneously available for evaluation by IO-Faith constraints. Paradigms are generated and evaluated as units, and the priority of the base over the derived word is ranking priority in a parallel derivation.

In short, underapplication in paradigms is possible because back-copying is not. Recursive evaluation ensures that when presented with a choice between underapplication in the derived word and overapplication in the base, the grammar chooses underapplication, even though it violates a higher-ranked markedness constraint. With the priority of the base

enforced as ranking priority, underapplication is produced by a simple hierarchy of OO-Identity >> M >> IO-Faith.

Of course, another way to rule out back-copying in paradigms is serial derivation: the base is produced first, and input to a later stage of derivation, where morphology creates the derived word. Some of the details of this kind of analysis have already been mentioned. The early stage of derivation has to be governed by a "no look-ahead" principle, keeping early stages blind to later ones, since without this restriction back-copying in paradigms could be incorrectly generated. Also, the serial model has to allow stages of derivation to differ in content, so that early rule application is not undone by later derivation. Rules are turned off, or faithfulness constraints are promoted, to generate a misapplication identity effect. And because it entails variation among the stages of derivation, serial theory has to explain why the stages of derivation in a language resemble each other as much as they do.[39]

I argue throughout this thesis that the recursive proposal improves on theories that enforce base priority with a serial stepwise derivation. As noted, enforcing base-priority with serialism comes at the cost of positing distinct stages of derivation and suffering the resultant increase in the typological predictions of the theory. The transderivational analysis obviates re-ranking and limits typology appropriately. Also, unlike serial theories, TCT provides a direct link between a morphologically-complex word and its underlying or input form. This link is crucial, because a complex word may be more faithful to the underlying form than its base is; for example, in English *condém<n>*   *condèmnátion*, the root-final segment surfaces in the derived word only. Explaining how complex words are sometimes faithful to their bases and sometimes faithful to their underlying forms requires some extra development of the basic serial proposal.[40] Some possible elaborations of serial theory are

[39] Itô & Mester (1995) propose that subgrammars are restricted in that they can differ only in the rank of faithfulness constraints, but it is unclear why this should be so (see §3.5).

[40] In *condém<n>*   *condèmnátion*, the derived word is faithful to the base's stress (Chomsky & Halle, 1968) but faithful to the UR of the root in segmentism. If the base is derived at level 1 to fix peninitial stress, it is unclear why cluster simplification does not also apply (see §5.7). The absence of a direct link between a complex word and the underlying form is also problematic with respect to affixal material which

considered, and arguments in support of the parallel recursion story are developed, in following chapters.

2.4.4 Emergent (Un)markedness

A fourth pattern generated by a ranking of BR-Identity, IO-Faith and markedness constraints is dubbed by McCarthy & Prince (1994a, 1995) *The Emergence of the Unmarked* (TETU). In TETU, a markedness constraint M that is generally invisible in the language emerges in a special morphological domain. The M constraint has no general effect in the language because it is dominated by IO-Faith, but M emerges in reduplicated words because it outranks BR-Identity.

(34) The Emergence of the Unmarked (TETU)

IO-Faith >> M >> BR-Identity

The Balangao case described in §1.3.1 demonstrates TETU. NOCODA is generally ineffective in Balangao because IO-MAX >> NOCODA. But the coda constraint forces less-than-total copying in optimal reduplicated words because NOCODA >> BR-MAX ([tagta-tagtag], *[tagtag-tagtag]). A markedness constraint emerges, and reduplicated words have less-marked structure than non-reduplicated words.

TETU cannot occur in paradigms because both members of the paradigm are related to an input by an IO-correspondence relation. Given a TETU ranking like (34), both words in the paradigm will obey top-ranked IO-Faith, and M does not emerge (cf. Benua, 1995; Burzio, 1997ab). The only way to produce TETU in paradigms would be to distinguish between two different IO-Faith relations in the paradigm, one proper to each word. It is not clear what could motivate such a distinction. McCarthy & Prince (1995) discuss a similar issue in reduplication, and appeal to morphology for a solution. Suppose that reduplicants are, like their bases, related to underlying segments by IO-correspondence (as in McCarthy

is not present in the base. If the affix has phonologically predictable features, correctly generating an affix in a non-initial cycle with high-ranking faithfulness is complicated (see §3.5).

& Prince's "full model" of reduplication). To get unmarked structure to emerge in reduplicants, the IO-relation on the reduplicant has to be distinguished from the IO-relation on the base. Since reduplicants are affixes, the input-base (IB) faithfulness >> M >> input-reduplicant (IR) faithfulness TETU ranking is consistent with the universal Root-Faith >> Affix-Faith meta-ranking.[41] No comparable story makes TETU possible in paradigms. Paradigmatically-related forms are both words containing roots, and they should both respond to high-ranking Root-Faith constraints. Without a way to distinguish between the two IO-Faith relations in a paradigm, TETU cannot be produced.

Although TETU is impossible, a similar pattern occurs in paradigms, which I call *The Emergence of the Relatively Unmarked* (TETRU). In TETRU, a markedness relation emerges in a special domain. Like TETU, TETRU is produced when two types of faithfulness constraints have different rank in the grammar; specifically, when OO-Identity ranks between two markedness constraints, and IO-Faith ranks below both. TETRU requires a particular relation between the two markedness constraints: top-ranked M_1 must penalize a subset of the structures that are marked by M_2. That is, the M_1 >> M_2 ranking establishes the relative markedness of two structures.

(35) The Emergence of the Relatively Unmarked (TETRU)

M_1 >> OO-Identity >> M_2 >> IO-Faith

As can be seen from this schematic hierarchy, TETRU involves an underapplication identity effect, generated by the bottom three constraints. The phonological process enforced by the markedness constraint M_2 underapplies in paradigms, because OO-Identity is dominant. But the process does not always underapply: higher-ranked M_1 asserts that underapplication must fail, and OO-Identity must be violated, when underapplication would

[41] McCarthy (p.c.) suggests that IR-Faith effects fall into the category of opaque interactions, and could be analyzed straightforwardly in terms of Sympathy Theory (McCarthy, 1997c; for a brief description of opacity and Sympathy, see §4.4.3 below). See also Struijke (forthcoming) for another theory of reduplicative TETU that does not assume IR-Faith constraints.

produce a highly-marked structure. Thus, marked structure emerges through underapplication, but only the less-marked of the marked set of structures is allowed.

A real example from Tiberian Hebrew (§4) is useful. Coda consonant clusters are generally avoided by epenthesis in Tiberian Hebrew because *COMPLEX-CODA >> IO-DEP. Epenthesis underapplies and coda clusters occur in morphologically truncated words like those in (36a) to avoid realizing an epenthetic vowel with no base correspondent. This underapplication is forced by the ranking OO-DEP >> *COMPLEX-CODA >> IO-DEP. However, underapplication cannot preserve identity in paradigms if it would produce a highly-marked rising-sonority coda cluster, as shown in (36b). Epenthesis must apply and disrupt paradigmatic identity because a sonority contour constraint (SON-CON) outranks OO-DEP.

(36) TETRU in Tiberian Hebrew Jussive Truncation

SON-CON >> OO-DEP >> *COMPLEX-CODA >> IO-DEP

a. Underapplication of epenthesis creates less-marked coda clusters

yiɸ.te	yiɸt	'be simple'
yiš.bē	yišb	'take captive'

b. Normal application of epenthesis avoids rising-sonority coda clusters

yiβ.ne	yi.βen	'build'
yiɣ.lē	yi.ɣel	'uncover

The universal markedness relation between rising sonority and level or falling sonority coda clusters is enforced by SON-CON ("no rising sonority coda clusters") ranked above *COMPLEX-CODA ("no coda clusters of any kind"). This universal markedness relation emerges in Tiberian Hebrew truncation, because OO-DEP ranks between these constraints and IO-DEP ranks below them. TETRU limits the underapplication of epenthesis, allowing only relatively unmarked coda clusters to occur in truncated words.

Since TETRU involves underapplication, it is possible but unlikely in reduplicated words. As discussed, underapplication in reduplication is not just a response to BR-Identity; it requires another constraint to rule out the overapplication option. Reduplicative TETRU would therefore entail the ranking M_1 >> BR-Identity, C >> M_2 >> IO-Faith, and all three markedness constraints would have to be related, such that M_1 penalizes a subset of

structures marked by M_2 (to establish the emergent markedness relation) and C prevents repair of M_2 violation in reduplicated words only. It is difficult to come up with a plausible set of three markedness constraints that could enforce the TETRU restriction on underapplication in reduplicated words.

In sum, TETU can occur only in reduplication – it cannot occur in paradigms, because both words are equally subject to IO-Faith constraints. TETRU, on the other hand, while theoretically possible in reduplication, is easier to generate in paradigms, where underapplication is driven by identity constraints alone.

2.5 Summary

This chapter has introduced the basic outlines of TCT, as well as many of its technical details. To review the main points, I proposed that morphological derivation is subcategorized by OO-correspondence relations, which provide a phonological link between a derived output and its output base. The phonological paradigms governed by OO-correspondence are linear and strictly local, and both members are available to the phonology at the same time, in fully parallel derivations. I argued that the illusion of serialism in word formation, characterized here as the PRIORITY OF THE BASE generalization, is enforced by recursive evaluation of related pairs of words. The recursive system differentiates the constraint violations incurred by each member of the paradigm, and thereby ensures that paradigmatic identity relations are asymmetrical: the derived word can copy its base, but the base cannot "anticipate" the phonology of the derived word.

Another goal of this chapter was to introduce the surface patterns produced by various rankings of OO-Identity with respect to IO-Faith and markedness constraints. As discussed, these are two identity-preserving phenomena, overapplication and underapplication (plus underapplication's companion TETRU effect), and identity-disrupting normal application of phonology. Each of these patterns is examined more closely in the following case studies.

CHAPTER 3

SUNDANESE

3.1 Introduction

Paradigmatic OO-Identity constraints force overapplication of phonology in the Austronesian language Sundanese. In plurals created by infixation, progressive nasal assimilation applies where it is not conditioned, nasalizing vowels that are not in a post-nasal context: [ɲ-ãl-ĩãr] 'seek (pl.)'. Nasalization overapplies in the plural to achieve identity with the singular base, where corresponding vowels are predictably nasal in post-nasal context, [ɲĩãr] 'seek'. This Sundanese case study shows that the paradigmatic OO-Identity requirements responsible for misapplication in paradigms are distinct from IO-Faith constraints on input-output relations, and that the two sets of faithfulness constraints coexist in the same markedness hierarchy.

The Sundanese facts are laid out in (37-39). Nasality is not contrastive in vowels. Predictable harmony spreads nasality onto vowels and vowel sequences that follow primary nasal consonants. The laryngeals [h, ʔ] are transparent to nasal spread (37a), but oral consonants and glides block it (37b). Thus, nasal vowels appear in post-nasal context, and oral vowels appear elsewhere.

(37) Sundanese Nasal Assimilation

a.	ɲĩãr	'seek'	b.	ŋãtur	'arrange'
	bɨŋhãr	'to be rich'		ŋĩsər	'displace'
	ɳãũr	'say'		ŋũliat	'stretch'
	nĩʔĩs	'relax in a cool place'		mãrios	'examine'
	nãʔãtkɨn	'dry'		ŋĩwat	'elope'

Certain plural words deviate from the canonical pattern, and have nasal vowels in oral context. The plural affix, which is realized as either *ar* or *al*, is prefixed to vowel-initial roots, as in (38a), and infixed if the root begins with a consonant or consonant cluster, as in (38b).[42]

[42] The plural morpheme alternates predictably between *al* and *ar* under the influence of liquids in the root (Robins, 1957; Cohn, 1992; Holton, 1995). It has the same distribution as other Austronesian VC prefixes (e.g., Tagalog *um*), infixing after a root-initial consonant. Infixation optimizes syllable structure (Anderson, 1972), and is forced by the constraint against coda consonants NOCODA ranked above the EDGEMOST or ALIGN constraint that requires prefixes to be leftmost in the word (Prince & Smolensky, 1993; McCarthy & Prince, 1993ab).

(38) Sundanese Plurals

a. Plural Prefixation

Singular	Plural	
alus	ar-alus	'be pleasant'
ala	ar-ala	'take'
omoŋ	ar-omoŋ-an	'say, their (our, your) words'

b. Plural Infixation

Singular	Plural	
bawa	b-ar-awa	'carry'
dahar	d-al-ahar	'eat'
hormat	h-al-ormat	'honor'

In (39), the plural marker is infixed after a root-initial nasal consonant. Unexpectedly, nasality spreads over the infix's liquid onto the following vowels (Robins, 1957; Anderson, 1972; Stevens, 1977; Hart, 1981; van der Hulst and Smith, 1982; Cohn, 1990).

(39) Plural Infixation after Nasal Consonants – Overapplication of Nasal Spread

Singular	Plural	
ɲĩãr	ɲ-ãl-ĩãr	'seek'
ɲãũr	ɲ-ãl-ãũr	'say'
mãhãl	m-ãr-ãhãl	'expensive'
ɲãʔãtkɨn	ɲ-ãr-ãʔãtkin	'dry'

Nasal harmony applies where its phonological conditions are not met to preserve identity in the plural paradigm. This is overapplication, forced by a high-ranking constraint on an OO-correspondence relation.

Cohn (1990) presents a cyclic analysis of Sundanese overapplication. The nasalization pattern presents an ordering paradox, in that the nasalization rule has to apply both before and after infixation of the plural morpheme. Cycles resolve the paradox, allowing the nasal spread rule to apply more than once in the derivation of the plural word. Nasal spread applies on the first cycle, nasalizing the root vowels in [ɲĩãr] while they are in post-nasal context, and applies again on the second cycle, after bracket erasure brings the infix into the derivation, to nasalize the infixal vowel.

(40) Cyclic Nasal Spread

Input (with morphological bracketing)	[al [ɲiar]]
Cycle 1 nasal spread	ɲĩãr
Bracket erasure	ɲ-al-ĩãr
Cycle 2 nasal spread	ɲ-ãl-ĩãr

The nasal spread rule is properly conditioned each time it applies. Morphology excluded from the first cycle destroys the conditioning environment of the first application of nasal spread, but since subsequent derivation does not denasalize the root's vowels, nasal vowels appear in oral context in the plural word. With cycles, nasality in the plural's root vowels is not enforced by any rule of grammar; it is simply a by-product of the serial derivation of the plural word.

Transderivational Correspondence Theory (TCT) gives the Sundanese pattern a different explanation: nasality in the plural is enforced by grammatically by OO-Identity constraints. The plural word and its singular base are linked phonologically by an OO-correspondence relation. Through ranking, constraints on this relation force plural paradigms to violate canonical phonotactics.

(41) Transderivational Identity

OO-correspondence

[ɲĩãr] → [ɲ-ãl-ĩãr]

↑ ↑ *IO-correspondence*

/ ɲiar / / aR + ɲiar /

The misbehavior of nasal harmony in Sundanese is overapplication: nasalization applies in both words, even though it is properly conditioned only in the base. A constraint demanding identity of nasality in the paradigm, ranked above a markedness constraint against nasal vowels, produces the overapplication effect. By the OO-IDENT[NAS] >> *VNAS ranking, it is better to achieve identity than to avoid marked vocalic nasality.

Like all constraints, OO-Identity constraints are ranked and violable under domination. In the paradigms in (42), an affix introduces nasality, and satisfaction of OO-IDENT[NAS] is not optimal. Instead, harmony applies normally, affecting all and only post-nasal vowels.

(42) Paradigmatic Identity Failures: Normal Application of Nasal Spread

gəde g-um-ə̃de	'big/be conceited'	*gəde g-um-əde *gə̃de g-um-ə̃de
rasa r-um-ãsa	'feel/admit to'	*rasa r-um-asa *rãsa r-um-ãsa
indit paŋ-ĩndit	'to leave/reason for leaving'	*indit paŋ-indit *ĩndit paŋ-ĩndit

Corresponding vowels in related words in (42) do not match in nasality, because OO-Identity is dominated by constraints that ban oral vowels from post-nasal context, abbreviated here as *NVORAL.[43] This prohibition is always obeyed – oral vowels never appear after nasals in Sundanese – so *NVORAL must outrank all conflicting constraints. In (42), *NVORAL conflicts with the paradigmatic identity requirement, and the markedness constraint is satisfied because it is dominant: *NVORAL >> OO-IDENT[NAS].

Together, overapplication in (39) and normal application in (42) show that OO-IDENT[NAS] ranks between two markedness constraints: it dominates *VNAS and is dominated by *NVORAL. Thus, identity in paradigms is optimal unless it would produce an oral vowel in a post-nasal context. The markedness hierarchy of *NVORAL >> *VNAS entailed by the OO-Identity effect is independently motivated in Sundanese, by the canonical distribution of oral and nasal vowels in (37). Ranked above faithfulness to the rich input, this markedness hierarchy ensures that nasal vowels appear, violating *VNAS, only if dominant *NVORAL demands them – that is, nasal vowels appear only after nasals, even if nasal vowels are assumed to be present underlyingly (see §3.2). Thus, the *NVORAL >> *VNAS ranking is constant, and two distinct faithfulness constraints, OO-IDENT[NAS] and IO-IDENT[NAS], interact with it. This case is evidence, then, that OO-Identity and IO-Faith coexist in a single hierarchy, and all words are derived by the same grammar.

43 A serious theory of nasal harmony would require a typological study that is not within the scope of this work. The *NVORAL constraint, which is borrowed from McCarthy & Prince (1995), is only a stand-in for whatever constraint or set of constraints is responsible for harmony in post-nasal context.

Since a single total ordering of constraints is responsible for both the canonical nasal harmony pattern in (37) and (42) and the overapplication identity effect in (39), the Sundanese analysis begins with an examination of canonical allophonic nasality (§3.2). Once the basic constraint ranking is established, OO-Identity constraints are introduced to explain overapplication of nasal spread in plural infixation paradigms (§3.3) and normal application in other paradigms (§3.4). The transderivational approach is compared to various alternatives (§3.5). In addition to the cyclic model in (40), three alternatives are considered: one based on underspecification of the plural morpheme's consonant, another that invokes underlying nasalization in Sundanese roots (derived by Prince & Smolensky's *Lexicon Optimization*), and a third that relies on a serial elaboration of an OT grammar. For various reasons, each of these analyses fails to improve on transderivational approach.

3.2 Allophonic Nasal Harmony

In monomorphemic Sundanese words, nasality in vowels is predictable from the vowel's phonological environment. Nasal vowels appear after nasal segments, and oral vowels appear elsewhere (43).

(43) Allophonic Nasal Harmony

ɲĩãr	'seek'	ŋãtur	'arrange'
bɨŋhãr	'to be rich'	ŋĩsər	'displace'
ɳãũr	'say'	ŋũliat	'stretch'
nĩʔĩs	'relax in a cool place'	mãrios	'examine'
nãʔãtkɨn	'dry'	ŋĩwat	'elope'

This is a simple allophonic alternation, predictable from phonological context alone. My analysis of allophonic nasality in Sundanese follows McCarthy & Prince's (1995) treatment of a similar pattern in the related language Madurese. The focus of the analysis is on the distribution of oral and nasal vowels, and not on the nature of the nasalization process itself.

McCarthy & Prince show that the distribution of allophones is determined by high-ranking markedness constraints. Two constraints interact, such that one forces the more-marked allophone in a specific context, and another demands the less-marked allophone in

the general case. These markedness constraints fully determine the allophonic alternation; faithfulness to input or underlying forms plays no active role. Vowels are nasal in post-nasal context and oral elsewhere because markedness demands it, and not because they are faithful to the input. IO-Faith constraints are low-ranked, below the markedness constraints that dictate the distribution of the allophones.

Domination of IO-Faith in an allophony hierarchy follows from the *Richness of the Input* principle (see Prince & Smolensky (1991:191ff) and §1.2.2 above.) A theory of output constraints cannot state restrictions on inputs, so the pool of possible inputs must be universal. Underlying forms are deduced from the language's outputs. Surface contrasts provide information about underlying forms – if the distribution of a feature is not predictable, it must be fixed in underlying representation and faithfully reproduced in optimal outputs. Predictable features, on the other hand, say nothing about inputs, because markedness, rather than faithfulness, determines a phonologically-predictable distribution. In the Sundanese case, it cannot be assumed that vowels are underlyingly oral or nasal, and it cannot be stipulated either. Possible inputs to the Sundanese grammar are rich in noncontrastive vocalic nasality, and present oral and nasal vowels without regard to context. Markedness constraints dominate faithfulness to the rich input, selecting optimal outputs that have nasal vowels in post-nasal context and oral vowels elsewhere.

The first step in identifying the markedness constraints that force an allophonic alternation is to determine the relative markedness of the allophones. In the Sundanese case this is simple: nasal vowels are more marked than oral vowels. Traditionally, (universal) implicational statements encode the relative markedness of segment types; for example, any system that admits nasal vowels must also allow oral vowels. OT allows a precise characterization of relative markedness: more-marked elements violate higher-ranked constraints (Smolensky, 1993). Nasal vowels are more marked than oral vowels because the constraint against nasal vowels is higher-ranked than the constraint against oral vowels.[44]

(44) Relative Markedness of Allophones

*VNAS "No nasal vowels."
*VORAL "No oral vowels."

*VNAS >> *VORAL "Nasal vowels are more marked than oral vowels."

This markedness hierarchy captures the correct implicational relation. A grammar that admits nasal vowels also has oral vowels, because any constraint ranked high enough to compel nasal vowels, in violation of *VNAS, must also outrank *VORAL. Conversely, domination of *VORAL does not entail domination of *VNAS, so a system with oral vowels will not necessarily have nasal vowels too.

By itself, the ranking *VNAS >> *VORAL bans nasal vowels. In Sundanese, nasal vowels do appear, but only in a specific context, after nasal consonants. Markedness constraints ban less-marked oral allophones from this specific environment, and force more-marked nasal allophones to appear. Nasal harmony is characterized here as a simple ban on oral vowels in post-nasal context, but is certainly enforced by a complex of constraints, including constraints that generalize over all types of assimilation and constraints on nasality in particular. The *NVORAL constraint in (45) stands in for this set of harmony constraints (McCarthy & Prince, 1995).

(45) Context-Sensitive Markedness

*NVORAL "No oral vowels in post-nasal context."

The prohibition against oral vowels in post-nasal context outranks the ban on nasal vowels: *NVORAL >> *VNAS. These constraints logically conflict, and with the opposite ranking nasal vowels would never surface. Since *NVORAL forces nasal spread and not any other possible alternation, *VNAS has to be dominated by certain other constraints, so that denasalization of consonants, deletion of either the nasal or the following vowel, or any

44 The apparent universality of the markedness ranking in (44) suggests that there is no constraint against oral vowels, so that *VNAS alone determines the relative markedness of oral and nasal vowels.

other possible repair of a *NVoral violation is dispreferred to nasal spread. To simplify matters, the only repair of *NVORAL violation considered here is nasalization of vowels.

The ranking *NVORAL >> *VNAS forces canonical nasal spread. When a vowel follows a nasal segment, *NVORAL forces nasality. When *NVORAL is irrelevant, lower-ranked *VNAS demands less-marked oral vowels. Faithfulness constraints play no role in the alternation. The crucially dominated IO-Faith constraint regulates nasality.

(46) IO-IDENT[NAS] “Correspondents in input-output pairs agree in nasality.”

The low rank of IO-IDENT[NAS] in Sundanese is demonstrated by the four tableaux in (47), which evaluate candidates generated from four possible inputs for [ŋãtur] ‘arrange’. In tableau (i) both input vowels are oral, in tableaux (ii-iii) the input contains one oral and one nasal vowel, and in tableau (iv) the input vowels are nasal. In each case, the grammar selects the optimal form (d) [ŋãtur], with a nasal vowel after the nasal and an oral vowel after the oral consonant. IO-IDENT[NAS] ranks below the markedness hierarchy, and all of these inputs converge on a single optimal output.

(47) Allophonic Nasal Harmony *NV$_{\text{ORAL}}$ >> *V$_{\text{NAS}}$ >> IO-IDENT[NAS]

(i) input vowels are oral

/ŋatur/	*NV$_{\text{ORAL}}$	*V$_{\text{NAS}}$	IO-IDENT[NAS]
a. ŋatur	*!		
b. ŋatũr	*!	*	*
c. ŋãtũr		**!	**
d. ☞ ŋãtur		*	*

(ii) input vowels are oral and nasal

/ŋãtur/	*NV$_{\text{ORAL}}$	*V$_{\text{NAS}}$	IO-IDENT[NAS]
a. ŋatur	*!		*
b. ŋatũr	*!	*	**
c. ŋãtũr		**!	*
d. ☞ ŋãtur		*	

(iii) input vowels are oral and nasal

/ŋatũr/	*NV$_{ORAL}$	*V$_{NAS}$	IO-IDENT[NAS]
a. ŋatur	*!		*
b. ŋatũr	*!	*	
c. ŋãtũr		**!	*
d. ☞ ŋãtur		*	**

(iv) input vowels are nasal

/ŋãtũr/	*NV$_{ORAL}$	*V$_{NAS}$	IO-IDENT[NAS]
a. ŋatur	*!		**
b. ŋatũr	*!	*	*
c. ŋãtũr		**!	
d. ☞ ŋãtur		*	*

The tableaux evaluate the same candidate set, and each tableau correctly selects optimal candidate (d). Candidates (a) and (b) have an oral vowel in a nasal context, and are eliminated by top-ranked *NVORAL. In candidate (c) both vowels are nasal, incurring gratuitous and fatal violation of *VNAS. Optimal (d) violates *VNAS minimally, just enough to satisfy higher-ranked *NVORAL.

The four tableaux in (47) differ only in the input vowels assumed. Because output-based OT cannot require vowels to be either oral or nasal in input forms, the grammar has to get the right result from any possible input vowel. It follows that IO-IDENT[NAS] is low-ranking. Comparison of candidates (c) and (d) in tableau (iii) demonstrates the ranking *VNAS >> IO-IDENT[NAS]. With this particular input, suboptimal (c) fares better on faithfulness than the optimal form does, but incurs worse violation of dominant *VNAS.

So far, I have shown that predictable nasal harmony in Sundanese is produced by the interaction of markedness constraints, which crucially rank above an IO-Faith requirement.

(48) Summary Ranking

*NVORAL >> *VNAS >> IO-IDENT[NAS]

With this basic ranking established, I turn now to the forms that disobey the canonical pattern, and show how paradigmatic identity constraints force overapplication of nasalization in infixed plurals. Nasal vowels appear in oral contexts – that is, *VNAS is violated even though *NVORAL is not relevant – when *VNAS violation increases phonological identity of morphologically-related words.

3.3 Overapplication of Nasal Spread in Infixed Plurals

Infixed plural words do not conform to the canonical nasal harmony pattern. Instead, they surface with nasal vowels in oral context.[45]

(49) Overapplication of Nasal Spread

Singular	Plural	
ɲĩãr	ɲ-ãl-ĩãr	'seek'
ɲãũr	ɲ-ãl-ãũr	'say'
mãhãl	m-ãr-ãhãl	'expensive'
ɲãʔãtkɨn	ɲ-ãr-ãʔãtkin	'dry'

The infixed plural words mimic nasality in their unaffixed bases. Nasal vowels correspond to nasal vowels, even though nasalization is phonologically conditioned only in the base. This overapplication of nasalization preserves identity in plural paradigms.

(50) *OO-correspondence*

[ɲĩãr] → [ɲ-ãl-ĩãr]

↑ ↑ *IO-correspondence*

/ ɲiar / / al + ɲiar /

The plural in (49) is faithful to a surface property of its base, the nasal vowel allophones. Since OT cannot make stipulations about input vowels, they must be allowed to be rich in noncontrastive nasality. The distribution of allophones is reliably determined only in

45 Robins (1957) reports that the vowel immediately following the plural infix is not nasal, although subsequent vowels are, as in [m-ãr-ahãl] or [ɲ-ãl-iãr]. However, in nasal airflow studies Cohn (1990) found orality only in vowels that immediately follow the trilled *ar* allomorph; vowels that follow the *al* alternant are nasalized. Orality after *ar* could be phonological – Cohn formulates a rule of denasalization, which spreads a [-nasal] feature from the trill onto the immediately following vowel. Cohn's denasalization rule could be recast in OT as a high-ranking constraint forbidding a nasal vowel after a trill. Alternatively, orality in vowels after *ar* could be a phonetic effect – lack of nasality in the vowel might reflect the lag time in lowering the velum after production of the trill. I leave this question aside, and abstract away from vocalic orality after the *ar* allomorph. This simplification of the data is irrelevant, because the second root vowel in [m-ãr-ahãl] is still forced to be nasal by the high-ranking paradigmatic identity requirement.

surface representations, where it is enforced by output constraints. If nasal vowels are reliably present only in the output [ɲĩãr], and the related infixed word is faithful to those nasal vowels, then the responsible constraints must compare two surface words. Paradigmatic identity is enforced by constraints on an output-output relation, the OO-Identity constraints.

IO-Faith and OO-Identity are distinct sets of constraints that can be ranked separately in the Sundanese grammar. The IO-Faith constraint on nasality is low-ranking; tableau (47) established that *VNAS >> IO-IDENT[NAS]. The overapplication pattern in plurals shows that OO-IDENT[NAS] is ranked higher; in (49-50), achieving identity of corresponding vowels takes precedence over avoiding nasal vowels: OO-IDENT[NAS] >> *V$_{\text{NAS}}$. Putting this all together gives the ranking in (51). Two faithfulness constraints, governing different types of relations, coexist in the nasalization hierarchy.

(51) Overapplication

*NV$_{\text{ORAL}}$, OO-IDENT[NAS] >> *V$_{\text{NAS}}$ >> IO-IDENT[NAS]

No ranking between *NVORAL and OO-IDENT[NAS] can be established on the basis of the plural paradigms (but see §3.4 below). With respect to these data, *NVORAL and the OO-Identity constraint do not conflict – optimal overapplication satisfies both constraints, as shown in tableau (52).

Paradigms are evaluated as units, in parallel, against ranked recursions of the language-particular hierarchy. To simplify the discussion and focus in on the relevant interaction, the candidate paradigms in tableau (52) vary in a limited way: root vowels are either both oral or both nasal in a given word, and the infix's vowel is always nasalized (as required by undominated *NVORAL). Also, the inputs shown have nasal vowels (irrelevantly, since IO-IDENT[NAS] is bottom-ranked). Four competitive candidate paradigms are listed above the tableau.

(52) *NV$_{\text{ORAL}}$, OO-IDENT[NAS] >> *V$_{\text{NAS}}$ >> IO-IDENT[NAS]

candidate (a) ɲiar ɲ-ãl-iar
candidate (b) ɲiar ɲ-ãl-ĩãr
candidate (c) ɲĩãr ɲ-ãl-iar
☞ candidate (d) ɲĩãr ɲ-ãl-ĩãr

Recursion (A)

/ɲĩãr/	*NV$_{\text{ORAL}}$	OO-IDENT[NAS]	*V$_{\text{NAS}}$	IO-IDENT[NAS]	>>
a. ɲiar	*!			**	
b. ɲiar	*!			**	
c. ɲĩãr			**		
d. ☞ ɲĩãr			**		

Recursion (B)

>>	/ãl + ɲĩãr/	*NV$_{\text{ORAL}}$	OO-IDENT[NAS]	*V$_{\text{NAS}}$	IO-IDENT[NAS]
	a'. ɲ-ãl-iar			*	**
	b'. ɲ-ãl-ĩãr		**	***	
	c'. ɲ-ãl-iar		**!	*	**
	d'. ☞ ɲ-ãl-ĩãr			***	

Candidates are represented discontinously across the recursive tableau, and the base is evaluated against the dominant recursion of constraints. In (52), candidates (a) and (b) are eliminated by the upper recursion of the hierarchy, by the *NVORAL violation incurred by the base [ɲiar]. Because other candidates have a more harmonic base, and better satisfy constraints in the dominant recursion, paradigms (a-b) are out of the running. In paradigm (c), nasal harmony applies normally, and all and only post-nasal vowels are nasalized, but corresponding vowels are in different environments, so (c) fatally violates the OO-Identity constraint. Candidate (d) fares worse on *VNAS than (c) does, but OO-IDENT[NAS] is dominant, and (d) is the optimal paradigm.

Recursive evaluation of paradigms plays no crucial role in overapplication patterns, because overapplication is the most harmonic way to satisfy paradigmatic identity constraints. In (52), optimal overapplication violates only *VNAS, and all other candidates violate one of the higher-ranked constraints. In particular, the identity-satisfying candidate (52a), which underapplies nasalization in the base, is ruled out by its *NVORAL violation, rather than by the recursive evaluation mechanism. As discussed in §2, the local evaluation of each paradigm member in a recursive system is essential when underapplication is optimal. It also plays a crucial in the evaluation of certain other paradigms in Sundanese, as set out shortly below.

To summarize, the allophonic oral/nasal alternation in vowels overapplies in infixed plurals under the force of an OO-Identity constraint. It is more harmonic to achieve identity of corresponding vowels in related words than to avoid marked nasality. The overapplication hierarchy is repeated in (53).

(53) Overapplication

$*NV_{ORAL}$, OO-IDENT[NAS] >> $*V_{NAS}$ >> IO-IDENT[NAS]

Two faithfulness constraints coexist in the ranking. IO-Faith is bottom-ranked, and the canonical nasalization pattern is produced from rich inputs by a dominant markedness ranking *NVORAL >> *VNAS. OO-Identity is higher-ranking, and can force markedness violations. Nasal vowels are forced to appear in non-nasal context, violating *VNAS, if nasalization satisfies the dominant OO-Identity constraint.

A ranking between OO-IDENT[NAS] and *NVORAL can be established by looking at nasality in other in Sundanese words. In particular, paradigms produced by affixes that contain nasal consonants show that the top-ranked markedness constraint, *NVORAL, can force violation of the OO-Identity constraint.

3.4 Nasality in Other Environments

Infixed plurals with root-initial nasals like [ɲ-ãl-ĩãr] are the only Sundanese words that do not obey the canonical generalizations about vowel nasalization; all other words have nasal vowels always and only in post-nasal context. Overapplication is limited to plurals for phonological reasons: the plural morpheme is the only non-nasal infix in Sundanese (Robins, 1957). Thus, no other morpheme creates the environment for overapplication by interposing an oral consonant between a root-initial nasal consonant and the root's vowels.

Obviously, misapplication identity effects are possible only if corresponding segments are in different environments, so that one correspondent conditions an alternation and the other does not. In the interesting plural paradigms, the base's vowels are post-nasal, and corresponding vowels in the derived word are not. The other important case is when the situation is reversed, and the derived word's vowels are post-nasal, but the base's vowels are not.

When an affix introduces nasality, corresponding vowels in a paradigm are not identical. Nasal harmony applies normally, affecting all and only post-nasal vowels.

(54) Identity Failure: Normal Application

Base		Derived Word	
omõŋ	'say'	paŋ-õmõŋ	'reason for saying'
dɤhɤs	'approach'	d-um-ɤ̃hɤ̃s	'approach a superior'
gəde	'big'	g-um-ə̃de	'be conceited'
saŋliŋ	'to polish'	s-in-ãŋliŋ	'to glitter'

Since all affixation triggers an OO-correspondence relation, and OO-IDENT[NAS] is high-ranking in Sundanese, the OO-Identity violations in (54) need an explanation.

Paradigmatic identity is sacrificed in (54) because oral vowels are absolutely forbidden after nasal consonants. *NVORAL is never violated in Sundanese. In (54), *NVORAL conflicts with and forces violation of the OO-Identity constraint, so it must be dominant: *NVORAL >> OO-IDENT[NAS]. Tableau (55) demonstrates this ranking in evaluation of the normal application paradigm [dɤhɤs   d-um-ɤ̃hɤ̃s] 'approach (a superior)'. The candidate set is simplified, in that all paradigms have the same base [dɤhɤs] (a candidate with a different base is considered below). Because all candidates have the same base, all of the action in (55) is in the lower-ranked recursion of constraints.

(55) $*NV_{ORAL}$ >> OO-IDENT[NAS] >> *VNAS >> IO-IDENT[NAS]

	candidate (a)	dɤhɤs	d-um-ɤhɤs
	candidate (b)	dɤhɤs	d-ũm-ɤhɤs
☞	candidate (c)	dɤhɤs	d-um-ɤ̃hɤ̃s
	candidate (d)	dɤhɤs	d-ũm-ɤ̃hɤ̃s

Recursion (A)

/dɤhɤs/	$*NV_{ORAL}$	OO-IDENT[NAS]	$*V_{NAS}$	IO-IDENT[NAS]	>>
a. dɤhɤs					
b. dɤhɤs					
c. ☞ dɤhɤs					
d. dɤhɤs					

Recursion (B)

>>	/ũm + dɤhɤs/	$*NV_{ORAL}$	OO-IDENT[NAS]	$*V_{NAS}$	IO-IDENT[NAS]
	a'. d-um-ɤhɤs	*!			*
	b'. d-ũm-ɤhɤs	*!		*	
	c'. ☞ d-um-ɤ̃hɤ̃s		**	**	***
	d'. d-ũm-ɤ̃hɤ̃s		**	***!	**

Candidate paradigms (a) and (b) satisfy OO-IDENT[NAS], because correspondent vowels in the paradigm are oral, but they fatally violate *NVORAL, because the vowels in the derived word are in a post-nasal context. Optimal paradigm (c) satisfies *NVORAL by nasalizing vowels in the infixed word and violating the lower-ranked OO-Identity constraint.

The competition between (c) and (d) is decided by *VNAS, ranked above IO-Faith. These paradigms differ only with respect to the infixal vowel; in (d) the infix's vowel is nasalized, and in optimal (c) it is not. Nasalization of the infix is not required by *NVORAL, since the infixal vowel is not post-nasal, or by the paradigmatic identity requirement, because the infix's vowel does not correspond to any base vowel. And since nasalization is not forced by any dominant constraint, it is prohibited by *VNAS. With a nasal vowel in the underlying form of the infix, tableau (55) shows that *VNAS >> IO-IDENT[NAS]: optimal (c) fares better on *VNAS and worse on IO-Faith than (d) does. Nasal spread applies normally in the optimal paradigm [dɤhɤs d-um-ɤ̃hɤ̃s], and all and only post-nasal vowels are nasalized.

Tableau (55) evaluates a limited set of candidates, those with the most harmonic base [dɤhɤs]. But paradigms are generated and evaluated in parallel, so other possible bases have to be considered. In particular, the optimal paradigm in (55c), which violates OO-IDENT[NAS], has to be compared with a candidate that satisfies OO-IDENT[NAS] by overapplying nasal spread.[46] This candidate [dɤ̃hɤ̃s d-um-ɤ̃hɤ̃s] has nasal vowels in the base of the paradigm, where they are not phonologically conditioned. Tableau (56) shows that misapplication of phonology in the base is never optimal, because it fatally violates dominant constraints.

(56) Asymmetrical Transderivational Identity

	candidate (a)	dɤ̃hɤ̃s	d-um-ɤ̃hɤ̃s
☞	candidate (b)	dɤhɤs	d-um-ɤ̃hɤ̃s

Recursion (A)

/dɤhɤs/	$*NV_{ORAL}$	OO-IDENT[NAS]	$*V_{NAS}$	IO-IDENT[NAS]	>>
a. dɤ̃hɤ̃s			**!	**	
b. ☞ dɤhɤs					

Recursion (B)

>>	/ũm + dɤhɤs/	$*NV_{ORAL}$	OO-IDENT[NAS]	$*V_{NAS}$	IO-IDENT[NAS]
	a'. d-um-ɤ̃hɤ̃s			**	***
	b'. ☞ d-um-ɤ̃hɤ̃s		**	**	***

The optimal paradigm (56b) violates OO-IDENT[NAS] to satisfy *NVORAL (as in (55)), while its competitor (56a) satisfies both of these constraints, and violates only *VNAS. Given overapplication in plurals paradigms (52), OO-IDENT[NAS] must dominate *VNAS. Normal application (52b) wins, even though it violates a dominant constraint, because the base of this paradigm is maximally harmonic. The related words are evaluated locally, and violations incurred in the base are more costly, because they are higher-ranked, than violations in the derived word. If all violations in a paradigm were counted equally in a non-recursive evaluation, the Sundanese grammar could not produce the correct result.

[46] The underapplication candidate, shown in (55a), is ruled out by its *NVORAL violation.

(57) Wrong Result from a Nonrecursive Ranking

/dɤhɤs / /um + dɤhɤs /	*NVORAL	OO-IDENT[NAS]	*VNAS	IO-IDENT[NAS]
a. 💣 dɤ̃hɤ̃s d-um-ɤ̃hɤ̃s			****	****
b. dɤhɤs d-um-ɤ̃hɤ̃s		**!	**	**

Misapplication of phonology in the base of a paradigm is universally prohibited by the recursive evaluation mechanism. In effect, recursion prevents OO-Identity constraints from forcing the base to violate other constraints, no matter how low-ranking they are. Thus, the *VNAS violation incurred by the base in (56a) is motivated solely by OO-Identity and it is fatal, even though *VNAS is lower-ranked than the OO-Identity constraint.[47]

Recursive evaluation enforces the *priority of the base* generalization, preventing satisfaction of paradigmatic identity by back-copying misapplication in the base. As discussed in §2, recursion is a significant alteration of the standard OT evaluation function, in that it allows a lower-ranked constraint to compel violation of a higher-ranked one. But it does so without undermining the established ranking, because every "paradoxical" case is one in which the lower-ranked constraint is violated in a word with *ranking priority* in the recursive grammar. The ranking priority of the base of the paradigm forces violation of the dominant constraint, and underapplication is optimal.

The ranking priority of the base reflects its morphological priority; in essence, the base is subject to a dominant recursion of constraints because it has undergone less morphological derivation. Because recursion takes over one of the roles played by serialism in traditional cyclic and stratal theories, it is important to compare the recursive system with alternatives, and this is undertaken in §3.5 below.

[47] As an alternative to the analysis in the text, it is possible to assume that the plural morpheme is associated with an OO-correspondence relation that is distinct from the OO-correspondence relation triggered by all other affixes in the language. Like English, Sundanese could instantiate two distinct paradigmatic relations, so that an OO_P-IDENT[NAS] constraint on plural paradigms ranks above *VNAS and forces overapplication, and an OO_A-IDENT[NAS] constraint proper to all other affixes ranks below *VNAS, producing canonical nasal harmony in the paradigms in (54). There is no independent evidence in support of this hypothesis (e.g., there are no misapplication effects of any kind in non-plural paradigms), so I pursue the more restrictive hypothesis that the same OO-Identity constraint is relevant to all morphological derivation in Sundanese.

Before turning to serial and other alternatives, review briefly the main points of the transderivational analysis of Sundanese. All nasality patterns are derived by the same fixed ranking.

(58) Summary Ranking

*NVORAL >> OO-IDENT[NAS] >> *VNAS >> IO-IDENT[NAS]

Canonical nasal harmony is produced by the markedness hierarchy *NVORAL >> *VNAS ranked above IO-Faith – nasal vowels appear always and only in post-nasal context, no matter which allophone the rich input presents. An OO-Identity constraint forces overapplication of harmony by dominating *VNAS. But overapplication is optimal only when the base's vowels are post-nasal and the derived word's vowel are not (as in ɲĩãr ɲ-ãl-ĩãr). When the situation is reversed (as in dɤhɤs d-um-ɤ̃hɤ̃s), normal application wins because OO-Identity ranks below *NVORAL. As discussed, recursive evaluation plays an important part in generating normal application; it rules out overapplication in the base of the paradigm (*dɤ̃hɤ̃s d-um-ɤ̃hɤ̃s), which satisfies both top-ranked constraints.

Overapplication in Sundanese is sensitive to phonological context. Nasal spread overapplies, violating one phonotactic constraint (*VNAS) unless overapplication would violate a more important phonotactic (*NVORAL). The result is that paradigmatic identity is not an across-the-board phenomenon; affixed words show a mixed pattern of overapplication and normal application. The relative importance of the phonotactic conditions (*NVORAL >> *VNAS) is constant in the Sundanese grammar; both affixed and unaffixed words evidence it. This is no coincidence – markedness rankings are not reversable in a monostratal parallel grammar. The different patterns of nasality in affixed and unaffixed words is produced by ranking two kinds of faithfulness constraints in the markedness hierarchy.

3.5 Alternatives

Four alternative analyses of the Sundanese data are considered here. These are (i) a rule-based model with cyclic rule application and/or stratification of morphological and phonological rules (§3.5.1); (ii) a theory that relies on underspecification of [±nasal] features consonants and vowels (§3.5.2); (iii) an OT analysis that avoid both cycles and transderivational relations by making use of Prince & Smolensky's Lexicon Optimization (§3.5.3); and (iv) a serial OT account, in which constraints are re-ranked at different levels of derivation (§3.5.4). I argue that the rule-based cyclic analysis is highly stipulative, the underspecification analysis entails language-particular assumptions that are unsupportable, and the Lexicon Optimization analysis entails a ranking paradox. The serial OT analysis is also rejected, on two grounds: (i) it generates several unattested patterns that are impossible to produce in the transderivational model, and (ii) it is incompatible with OT's theory of inputs and lexical forms.

3.5.1 Cycles and Strata

In Cohn's (1990) cyclic analysis of Sundanese plurals, a rule of rightward nasal spread (formulated in autosegmental representation) applies on the first cycle, targeting the post-nasal vowels in the inner morphological constituent, the root [ɲĩãr]. The same rule applies again on a second cycle, which takes place after morphological brackets are erased and the infixal material becomes available to the phonology.

(59) Cyclic Nasal Spread

Input	[al [ɲiar]]
Cycle 1 nasal spread	ɲ ĩ ã r | [+nas]
Cycle 2 nasal spread	ɲ - ãl - ĩãr | | / [+nas] [+nas]

Lexical Phonology (Pesetsky, 1979; Kiparsky, 1982ab, 1985ab; Mohanan, 1982, 1986; among others) would give Sundanese plurals a similar analysis. Morphology and

phonological components are interleaved, so that morphological operations can both precede and follow phonological operations. In Sundanese, the plural affix is absent at the first level of derivation (or absent at the first cycle of the first level), so that nasal spread at stratum 1 affects the root's vowels. When the infix becomes available at the second stratum, the rule applies again to nasalize the infix's vowel.

(60) Stratal Grammar

Stratum 1	morphology	ɲiar
	phonology	ɲĩãr
Stratum 2	morphology	ɲ-al-ĩãr
	phonology	ɲ-ãl-ĩãr

The cyclic and stratal models are fundamentally similar: their central advantage is that the nasal spread rule can be properly conditioned each time it applies. Nasal vowels surface in post-oral context because they were post-nasal at an earlier stage of derivation. There is no need to formulate a special rule to nasalize vowels in plural words; the anomalous vowels get their nasality by the regular nasal spread rule. The conditioning context of the early rule is obscured by later morphological derivation, and nasal vowels appear in post-oral context in the grammar's ultimate output.

On the cyclic/stratal analysis, the identity of the singular and plural forms is essentially epiphenomenal; it is a by-product of the serial architecture of the grammar. It may seem that paradigmatic identity comes for free in this theory, but a closer examination reveals the costs: the cyclic/stratal model is quite stipulative. For one thing, later cycles do not always respect features derived at an earlier level, so something has to be said about when and which features are preserved. Recall the English stress example introduced in §1, *órigin oríginal orìginálity*, where initial stress derived on the first cycle is not preserved in the second cycle, but peninitial stress is preserved between cycles two and three. Of course *orìginálity* is not entirely faithful to *oríginal*; these words differ in main stress and vowel quality. Determining which properties are preserved on which cycles is central to the serial enterprise.

Fixing the extent of the "preservation" or faithfulness effects between cycles is just part of the more general question: how different can the cycles or levels in a grammar be from one another? If each level is comprised of a distinct rule set (or constraint ranking), the grammar can produce as many surface patterns as it has levels. Typological predictions have to be constrained. One proposed constraint is Structure Preservation (Kiparsky, 1982), which prevents early levels from manipulating noncontrastive features (but see Borowsky for SP violations in lexical phonology). Another Kiparskian restriction on inter-level variation is the Strong Domain Hypothesis (cited in Borowsky, 1986), which holds that rules can be turned off but they cannot be turned on at later levels of derivation. Later levels consist of a subset of the rules that apply at earlier levels. Since turning off a rule often leads to preservation of the derived feature in the ultimate output,[48] the SDH explains why a complex word appears to mimic its less-complex counterpart. A level-ordered Optimality grammar captures the same facts by promoting faithfulness constraints at later levels (see §3.5.4 on serial OT), and Itô & Mester (1995) propose that this is the only way that levels or subgrammars can differ. Note however that Kiparsky's SDH and Itô & Mester's re-ranking restriction are stipulations. Why can't rules be turned on later in the derivation, or why isn't faithfulness demoted?

The cyclic/stratal theory has to stipulate how many levels there are and to what extent the levels can differ, and it also has to determine what morphological constituents undergo cycles of rules. Cycles do not apply to morphologically-bound constituents (Brame, 1974), and this has to be built into the theory. Statements like the (Revised) Alternation Condition (Kiparsky, 1968) or the Strict Cycle Condition (Kean, 1974; Mascaró, 1976; Kiparsky 1982a; see also Inkelas, 1989; Kiparsky, 1993) prevent rules from cycling on strings smaller than a word, such as bound roots or affixes (cf. Borowsky, 1986). Obviously, such stipulations are unnecessary in the transderivational approach,

[48] This is rule-based theory's "do-nothing" concept of faithfulness: as long as no rule alters the features derived at the early stage, those features survive to the surface. In fact, turning off a rule is not enough to ensure preservation, since another rule may transform the features derived by the early rule.

where "cyclic effects" are understood as a strategy to preserve identity of two related surface forms. A morphologically-bound constituent cannot be a surface form, so it cannot participate in cyclic effects.

I return to these and other arguments against the cyclic/stratal theory in §3.5.4 and again in later chapters, in discussion of an Optimality Theoretic version of the basic cyclic analysis, which shares many of the rule-based model's empirical and conceptual shortcomings.

3.5.2 Underspecification

Cycles/strata and transderivational relations could both be rendered unnecessary in Sundanese by underspecification of phonological features (Kiparsky, 1982a; Archangeli, 1984; Mester & Itô, 1988; Clements, 1988; Steriade, 1987, 1995). Many different underspecification theories have been proposed, but it is generally held that elements (typically, noncontrastive features) are underspecified in underlying (and possibly in surface) representations. Two functions of underspecification are (i) to encode markedness, such that less-marked structures have fewer features, or have their features filled in by late default rules, and (ii) to explain phonological inactivity or transparency as underspecification of features in the inert or transparent segment.

The second function of underspecification could be invoked in an analysis of Sundanese plurals. Suppose that the oral consonant of the plural infix is underspecified for its [-nasal] feature, and for this reason fails to block nasal spread onto following vowels. If this is correct, there is no need for any cyclic derivation or for a transderivational identity relation – plural words behave irregularly because the plural infix is underspecified. A simple underspecification analysis is in (61). The liquid in the plural morpheme is underspecified for a [-nasal] feature, so spreading from the root-initial nasal past the infixal consonant is possible (a). Other oral consonants are specified for [-nasal] and block spreading. Spreading nasality past a [-nasal] segment, as in the starred form in (b), violates the no-line-crossing convention (Goldsmith, 1976) and is prohibited.

(61) Underspecification

a. ɲ-ãl-ĩãr 'seek (pl)'

ɲ ã l ĩ ã r
[+nas]

b. ŋãtur 'arrange'

ŋ ã t u r
[+nas] [-nas]

*ŋ ã t ũ r
[+nas] [-nas]

The problem is that not every liquid in Sundanese can be underspecified for its [-nasal] feature. Liquids are transparent to nasal spread only when they are part of the plural morpheme. In monomorphemic words, liquids block nasal spread: [ŋũliat] 'stretch', [mãrios] 'examine'. It is not clear how morpheme-specific featural underspecification could be enforced other than by ad hoc stipulation.

The markedness-encoding function underspecification might also play a role in Sundanese, in the allophonic nasal harmony pattern. Suppose that vowels are underspecified for noncontrastive nasality in underlying forms of Sundanese, and a rule spreads [+nasal] onto post-nasal vowels. This underspecification approach is tied to a theory of markedness, in that oral vowels are considered less-marked because they have no nasal feature (or because [-nasal] is filled in by a late default rule). Note, however, that underspecification cannot be a universal theory of markedness: vowels could be underspecified for nasality in Sundanese, they cannot be underspecified in languages with contrastive nasality, where [±nasal] must be present underlyingly. If underspecification is not universal, then Sundanese vowels have to be required to be underlyingly oral by a language-particular restriction, and language-particular restrictions on inputs cannot be stated in a theory of output constraints (see Prince & Smolensky, 1993 on the *Richness of the Input*).

I conclude that an underspecification analysis of nasality in Sundanese is unprincipled. There is no plausible way to force liquids in the plural affix to be

underspecified when liquids elsewhere are not, and underspecification of nasality in vowels is inconsistent with OT's fundamental output orientation.

3.5.3 Lexicon Optimization

A third alternative approach to the Sundanese problem holds that vocalic nasality is fixed in the underlying representations of Sundanese morphemes by Lexicon Optimization (Prince & Smolensky, 1993). Speakers use the grammar to optimize the lexicon, and fix nasal vowels in the underlying form of the root [ɲĩãr] 'seek'. Overapplication in the infixed word [ɲ-ãl-ĩãr] 'seek (pl)' is faithfulness to the nasalized underlying form. If this is correct, there is no need for any intermediate stage in the derivation of the infixed word, and there is no need for a transderivational relation to explain its nasal vowels. Overapplication of nasal harmony is derived in a single input-output mapping from a nasalized underlying form.

This analysis is fatally flawed by a ranking paradox. To produce nasal vowels in the infixed word [ɲãlĩãr] directly from an optimized, nasalized input root /ɲĩãr/, faithfulness to nasality has to rank above the ban on nasal vowels: IDENT[NAS] >> *VNAS.

(62) Overapplication, with Lexicon Optimization

/al + ɲĩãr/	IDENT[NAS]	*V_{NAS}
a. ɲ-ãl-iar	***!	**
b. ☞ ɲ-ãl-ĩãr	*	*

The problem is that Lexicon Optimization is relevant only when the opposite ranking obtains: *VNAS >> IO-IDENT[NAS].

Lexicon Optimization is a system by which speakers fix rich noncontrastive properties in the underlying forms of morphemes. From the set of possible inputs that converge on some output, the input that entails the fewest lowest-ranked violations in the mapping to the output is selected as the optimal underlying form. Thus the most harmonic underlying representation of the Sundanese word [ɲĩãr] is /ɲĩãr/, with nasal vowels.

(63) Lexicon Optimization

actual output:		[ɲĩãr]
possible inputs:		
	/ɲiar/	violates IO-IDENT[NAS]
	/ɲiãr/	violates IO-IDENT[NAS]
	/ɲĩar/	violates IO-IDENT[NAS]
☞	/ɲĩãr/	satisfies IO-IDENT[NAS]

IO-Faithfulness alone determines the optimal lexical entry. Obviously, other constraints are irrelevant to optimizing the lexicon – markedness constraints like *VNAS hold over the output [ɲĩãr], not over possible inputs. IO-IDENT[NAS] is low-ranking and ineffective in the selection of the output, but it is determinate in Lexicon Optimization.

Lexicon Optimization is relevant only when multiple inputs converge on the same output form, and logically, multiple inputs converge on an output only if faithfulness is lower-ranked than markedness. In Sundanese, multiple possible inputs converge on an output like [ɲĩãr] because IO-IDENT[NAS] is low-ranking in the grammar, below *VNAS. Thus, the analysis of the Sundanese overapplication identity effect based on Lexicon Optimization entails a ranking paradox: to derive nasal vowels in oral context in plural words from optimized nasal root vowels IDENT[NAS] has to outrank *VNAS, but to derive nasal input vowels by Lexicon Optimization the opposite ranking must hold.

3.5.4 Serial Optimality Theory

Another alternative to the transderivational theory imports the core of rule-based cyclicity into constraint-based OT. The OT grammar is elaborated to allow multiple levels of derivation, each characterized by a distinct constraint ranking (see, e.g., McCarthy & Prince 1993a; Black 1993; Inkelas 1994; Kenstowicz 1995). These subgrammars are chained together in serial order, so that the optimal output of one subgrammar is input into a subsequent level of derivation.[49] At each step candidate outputs are generated and evaluated

[49] Subgrammar theory in OT does not entail serial ordering. Itô & Mester's (1995) analysis of Japanese vocabulary strata, for example, posits subgrammars that are not ordered with respect to one another (see also Inkelas, Orgun & Zoll, 1996). To produce misapplication identity effects in paradigms, however, OT levels must chained together in serial order.

in parallel, and the optimal output is selected by best-satisfaction of the ranking. Thus there is no serial ordering within any level, but there is serial ordering among the levels of derivation.

Serial OT is necessarily a theory of subgrammars, since distinct levels are invoked only when the proposed intermediate stage of derivation and the ultimate output show different phonological patterns. In misapplication or "cyclicity" cases multiple surface patterns are observed – in Sundanese, unaffixed words (ɲĩãr, dɤhɤs) reflect one pattern of nasality (all and only post-nasal vowel are nasal), and infixed plurals (ɲ-ãl-ĩãr) show a different pattern (vowels are nasal in non-nasal context). These two patterns are produced by distinct subgrammars of Sundanese.

Consider a simple serial model, in which morphologically-simplex words are derived at level 1, and complex words are produced at level 2.[50] The canonical pattern of nasal harmony is generated at the first level of derivation by the ranking *NVORAL >> *VNAS >> IDENT[NAS]. This level 1 ranking derives simplex words with nasal vowels in nasal contexts and oral vowels elsewhere from inputs that are rich in noncontrastive vocalic nasality. Possible inputs /ɲiar/, /ɲĩar/, /ɲiãr/ and /ɲĩãr/ converge on the optimal output [ɲĩãr] in (64.i), and possible inputs /dɤhɤs/, /dɤ̃hɤs/, /dɤhɤ̃s/ and /dɤ̃hɤ̃s/ converge on the optimal output [dɤhɤs] in (64.ii). Only one possible input is shown in each tableau.

(64) Level 1 *NVORAL >> *VNAS >> IDENT[NAS]

(i)

/ɲiar/	*NV$_{ORAL}$	*V$_{NAS}$	IDENT[NAS]
a. ɲiar	**!		
b. ☞ ɲĩãr		**	**

(ii)

/dɤ̃hɤ̃s/	*NV$_{ORAL}$	*V$_{NAS}$	IDENT[NAS]
a. ☞ dɤhɤs			**
b. dɤ̃hɤ̃s		**!	

[50] Further refinements of serial OT can be imagined. For instance, some morphologically complex words could be evaluated at level 1 or level 3, rather than at level 2.

This is of course the same ranking established in the analysis of allophonic harmony presented in §3.2. The difference is that here faithfulness is not relativized to different types of correspondence relations. In the serial theory there is only input-output mapping (although some inputs may be outputs), so there is only one faithfulness constraint, IDENT[NAS].

The optimal outputs produced at level 1 can be concatenated with an affix and input into a second level of derivation. IDENT[NAS] is promoted at level 2, moving up to a position above *VNAS, so that the level 2 ranking selects optimal overapplication of nasalization in the infixed plurals in (65i). But IDENT[NAS] still ranks below *NVORAL at level 2, and normal application is optimal in words with nasal affixes, as in (65ii). This is the same position in the hierarchy held by OO-IDENT[NAS] in the transderivational analysis.

(65) Level 2 *NVORAL >> IDENT[NAS] >> *VNAS

(i)

/aR/ + [ɲĩãr]	*NVORAL	IDENT[NAS]	*VNAS
a. ɲ-al-iar	*!	**	
b. ɲ-al-ĩãr	*!		**
c. ɲ-ãl-iar		**!	*
d. ☞ ɳ-ãl-ĩãr		*	***

(ii)

/um/ + [dɤhɤs]	*NVORAL	IDENT[NAS]	*VNAS
a. d-um-ɤhɤs	*!		
b. ☞ d-um-ɤ̃hɤ̃s		**	**
c. d-ũm-ɤhɤs	*!	*	*
d. d-ũm-ɤ̃hɤ̃s		***!	***

The tableaux in (65) select the correct outputs. In (i) the ranking IDENT[NAS] >> *VNAS selects overapplication, and in (ii) *NVORAL >> IDENT[NAS] generates normal application of nasal harmony. Of course it is crucial that the IDENT[NAS] constraint compares the

candidates with the input to level 2, which consists of the affix plus the surface form of the base that was output from level 1.

Like Lexical Phonology, serial OT models misapplication in paradigms by deriving morphologically-complex words in a series of steps: an unaffixed word is produced first and an affixed version is produced later, and the rules/rankings operative at each stage are different. Serial OT therefore faces many of the same questions that Lexical Phonology does: it has to decide how many levels coexist in a grammar, to what extent they differ, and which morphemes are relevant at which level. There are of course some differences between the theories. For instance, as long as OT is committed to mapping inputs onto licit output forms, the first level in an OT grammar cannot output a bound root. And if a bound root cannot be derived phonologically, a word created by affixation to a bound root cannot be forced (by promoted faithfulness) to show misapplication identity effects. Another change from traditional rule-based cyclicity is that serial OT enforces faithfulness directly, by constraints, rather than by inactivity or nonapplication of rules (see fn. 48). But serial OT does not demand paradigmatic faithfulness per se, and the IDENT[NAS] in (65) does not distingush between inputs that are lexical forms and inputs that are output from an earlier level of derivation. The fact that the plural word is like the singular's surface form is epiphenomenal; no formal connection is made between their morphological relation and their phonological similarity. Related words are similar because they are derived in serial order, and faithfulness is promoted at level 2.

Like traditional rule-based cyclic or stratal theories, serial OT sees paradigmatic identity effects as essentially accidental phenomena, produced passively by the serial derivation of morphologically-complex words. And like rule-based cyclicity, the OT version pays a price for its serialism; without further stipulation, serial OT predicts a large number of unattested grammars. In §3.5.4.2 I show that minimal re-ranking of constraints at different levels of derivation produces some highly unlikely surface patterns. In addition to its typological problems, serial OT is internally inconsistent in that it cannot support the

Richness of the Input corollary of the theory. By promoting faithfulness constraints at level 2, serial OT predicts that material input into the system at level 2 is not rich in noncontrastive properties, as discussed below.

3.5.4.1 Serial OT Cannot Maintain the *Richness of the Input* Principle

As shown, serial OT models misapplication identity effects by re-ranking a faithfulness constraint at a second level of derivation: in Sundanese, IDENT[NAS] is promoted over *VNAS. This entails that inputs to level 2 are not rich in predictable properties. In the Sundanese case it has to be stipulated that vowels in affixes are underlyingly oral, as in (65). If affixes are allowed to have underlyingly nasal vowels, as in (66), the level 2 ranking produces the wrong results. In (66.i), the plural marker /ãR/ is prefixed to a vowel-initial root, and in (66.ii) /ũm/ is infixed after an oral consonant. These affixes are introduced at level 2 in their lexical or underlying forms; that is, they have not undergone any previous derivation. Since nasality is not contrastive, the vowels in lexical forms should be allowed to vary between orality and nasality. The input affixes in (66) have nasal vowels. The input stems are the outputs selected at level 1.

(66) The Wrong Result from Rich Affixal Inputs

Level 2 *NVORAL >> IDENT[NAS] >> *VNAS

(i)

/ãR/ + [ayɨm]	*NV$_{ORAL}$	IDENT[NAS]	*V$_{NAS}$
a. ar-ayɨm		*!	
b. 💣 ãr-ayɨm			*

(ii)

/ũm/ + [dɤhɤs]	*NV$_{ORAL}$	IDENT[NAS]	*V$_{NAS}$
a. d-um-ɤ̃hɤ̃s		***!	**
b. 💣 d-ũm-ɤ̃hɤ̃s		**	***

High-ranking IDENT[NAS] produces nasal vowels in the affixes, even though the affixes surface in oral contexts, and this is not correct. Affixal vowels in Sundanese conform to the canonical nasality pattern, and are nasal always and only post-nasally.

If serial OT is committed to the output-orientation of the standard theory, it must somehow require affixes and other material introduced at later levels to have their noncontrastive features fixed in their lexical forms, contra the *Richness of the Input* principle. The transderivational theory, on the other hand, maintains OT's entailments about the lexicon by assuming that IO-correspondence and OO-correspondence relations coexist in the paradigm. The affixal vowel in [dɤhɤs d-um-ɤ̃hɤ̃s] does not correspond to any base vowel, so high-ranking OO-IDENT[NAS] is irrelevant to it. The other faithfulness constraint, IO-IDENT[NAS], ranks below the markedness hierarchy *NVORAL >> *VNAS, so the affixal vowel is nasal always and only post-nasally, no matter what its lexical form presents (see tableau (56), where the affix's input has a nasal vowel).

This argument against serial OT can be stated more generally: the theory has difficulty relating level 2 material with underlying forms. When faithfulness is promoted at level 2 (to induce a misapplication or "cyclic" effect) material that undergoes level 2 derivation only cannot be underlyingly rich in noncontrastive features, as set out above. Moreover, material that undergoes level 1 derivation has no link to its lexical form in the level 2 phonology. The candidates in (66) have to be faithful to the surface form of the base (the level 1 output), and not to the underlying form. This predicts that an affixed word is never more faithful to the underlying form than the base word is, but this situation is in fact common; for example, in cases of stem-final deletion (English *damn damnation*) the affixed word realizes material that is not present in the level 1 output. Serialists can work out solutions to this problem – e.g., some affixed words could be derived at level 1 or level 3 – but the growing apparatus begins to outweigh the elegance of the serial word formation model. I return to this argument in discussion of a serial OT analysis of cluster simplification and stress in English word formation (§5).

3.5.4.2 Typological Predictions of Serial OT

Like any theory of derivational levels, serial OT allows a potentially unlimited number of subgrammars which may differ from one another maximally. I leave aside the question of how many levels are possible; Sundanese appears to require just two levels. I focus here on the extent to which the levels of derivation may differ, and show that with minimal re-ranking of constraints, a two-level serial OT grammar can produce an unlikely variety of phonological patterns in the same language.

As set out above, serial OT models misapplication by re-ranking faithfulness constraints; in Sundanese, IDENT[NAS] is bottom-ranked at level 1 and promoted at level 2. Promotion of faithfulness is the key to serial OT analyses of cyclic effects – in fact it is only faithfulness, and never markedness, that changes its ranking position between levels. In their study of Japanese vocabulary strata, Itô & Mester (1995) propose that OT subgrammars are universally restricted such that they may differ only in the rank of faithfulness constraints. Markedness rankings are fixed across the grammar. But this is simply a stipulation, that does not follow from anything else in the subgrammar theory. If re-ranking between levels is possible at all, it is unclear why faithfulness constraints are mobile and markedness constraints are not.

Consider what happens if markedness constraints are re-ranked at different levels of derivation. Imagine a language like Sundanese, with the same level 1 ranking, but with the rank the markedness constraints reversed at level 2. Actually, two possible languages have to be considered, since IDENT[NAS] be ranked above or below the markedness constraints at the later level. In Language A, IDENT[NAS] is low-ranking at level 2.

(67) Possible Language A

level 1	*NVORAL >> *VNAS >> IDENT[NAS]
level 2	*VNAS >> *NVORAL, IDENT[NAS]

In possible Language B, IDENT[NAS] is high-ranking at level 2.

(68) Possible Language B

level 1 *NVORAL >> *VNAS >> IDENT[NAS]

level 2 IDENT[NAS] >> *VNAS >> *NVORAL

These two possible languages differ minimally from Sundanese, but they produce very different surface patterns.

Language A has the same level 1 ranking as Sundanese, so it has the same canonical nasal harmony pattern in unaffixed words. These simplex outputs can be concatenated with affixes and input into a second level of derivation, where the markedness ranking is reversed. Because the top-ranked constraint at level 2 is *VNAS, all outputs of level 2 contain oral vowels exclusively. Three tableau are presented in (69) to show each of the relevant structural configurations. In tableau (i), infixation of the plural marker after a root-initial nasal means that the base's vowels are post-nasal but the derived word's vowels are not. In tableau (ii), the plural marker is prefixed, and all vowels are in oral contexts. In tableau (iii), infixation of the nasal affix /um/ entails that the derived word's vowels are post-nasal and the base's vowels are not.

(69) Language A Low-ranking IDENT[NAS] at level 2

(i)

/aR/ + [ɲĩãr]	$*V_{NAS}$	$*NV_{ORAL}$	IDENT[NAS]
a. ☞ ɲ-al-iar		*	**
b. ɲ-al-ĩãr	**!	*	
c. ɲ-ãl-iar	*!		***
d. ɲ-ãl-ĩãr	***!		*

(ii)

/ãR/ + [ayɨm]	$*V_{NAS}$	$*NV_{ORAL}$	IDENT[NAS]
a. ☞ ar-ayɨm			*
b. ãr-ayɨm	*!		

(iii)

/ũm/ + [dɤhɤs]	$*V_{NAS}$	$*NV_{ORAL}$	IDENT[NAS]
a. ☞ d-um-ɤhɤs		**	*
b. d-um-ɤ̃hɤ̃s	**!		***
c. d-ũm-ɤhɤs	*!	**	
d. d-ũm-ɤ̃hɤ̃s	***!		**

In every case, top-ranked *VNAS dictates the optimal result, banning all nasal vowels. It makes no difference whether the output vowels are in an oral or a nasal environment; *VNAS >> *NVORAL prohibits all nasal vowels in outputs of level 2. It also doesn't matter what the output of level 1 presents, or what the lexical forms of the affixes are. Top-ranked *VNAS demands oral vowels.

If all unaffixed words are derived at level 1, and all affixed words are evaluated at level 2, then Language A produces the pattern in (70), with canonical nasal harmony in unaffixed words, and no nasal vowels at all in affixed words. This is strange, and unlikely to be attested in natural language.

(70) Results: Language A

Grammar level 1 *NVORAL >> *VNAS >> IDENT[NAS]
level 2 *VNAS >> *NVORAL >> IDENT[NAS]

Results		description
ɲĩãr	ɲ-al-iar	• Unaffixed words show canonical nasal harmony. Affixed words have no nasal vowels at all.
ayɨm	ar-ayɨm	
dɤhɤs	d-um-ɤhɤs	

In a procedural terms, nasal vowels derived by nasal harmony at level 1 are denasalized, and nasal harmony fails to apply at the second level of derivation. Obviously, unaffixed words must not be fed through the level 2 subgrammar – if they were, there would be no nasal vowels in any surface form.

Possible Language B differs from Language A in the rank of faithfulness at level 2.

(71) Possible Language B

level 1 *NVORAL >> *VNAS >> IDENT[NAS]

level 2 IDENT[NAS] >> *VNAS >> *NVORAL

Because IDENT[NAS] is highly-ranked at level 2, affixed words in Language B are faithful to the vowels presented by the output of level 1, and they are also faithful to the vowels presented in the lexical forms of affixes. The vowels output by level 1 are predictable; they show the canonical nasal harmony pattern. But the vowels in the input forms of affixes are not predictable, since the affixes have not undergone level 1 derivation. Vowels in the input form of affixes can be either oral or nasal.

Consider what Language B generates if vowels in affixes are underlyingly oral. Again, three cases are presented: (i) infixation after a root-initial nasal consonant, (ii) prefixation, and (iii) affixation of a morpheme with a nasal in it.

(72) Language B High-ranking IDENT[NAS] at level 2, oral affixes

(i)

/aR/ + [ɲĩãr]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. ɲ-al-iar	**!		*
b. ☞ ɲ-al-ĩãr		**	*
c. ɲ-ãl-iar	***!	*	
d. ɲ-ãl-ĩãr	*!	***	

(ii)

/aR/ + [ayɨm]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. ☞ ar-ayɨm			
b. ãr-ayɨm	*!	*	

(iii)

/um/ + [dɤhɤs]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. ☞ d-um-ɤhɤs			*
b. d-um-ɤ̃hɤ̃s	**!	**	
c. d-ũm-ɤhɤs	*!	*	*
d. d-ũm-ɤ̃hɤ̃s	***!	***	

In tableau (i) the level 2 ranking selects (b) [ɲ-al-ĩãr], with nasal vowels in an oral context and an oral vowel in nasal context. This could be called a "backwards application" pattern, because it is the reverse of the canonical pattern shown by the language's unaffixed words. In tableau (ii) the level 2 grammar produces an oral vowel in an oral context. But it is faithfulness, not markedness, that demands this: the *VNAS constraint responsible for orality in level 1 outputs is demoted and irrelevant at level 2 . In tableau (iii) the ranking produces underapplication: post-nasal vowels are not nasal in the affixed word because the corresponding vowels are not nasal in the unaffixed word. Identity-driven underapplication

is of course attested, but in hypothetical Language B underapplication occurs only in certain affixed words, while others show the canonical pattern and "backwards application".

The grammar produces different results if the input forms of affixes have nasal vowels in them. The tableaux in (73) show the patterns produced if affixal vowels are underlyingly nasal. Since IDENT[NAS] is top-ranked at level 2, affixed words are optimally faithful to the vowels that are input into the level 2 subgrammar.

(73) Language B High-ranking IDENT[NAS] at level 2, nasal affixes

(i)

/ãR/ + [ɲĩãr]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. ɲ-al-iar	***!		*
b. ɲ-al-ĩãr	*!	**	*
c. ɲ-ãl-iar	**!	*	
d. ☞ ɲ-ãl-ĩãr		***	

(ii)

/ãR/ + [ayɨm]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. ar-ayɨm	*!		
b. ☞ ãr-ayɨm		*	

(iii)

/ũm/ + [dɤhɤs]	IDENT[NAS]	$*V_{NAS}$	$*NV_{ORAL}$
a. d-um-ɤhɤs	*!		*
b. d-um-ɤ̃hɤ̃s	***!	**	
c. ☞ d-ũm-ɤhɤs		*	*
d. d-ũm-ɤ̃hɤ̃s	**!	***	

If affixes are assumed to have nasal vowels in their lexical forms, the level 2 ranking of Language B produces optimal overapplication of nasal harmony in (i), just like Sundanese. But note that here the infixal vowel in [ɲ-ãl-ĩãr] is nasalized by IDENT[NAS], and not *NVORAL – that is, the infix's vowel is nasal because the input happens to be nasal and not because this vowel follows a nasal consonant. Similarly in tableau (ii), a nasal vowel surfaces because it is nasal underlyingly, and even though the vowel appears in an oral context. In (iii), the grammar produces a "backwards application" pattern, with a nasal vowel in oral context and oral vowels in nasal context.

If IDENT[NAS] is high-ranking at level 2 affixed words are faithful to input vowels, whether these vowels are presented by outputs produced at level 1 or by lexical forms of affixes. Vowels presented by level 1 outputs are fixed by the level 1 subgrammar, but vowels in the lexical forms of affixes may vary between oral and nasal allophones. Depending on what affixal vowels are input into level 2, Language B generates the patterns summarized in (74).

(74) Results: Language B

Grammar	level 1	*NVORAL >> *VNAS >> IDENT[NAS]
	level 2	IDENT[NAS] >> *VNAS >> *NVORAL

i. affixal vowels are oral in inputs

Results		description
ɲĩãr	ɲ-al-ĩãr	• "backwards application": oral vowels in nasal context, nasal vowels in oral context
ayɨm	ar-ayɨm	• expected result
dɤhɤs	d-um-ɤhɤs	• underapplication: oral vowels in post-nasal context

ii. affixal vowels are nasal in inputs

Results		description
ɲĩãr	ɲ-ãl-ĩãr	• overapplication: nasal vowels in oral context
ayɨm	ãr-ayɨm	• overapplication: nasal vowels in oral context
dɤhɤs	d-ũm-ɤhɤs	• "backwards application": oral vowels in nasal context, nasal vowels in oral context

No matter what assumption is made about input vowels, the Language B grammar produces the "backwards" application pattern, in which unaffixed words show canonical nasal harmony, and affixed words show the opposite pattern. This is a clearly undesirable consequence of re-ranking at serially-ordered derivational levels.

In sum, the hypothetical Languages A and B differ minimally from Sundanese, but produce very different results. Like Sundanese, Languages A and B have just two levels of

derivation, and only three constraints are considered. But allowing even simple ranking reversals between levels can make quite a large difference in the surface patterns produced. The transderivational model is naturally much more restricted in its typological predictions. Inter- and intra-language variation is limited because a grammar consists of a single total ordering of constraints. Different types of faithfulness constraints coexist in the hierarchy, producing all and only the attested patterns: underapplication, overapplication and normal application. The "backwards application" pattern is impossible to produce, because markedness rankings cannot be reversed.

In its empirical predictions, the transderivational theory proposed here resembles a serial OT model that stipulates that only faithfulness constraints can re-rank between levels (and faithfulness is always promoted, rather than demoted, at later levels (see §5.7.2)). By recognizing distinct types of faithfulness constraints, TCT obviates the re-ranking analysis. No stipulation is required to prevent markedness reversals; it simply follows from the basic premises of the proposal.

As discussed earlier, serialism in word formation has two functions: (i) it allows outputs to be faithful to other outputs (instead of to the underlying form) and (ii) together with a "no look-ahead" provision, it enforces the PRIORITY OF THE BASE generalization, preventing a less-complex word from violating canonical generalizations in anticipation of later morphological derivation. In effect, [dɤhɤs] does not surface with nasal vowels because it is unaware that /um/ will be introduced and faithfulness will be promoted at a later level of derivation. In TCT, the serialism's first job is taken over by the constraints on an OO-Identity relation, and the second falls to the recursive evaluation mechanism. Recursion enforces the base's priority as ranking priority, rather than as "no look-ahead" serialism. Thus, the base of the paradigm [dɤhɤs d-um-ɤ̃hɤ̃s] has oral vowels, not nasal ones, because back-copying overapplication is prohibited by the recursive evaluation.

3.6 Summary

The Sundanese case study shows that paradigmatic OO-Identity constraints are distinct from IO-Faith requirements but ranked in the same grammar. The markedness ranking is fixed, and two sets of faithfulness constraints are interleaved in it.

Overapplication of nasal harmony is sensitive to phonological context: paradigmatic identity is satisfied, unless this entails realizing an oral vowel in a post-nasal context. OO-IDENT[NAS] ranks above the *VNAS ban on nasal vowels and forces overapplication of nasalization in oral contexts, but it ranks below *NVORAL, so there is normal application of nasalization in nasal contexts. IO-Faith interacts with this same *NVORAL >> *VNAS hierarchy: with IO-IDENT[NAS] ranked below the markedness constraints, the canonical nasal harmony pattern is produced from rich input representations. Because both types of faithfulness constraint interact with the same fixed markedness ranking, the Sundanese case is evidence that IO-Faith and OO-Identity are part of the same grammar.

This chapter also devoted some space to comparison of the transderivational analysis with various alternatives, particularly the more familiar serial model of word formation. I argued that a number of complications in the serial account support TCT's parallel alternative. In this dicussion only a very simple serial grammar was considered, in which all simplex words are derived at one level and all complex words are derived at another. Various enrichments of the basic serial model are discussed in following chapters.

CHAPTER 4

TIBERIAN HEBREW

4.1 Introduction

Phonology fails to apply where expected – it underapplies – to achieve paradigmatic identity in Tiberian (Masoretic) Hebrew. This case study focuses on two phonological processes, epenthesis into complex syllable margins and post-vocalic spirantization, that interact with two kinds of morphological truncation, final-vowel truncation in jussives and second person feminine singular (2fs) stems and initial-CV truncation in imperatives.[51] Epenthesis prevents tautosyllabic consonant clusters and spirantization affects post-vocalic stops everywhere except in certain truncated words, where epenthesis and spirantization are blocked. These are underapplication identity effects; phonology fails to apply so that the truncated output is more similar to its non-truncated base. Like overapplication, underapplication is produced by high-ranking constraints on an OO-correspondence relation between two output words.

In underapplication, an alternation fails to apply in a derived word because it is not conditioned in its base. Consider the Tiberian Hebrew epenthesis facts. Complex syllable margins are avoided by epenthesis generally in the language, which means that a constraint against complex margins dominates a constraint against epenthesis. The ranking *COMPLEX-CODA >> IO-DEP prevents complex codas in optimal input-output pairings. Coda clusters do occur, however, in jussive and 2fs stems, which are formed by final-V truncation. Epenthesis is expected but it fails to apply, or underapplies, in the truncated words in (75).[52]

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[51] I do not develop a theory of truncatory morphology. It makes no difference how truncation is effected (e.g., by an abstract truncation morpheme in an item-and-arrangement theory, or as a subtractive operation in an item-and-process view) as long as truncation, like other kinds of morphological derivation, triggers a phonological relation between the truncated word and its base.

[52] In these and all subsequent data, periods mark word-internal syllable boundaries.

(75) Underapplication of Epenthesis

Imperfective Base	Truncated Jussive		
yiš.bē	yišb	*yi.šeβ	'take captive'
yiɸ.tē	yiɸt	*yi.ɸeθ	'be simple'
yēš.te	yēšt	*yē.šeθ	'drink'
yiś.ṭe	yēśṭ	*yë.śeṭ	'turn aside'
1sg. Base	Truncated 2fs Verb		
kā.θaβ.tī	kā.θaβt	*kā.θa.βeθ	'I/you (f) wrote'
kā.rat.tī	kā.ratt	*kā.ra.teθ	'I/you (f) cut off'

Because epenthesis underapplies, the jussive and 2fs stems are identical to their bases (minus the morphologically-suppressed final vowel). If the constraint against coda clusters were satisfied by epenthesis, OO-Identity would suffer: the derived word would contain a segment without a correspondent in the base. In optimal paradigms, identity takes precedence over the ban on complex codas.

The ranking logic runs as follows. The suboptimal paradigm with epenthesis *[yišbē   yišeβ] satisfies *COMPLEX-CODA but violates OO-DEP because one segment in the derived word has no base correspondent. The optimal paradigm [yišbē   yišb] satisfies OO-DEP (all segments in the derived word correspond to a base segment) but has a complex coda. The ranking must be OO-DEP >> *COMPLEX-CODA. Putting this together with the ranking that induces epenthesis generally in the language, the underapplication hierarchy is OO-DEP >> *COMPLEX-CODA >> IO-DEP.

In underapplication, paradigmatic identity blocks a phonological process. An OO-Identity constraint conflicts with and forces violation of the markedness constraint responsible for the process. The underapplication ranking is a more articulated version of the overapplication hierarchy.

(76) Underapplication   OO-Identity >> M >> IO-Faith
     Overapplication   OO-Identity, M >> IO-Faith

In overapplication, no ranking can be established between OO-Identity and the markedness constraint that drives the phonology because they do not conflict; both are satisfied by optimal overapplication. In the Sundanese case, overapplication of progressive nasalization in [ŋ̃ĩãr   ŋãl̃ĩãr] satisfies both OO-IDENT[NAS] and the spread-inducing constraint

*NVORAL. Underapplication, in contrast, results when OO-Identity forces violation of an alternation-inducing markedness constraint, as OO-DEP demands a *COMPLEX-CODA violation in Tiberian Hebrew. Logically, then, underapplication is less harmonic than overapplication, because underapplication entails violation of high-ranking markedness and overapplication does not. Faced with a choice, the grammar should always choose overapplication. For underapplication to be optimal, something has to rule out the overapplication alternative.

Underapplication is made possible by evaluating each member of the paradigm separately against a recursive constraint hierarchy. When the derived word in a paradigm conditions a phonological process and its base does not, there are two ways to satisfy paradigmatic identity: (i) by underapplication of the process in the derived word, or (ii) by overapplication of the process in the base. Recursive evaluation eliminates the second option. The base always conforms to canonical patterns because it is evaluated by a dominant recursion of the constraint hierarchy. Paradigms with non-canonical phonology in the base are eliminated from competition by their high-ranking violations. Overapplication in the base is impossible, and underapplication in the derived word wins. Analyses of the underapplication patterns in Tiberian Hebrew demonstrate the crucial role played by the recursive evaluation of paradigms.

Not all jussive and 2fs stems show underapplication of epenthesis. In (77) epenthesis applies normally and paradigmatic identity is disrupted.

(77) Epenthesis Applies Normally in Truncated Words

Imperfective Base	Truncated Jussive		
yiɣ.lē	yi.ɣel	*yiɣl	'uncover'
yiβ.ne	yi.βen	*yiβn	'build'
yiβ.zē	yi.βez	*yiβz	'despise'
yiš.ʕē	yi.šaʕ	*yišʕ	'gaze'
1sg. Base	Truncated 2fs Verb		
šā.maʕ.tī	šā.ma.ʕat	*šā.maʕt	'I/you (f) heard'
šā.laħ.tī	šā.la.ħat	*šā.laħt	'I/you (f) sent'

The difference between these paradigms and the underapplicational paradigms in (75) is the composition of the stem's consonant cluster. If the consonant sequence in the base has a level or falling sonority profile, as in (75), epenthesis underapplies and the truncated word surfaces with a complex coda. But if the base's consonant sequence rises in sonority or is a guttural-obstruent sequence, as in (77), epenthesis is optimal. Thus, epenthesis underapplies in truncated jussive/2fs stems unless underapplication would produce a highly-marked coda cluster, one with a rising sonority profile or a non-final guttural consonant.

The OO-Identity constraint against epenthesis, OO-DEP, is violated in (77) under domination by markedness constraints. The rising-sonority cases show that it ranks below a sonority sequencing constraint, SON-CON ("codas do not rise in sonority"). Some coda clusters are possible in truncated words (because OO-DEP >> *COMPLEX-CODA) but only a subset of possible coda clusters, the least-marked ones, are tolerated (because SON-CON >> OO-DEP). This limitation on underapplication is The Emergence of the Relatively Unmarked (TETRU). Like The Emergence of the Unmarked (TETU) in reduplication (McCarthy & Prince, 1994a), TETRU is the emergence of less-marked structure generated by ranking two different types of faithfulness in a markedness hierarchy (see §4.3.2). Epenthesis between guttural glides and following obstruents is different, because these sequences fall in sonority and do not violate SON-CON. Epenthesis is forced in these cases by a CODACOND against gutturals, a constraint that is active across the language (McCarthy & Prince, 1993b; see §4.3.3).

The Tiberian Hebrew epenthesis facts entail a relatively complex interaction between paradigmatic identity and phonological markedness. OO-Identity takes precedence over some markedness requirements (OO-DEP >> *COMPLEX-CODA), but it is dominated by others (SON-CON, CODA-COND >> OO-DEP). As a result, epenthesis applies in truncated words only under special circumstances, to avoid the most highly-marked coda clusters. Also, it is clear from this case that words in paradigms respond to the same phonotactic

restrictions as other words: epenthesis between guttural-obstruent sequences is just the normal repair of CODACOND violations seen throughout the language, and epenthesis in rising sonority clusters reflects the universal preference for level and falling sonority codas. As members of paradigms truncated words are subject to OO-Identity constraints, but otherwise there is nothing special about their derivations. In particular, they are subject to the same markedness hierarchy that rules all Tiberian Hebrew words.

When epenthesis is forced by either SON-CON or the guttural CODACOND, another identity effect occurs: the underapplication of post-vocalic spirantization. Post-vocalic stops are generally prohibited in Tiberian Hebrew, and spirants appear instead. But in truncated jussive and 2fs stems, post-vocalic stops are forced by a high-ranking OO-Identity constraint. Failure to spirantize achieves perfect identity of correspondent segments in truncation paradigms: the coronal stop in the 2fs stem [šāmaʕat] 'you (fs) heard' is identical to its correspondent in the base [šāmaʕtī] 'I heard', even though the stop is post-vocalic in the 2fs form. As in all underapplication patterns, phonology is blocked in a derived word because it is not conditioned in its base.

This Tiberian Hebrew case shows that paradigmatic identity is not an all-or-nothing proposition. In paradigms like [šāmaʕtī šāmaʕat] identity is violated along one dimension, by the epenthetic vowel, but a different dimension of faithfulness emerges, and post-vocalic spirantization underapplies. This suggests that identity in paradigms is regulated in the same way that input-output faithfulness is regulated: by separate evaluation of each variable property of two corresponding representations.

The bulk of this chapter is devoted to the underapplication patterns in jussive and 2fs truncation paradigms. These are not, however, the only truncations in the language. Imperative stems are formed by suppression of the initial CV of the related imperfective. As shown in (78), epenthesis and spirantization apply normally in imperative paradigms, disrupting identity of related words.

(78) Imperative Truncation

Imperfective Base	Truncated Imperative		
yix.tōβ	kə.θōβ	*xtōβ	'write'
yiš.maʕ	šə.maʕ	*šmaʕ	'hear'
yiṣ.ħaq	ṣə.ħaq	*ṣħaq	'laugh'
yil.mað	l̇ə.mað	*l̇mað	'learn'

Epenthesis and spirantization apply where they are properly conditioned: all tautosyllabic clusters are avoided by epenthesis, and spirants appear always and only post-vocalically. The phonology proceeds normally, even though it compromises identity in paradigms. This means that OO-Identity constraints on imperative truncation rank lower than the markedness constraints that drive epenthesis and spirantization.

Together, the two classes of truncations present a ranking paradox. OO-Identity has to be high-ranking to force underapplication in jussive/2fs truncation (OO-Identity >> M) but low-ranking to allow normal application in imperative truncation (M >> OO-Identity). My proposal is that each class of truncation invokes a distinct OO-Identity relation. As discussed earlier, morphological derivation is subcategorized by an OO-correspondence relation. Each morpheme or morphological operation is lexically marked for an OO-correspondence relation in the same way that it is lexically marked as a prefix or suffix, or for its selectional restrictions. The Tiberian Hebrew truncation morphology that forms jussive/2fs stems triggers one correspondence relation, call it OO_J-correspondence, while imperative morphology is subcategorized by a distinct relation, OO_I-correspondence. Each relation is regulated by a full complement of identity constraints, which are distinct and separately rankable. Phonological differences between the two classes of truncated words follow from the different rank of the OO-Identity constraints proper to each class. With this further differentiation of faithfulness relations, all words are evaluated against the same fixed constraint hierarchy, and the ranking paradox is resolved.

The rest of this chapter is organized as follows. Section 4.2 introduces the class of jussive/2fs truncation. The epenthesis patterns are discussed in §4.3, spirantization is analyzed in §4.4, and §4.5 summarizes the discussion of underapplication. In §4.6,

jussive/2fs truncation is compared to imperative truncation to show that multiple OO-correspondence relations coexist in Tiberian Hebrew. Serial alternatives to the TCT analysis are considered in §4.7, and §4.8 reviews and concludes the case study.

4.2 Jussive/2fs Truncation

Two different categories are marked by truncation of a word-final vowel. Jussives are formed by truncating the final vowel of the imperfective (Prince, 1975) and second person feminine singular (2fs) verbs are marked by suppressing the final vowel of the related first person stem. Jussives and 2fs stems not only bear the same kind of subtractive morphology, they also pattern together phonologically. Both show underapplication of epenthesis and post-vocalic spirantization.

The jussives in (79) fall into two groups. In (79a), the jussive stem is identical to the imperfective base minus its morphologically-suppressed final vowel. In (79b), identity between the jussive and the imperfective is not as good – an epenthetic vowel appears in the jussive, separating consonants that are adjacent in the imperfective base. The epenthetic vowel is [e] (reduced to [ə] in open syllables) or [a] next to a guttural.

(79) Jussive Truncation

	Imperfective	Jussive	
a.	yiš.bē	yišb	'take captive'
	yiɸ.tē	yiɸt	'be simple'
	yēš.te	yēšt	'drink'
	yēβ.ke	yēβk	'weep'
	yiś.ṭe	yēśṭ	'drink'
	yaš.qe	yašq	'cause to drink'
b.	yiɣ.lē	yi.ɣel	'uncover'
	yiβ.ne	yi.βen	'build'
	tiɸ.nē	tē.ɸen	'turn'
	yiβ.zē	yi.βez	'despise'
	yiš.ʕē	yi.šaʕ	'gaze'
	not attested	yi.ħad	'rejoice'

When epenthesis does apply, as in (79b), post-vocalic spirantization fails to apply, and jussives surface with post-vocalic stops.[53]

Second person feminine singular (2fs) verbs fall into similar groups. Sometimes epenthesis occurs in the 2fs stem (80b), and sometimes epenthesis underapplies, allowing a complex coda cluster to surface (80a). The 2fs stems also show underapplication of post-vocalic spirantization: stops that follow epenthetic vowels in (80b) are not spirantized.

(80) Second Feminine Singular Truncation

	First sg. (1s)	Second fem. sg. (2fs)	
a.	kā.θaβ.tī	kā.θaβt	'I/you (f) wrote'
	kā.rat.tī	kā.ratt	'I/you (f) cut off'[54]
	First sg. (1s)	Second fem. sg. (2fs)	
b.	šā.maʕ.tī	šā.ma.ʕat	'I/you (f) heard'
	šā.laħ.tī	šā.la.ħat	'I/you (f) sent'

Some remarks on 2fs morphology are in order. According to Prince (1975:43-4, 56), 2fs subjects are marked by the suffix /-ī/ preceded by a stem augment /-t-/ or /-k-/ (the coronal marks the subject of a finite verb, and the velar appears elsewhere). Both the suffix and the augment surface word-medially – for example, when the 2fs subject is followed by object agreement, as in [kəθaβtīm] 'you (fs) wrote to them' and [kəratīm] 'you (fs) cut them (m) off' – but the suffixal vowel never appears in word-final position. The first person stems show that there is no general ban on word-final long high vowels. For this reason, and because of the underapplicational phonology in 2fs stems, Prince concludes that the 2fs suffix /-ī/ is morphologically suppressed when word-final. As shown in (80), I propose that 2fs verbs are truncated versions of first person singular (1s) stems.

[53] Only one jussive stem in (79) ends in a stop [yiħad] 'rejoice', and its imperfective base is unfortunately unattested in the records of the language. The analysis predicts that the imperfective stem is [yiħdē], with a post-consonantal, non-spirant [d]. The truncated jussive undergoes epenthesis to break up the consonant sequence, but it is faithful to its base's stop.

[54] Tiberian Hebrew orthography does not distinguish geminates from non-spirant singleton stops, so it is impossible to know whether the truncated word [kāratt] 'you (fs) cut off' in (80a) ends in a geminate or a singleton [t]. If it ends in a geminate, it shows underapplication of degemination at word edges, a process observed elsewhere in the language. If degemination applies and this word ends in an ordinary stop, then it shows underapplication of post-vocalic spirantization, a process expected in singleton (but not geminate) stops. Under any analysis, some phonological process (epenthesis, degemination or spirantization) underapplies in the 2fs stem [kāratt] under the force of OO-Identity constraints.

Naturally, Prince does not consider a relation between the 2fs stem and the 1s form. In the rule-based theory current in 1975, the deviant underapplicational phonology of 2fs stems is a by-product of rule ordering: Prince posits a late 2fs truncation rule, ordered after segholation (the general epenthesis rule) and spirantization (see §4.7). Since misapplication follows from ordering, no connection is made between the intermediate (post-spirantization but pre-truncation) stage of the 2fs derivation [kāθaβ-t-ī] and the homophonous first person output [kāθaβtī].

The core of the transderivational proposal is that phonology underapplies in 2fs stems because they are phonologically related to an output base word which does not itself condition the alternation. The first person singular (1s) stem is the base of 2fs truncation because it is the independent word identified with the string that undergoes truncation. In other words, the 1s stem is the output expected if 2fs truncation did not take place.

(81) 2fs Truncation[55]

	OO$_J$-Identity	
[kā.θaβ.tī]	→	[kā.θaβt]
↑		↑
/katab-tī/ 'I wrote'		/katab-tī-TRUNC$_{2FS}$/ 'you (fs) wrote'

This phonological paradigm raises questions about the morphological relation between these words. In derivational systems, the base of a phonological relation typically consists of a subset of the morphemes that appear in the derived word. In the case at hand, a subset relation may or may not hold. The question is whether the /tī/ sequence in the UR of each word in (81) is the same morpheme. Prince's analysis of 2fs morphology as a vocalic suffix plus a consonantal augment suggests that the /tī/ strings are not morphologically identical (although Prince does not explicitly discuss the 1s marker). However, some evidence suggests that the /tī/ strings are related: like 2fs marking, the 1s suffix shows coronal/velar allomorphy (the velar alternant shows up in the 1s free pronoun [ʔanōkī]).

[55] The stop/spirant alternation shown in (81) is analyzed in §4.4. (In fact, obstruents in the input strings may be either stops or spirants, since their [±cont] features are fully predictable from their surface positions.) A number of other phonological processes shown in the data, such as the alternations in vowel length, are not dealt with here.

One line of analysis, suggested by McCarthy (p.c.), is that Proto-Semitic agreement had a velar in 1s *[-ku] and a coronal in 2fs *[-ti], and that the coronal in the Tiberian Hebrew 1s suffix is an extension of the 2fs morphology. It is plausible, then, that the /tí/ string in each UR in (81) is the exponent of the same morpheme.

It is also plausible that the expectation of a subset relation between derived word and base is wrong, particularly in inflectional morphology. Kraska-Szlenk (1995: 108ff) presents a relevant case from Polish. The genitive of feminine diminutive stems show misapplication of a vowel height alternation in order to be more like other feminine diminutive forms. A "raising rule" takes [o] in open syllables to [u] in closed syllables. All of the feminine diminutives in (82) have a high vowel [u], even though the stem vowel in the genitive plural is in an open syllable, and is expected to be mid [o].

(82) Polish Feminine Diminutives

'cow'	Singular	Plural
Nom.	kr[u]w.ka	kr[u]w.ki
Gen.	kr[u]w.ki	<u>kr[u].wek</u>
Dat.	kr[u]w.ce	kr[u]w.kom
Acc.	kr[u]w.ke	kr[u]w.ki
Inst.	kr[u]w.ka	kr[u]w.kami
Loc.	kr[u]w.ce	kr[u]w.kach

Kraska-Szlenk proposes that misapplication of the raising rule in the genitive plural is forced by a high-ranking ROOT-IDENTITY constraint, which states that "[t]he root of every noun has to be identical to the root of the Nominative singular of the same noun." Thus closed-syllable-raising misapplies in the genitive plural [kru.wek] to make this word more like the nominative singular [kruw.ka], where the high vowel is properly conditioned.[56] These two words are not in a morphological subset relation: the nominative base [kruwka] (< /kruw + ka/) bears a suffix that does not appear in the genitive [kru.wek] (< /kruw + ek/). To the extent that Kraska-Szlenk's analysis is correct, this case shows that two words in an

56 The relevant base is the diminutive nominative singular. The non-diminutive nominative singular [kro.wa] has a mid vowel in an open syllable.

OO-correspondence relation need not be in a morphological subset relation. Further discussion of this point and other examples appear in §6 below.[57]

Return now to the focus of this introductory discussion, the similarities between jussive and 2fs stems in Tiberian Hebrew. Both are marked by final-V truncation, and both show misapplication of the same phonological processes under the same conditions: epenthesis underapplies, producing a complex coda cluster, unless that cluster rises in sonority or has a non-final guttural, and post-vocalic spirantization underapplies on stops that follow epenthetic vowels. Jussives and 2fs stems show the same surface patterns. They are a phonological class.

It is tempting to say that jussive marking and (word-final) 2fs morphology are homophonous, but neither has any phonological content of its own. Jussive and 2fs marking might be usefully thought of as a morphological class because both are word-final (suffixing) truncation processes. But by other morphological criteria they are not alike; for instance, they mark unrelated categories (mood/voice and argument agreement). The most salient parallels between jussive and 2fs stems are phonological. Both subscribe to the same phonotactic patterns, showing normal application of some phonological processes and underapplication of others.

A phonological class can be defined solely in terms of faithfulness relations. Words that enter into the same correspondence relations show the same surface patterns, obeying and disobeying the same phonotactic constraints. Three broad phonological classes of words can be identified in this way: simplex words (those that enter into IO-correspondence only); affixed or otherwise morphologically-derived words (that require OO-correspondence and IO-correspondence relations); and reduplicated words (which involve IO- OO- and BR-correspondences). Within these three classes, further distinctions can be made. Multiple IO-correspondences may be instantied to govern different classes of

57 An alternative to Kraska-Szlenk's analysis of Polish is possible: the diminutive genitive plural [kru.wek] could be related by OO-correspondence to the non-diminutive genitive plural [kruw], which has no overt agreement suffix. If this is correct, a subset relation obtains.

roots based on part-of-speech or etymology (see, e.g., Fukazawa (1997) on Japanese sublexicons). Similarly, various reduplicants in a language may subscribe to distinct BR-correspondence relations and show variation in size or shape, as demonstrated by Urbanczyk (1995, 1996).

With respect to paradigmatic relations, a phonological class is a set of words that bears morphology subcategorized by the same OO-correspondence relation. In English, words with class 2 affixes show one set of surface patterns, and words with class 1 affixes show another, because English affixes are subcategorized by distinct OO-correspondence relations. Ranked differently in a fixed markedness hierarchy, faithfulness constraints on each OO-relation produce different phonological patterns in each class of affixed words. In the English case no reliable morpho-syntactic or etymological criteria correlate with affix classhood, and I argue in §5 that affixes are grouped arbitrarily into class 1 and class 2. Similarly, Tiberian Hebrew jussive and 2fs arbitrarily comprise a phonological class apart from other morphologically derived words of the language, because jussive and 2fs paradigms are governed by the same OO_J-correspondence relation.

(83) Jussive Truncation

	OO_J-Identity	
[yiš.bē]	→	[yišb]
↑		↑
/ya-šbē/		/ya-šbē-TRUNC$_{JUS}$/

Given their dissimilar functions, it seems unlikely that morphological features can distinguish the jussive and 2fs categories from all others instantiated in the language. Thus, along with English, Tiberian Hebrew presents evidence that phonological classhood does not require any etymological, morphological, morpho-syntactic or other commonality among its members.

Under the present proposal, arbitrarily many distinct faithfulness relations can coexist in the same language. In the limit each morpheme in the lexicon can be associated

with a unique correspondence relation.[58] This freedom is constrained by learnability: morphemes class together to limit the demands on the language learner. Nevertheless, a single language may make use of a number of distinct OO-correspondence relations. In Tiberian Hebrew, truncated imperatives behave differently from the jussive/2fs truncation class, because imperative truncation is subcategorized by a distinct OO_I-correspondence relation (see §4.6). Other OO-relations are established by overt (non-truncatory) affixes; for example, infinitives formed with the prefix /la-/ mimic surface properties of imperatives (see Prince, 1975; Wilson, 1996). However, the majority of overtly affixed words do not misbehave phonologically to achieve identity with their unaffixed bases; they conform to the canonical patterns of the language. I assume there is a general OO_A-correspondence relation (where "A" stands for affix) triggered by overt non-infinitival affixes, and that the OO_A-Identity constraints on this relation are indistinguishable in rank from IO-Faith constraints. Because OO_A-Identity constraints rank equally with their IO-Faith analogues, simplex words and affixed words show the same surface patterns – the "canonical" patterns.

I return to discussion of phonological classhood in §4.6, where imperative truncation and jussive/2fs truncation are compared. But first I develop analyses of the misapplication identity effects in the class of jussive/2fs stems: §4.3 shows how OO_J-Identity constraints interact with the markedness constraints that drive epenthesis, and §4.4 analyzes the spirantization patterns.

4.3 Epenthesis

Word-final consonant clusters do not occur in non-truncated words of Tiberian Hebrew.[59] Two consonants that would otherwise be parsed tautosyllabically are separated by epenthesis. A universal markedness constraint against coda consonant clusters,

[58] It is possible that jussive and 2fs morphology trigger distinct relations, but the OO-Identity constraints on each relation have the same rank in the grammar. Since there is no evidence to the contrary, I make the simpler assumption that jussive and 2fs truncation are associated with the same relation.

[59] Except in a handful of nouns.

*COMPLEX-CODA, is high-ranking in the Tiberian Hebrew grammar, above the faithfulness constraint that penalizes epenthesis, IO-DEP. These constraints, along with the anti-deletion constraint IO-MAX, are informally defined in (84).[60]

(84) *COMPLEX-CODA "No more than one consonant may be parsed in a coda."
IO-MAX "Every input segment has an output correspondent."
IO-DEP "Every output segment has an input correspondent."

Epenthesis is induced by *COMPLEX-CODA and IO-MAX ranked above IO-DEP. Coda clusters are forbidden and deletion is impossible, so epenthesis prevails.

Epenthesis in Tiberian Hebrew is demonstrated in (85) with the monomorphemic word [sēɸer] 'book', which is related to the input root /sipr/ (compare [siɸrī] 'my book', in which the root's consonant cluster surfaces intact in a heterosyllabic parse). In the optimal output (85c) an epenthetic vowel breaks up the root's consonant cluster.[61]

(85) Epenthesis in Monomorphemic Words

*COMPLEX-CODA, IO-MAX >> IO-DEP

/sipr/	*COMPLEX-CODA	IO-MAX	IO-DEP
a. sēɸr	*!		
b. sēɸ		*!	
c. ☞ sē.ɸer			*

Candidate (85a) is faithful to the input but fatally violates the constraint against complex codas. Candidate (85b) fails to realize the root-final consonant and is eliminated by IO-MAX. Optimal (85c) satisfies both higher-ranked constraints by epenthesizing a vowel and violating IO-DEP. Complex codas are avoided by epenthesis because IO-DEP ranks below *COMPLEX-CODA.[62]

60 Many languages treat onsets and codas differently. In Tiberian Hebrew, complex codas occur in truncated words but complex onsets are prohibited absolutely. For present purposes I assume that onsets and codas are regulated by different markedness constraints. Onset/coda asymmetries can also be analyzed in terms of positional faithfulness (Beckman, 1997; Lombardi, 1995a).

61 Insertion and deletion of vowels in Tiberian Hebrew is complex, and a full analysis would go far beyond the scope of this study. I take the underlying root in (85) from Prince's work. As noted earlier, a number of phonological alternations are shown but not analyzed; these include the lowering and lengthening of the vowel in (85).

62 Word-final consonant clusters are parsed tautosyllabically as complex codas; the last consonant is not appended to a higher level of prosodic structure or parsed as the onset to a catalectic vowel. The effect of sonority sequencing in truncated words suggests that this is correct. Candidate parses with appendices are ruled out by a high-ranking *APPENDIX constraint, and catalectic parses (if they are possible) are eliminated by a HEADEDNESS constraint against empty nuclei. Also note that epenthesis occurs root-internally, and not at the end of the word (*[seɸ.rə]), because a high-ranking ANCHOR constraint demands alignment of root-edge material with a syllable edge (see §4.3.3).

Truncated jussive and 2fs stems show a different pattern, tolerating some coda clusters and prohibiting others. Epenthesis underapplies unless underapplication would produce a coda cluster with a rising sonority profile or a non-final guttural consonant. The analysis of this pattern is divided into three parts. Section 4.3.1 looks at the underapplication that produces coda clusters with level or falling sonority profiles. Section 4.3.2 analyzes the normal application of epenthesis in rising-sonority sequences, and §4.3.3 addresses the cases with guttural-obstruent clusters. I show that the OO_J-DEP constraint on truncation paradigms ranks higher in the grammar than its IO-Faith counterpart. Specifically, OO_J-DEP ranks above *COMPLEX-CODA and below two other markedness constraints, one that regulates sonority sequencing in syllable margins, and another that bans guttural glides from coda position.

4.3.1 Underapplication of Epenthesis

Epenthesis fails to apply in truncated jussive/2fs stems between consonants with a level or falling sonority profile. This observation is based on a sonority scale that partitions obstruents into two groups: from most to least sonorous, the scale is Vowel > Glide > Liquid > Nasal > Fricative > Stop. In the example in (86), an epenthetic vowel does not appear between a fricative and a less sonorous stop. Epenthesis underapplies, and the truncated word surfaces with a complex coda.

(86) *OO$_J$-Identity*

[yiš.bē] → [yišb]

IO-Faith ↑ ↑

/ya-šbē/ /ya-šbē-TRUNC/

In the base word, the consonant cluster is heterosyllabic, with the first consonant parsed as a coda and the second parsed as onset to the word-final vowel. In the truncated word, the root's final vowel is morphologically suppressed, and the consonant sequence is parsed as a complex coda. Epenthesis is expected, given the general ban on complex codas, but it fails to apply.

Underapplication of epenthesis in truncated words respects paradigmatic identity. Because epenthesis underapplies, all segments in the truncated word have correspondents in the base. If epenthesis took place and eliminated the coda cluster, an OO$_J$-DEP violation would result. Since epenthesis is not optimal, OO$_J$-DEP must outrank *COMPLEX-CODA.

Tableau (87) shows evaluation of the jussive paradigm [yiš.bē yišb] 'take captive' against ranked recursions the Tiberian Hebrew hierarchy. Each word in the paradigm is evaluated by one of the recursions; the base is evaluated against a higher-ranked recursion, and the derived word is evaluated against a lower-ranked recursion. In the candidates given in (87), an epenthetic vowel appears between the root consonants in one, both, or neither word in the paradigm.[63]

[63] Tiberian Hebrew's stop/spirant alternation is ignored in this tableau (see §4.4).
Also note that the imperfective base of jussive truncation is itself morphologically complex, bearing the imperfective prefix [yi-] (underlyingly /ya-/). The imperfective prefix triggers an OO$_A$-correspondence relation between the imperfective and a less complex base word (if any), so that the imperfective is evaluated by both OO$_A$-Identity and IO-Faith constraints. These constraints are equally ranked, and imperfectives show canonical surface phonology.

(87) Underapplication: OO$_J$-DEP >> *COMPLEX-CODA >> IO-DEP

candidate (a) [yi.šə.bē] [yi.šeb]
candidate (b) [yi.šə.bē] [yišb]
candidate (c) [yiš.bē] [yi.šeb]
☞ candidate (d) [yiš.bē] [yišb]

Recursion (A)

/ya-šbē/	OO$_J$-DEP	*COMPLEX-CODA	IO-DEP	>>
a. yi.šə.bē			*!	
b. yi.šə.bē			*!	
c. yiš.bē				
d. ☞ yiš.bē				

Recursion (B)

>>	/ya-šbē-TRUNC/	OO$_J$-DEP	*COMPLEX-CODA	IO-DEP
	a'. yi.šeb			*
	b'. yišb	*	*	
	c'. yi.šeb	*!		*
	d'. ☞ yišb		*	

Candidate paradigms (87a) and (87b) violate IO-DEP in the dominant recursion; these paradigms have less-than-optimal bases and are out of the running. Candidate paradigms (87c) and (87d) satisfy all constraints in the upper recursion, so the competition between them is decided by the lower-ranked recursion of constraints. There are no complex codas in (87c), but this paradigm fatally violates the OO-Identity constraint. The underapplication candidate (87d) satisfies OO$_J$-DEP by violating lower-ranked *COMPLEX-CODA, and it is optimal.

When a phonological process is properly conditioned in a derived word but not in its base, high-ranking OO-Identity forces underapplication of the process. To preserve identity in the paradigm, the markedness constraint that drives the process is violated. There is, however, a way to satisfy OO-Identity that does not entail a high-ranking markedness violation: in (87a) both OO$_J$-DEP and *COMPLEX-CODA are satisfied by overapplying epenthesis in the base of the paradigm. Recursion of the constraint hierarchy makes underapplication possible by ruling out this overapplication competitor. Tableau (88) shows that a non-recursive evaluation generates the incorrect result. Both candidates satisfy OO-Identity, in that all segments (except the morphologically-suppressed vowel) correspond to a segment in the related word. Candidate (88a) shows overapplication of epenthesis in the base, and (88b) shows underapplication of epenthesis in the derived word.

(88) Wrong Result from a Non-Recursive Hierarchy

/ya-sbē/	/ya-sbē-TRUNC/	OO_J-DEP	*COMPLEX-CODA	IO-DEP
a. 💣 yi.šə.bē	yi.šeb			**
b. yiš.bē	yišb		*!	

Non-recursive evaluation of paradigms can only produce the overapplication pattern (88a). It will never select underapplication (88b), because underapplication violates the markedness constraint that drives the process, while overapplication violates only low-ranking IO-Faith.

Nevertheless, if certain conditions hold – if a process is conditioned in the base but not in the derived word and OO-Identity is high-ranking – underapplication is optimal. By distinguishing where in the paradigm constraint violations are incurred, and assigning greater cost to violations in the paradigm's base, recursion prevents the "back-copying" overapplication in (88a), where epenthesis applies in the base just because epenthesis is conditioned in the truncated word. In a recursive evaluation, the base never deviates from canonical patterns to satisfy an OO-Identity requirement. The violations entailed by misapplication are always preferentially incurred in the derived word, because the derived word's violations are lower-ranked. This asymmetry, the *priority of the base*, is enforced as *ranking priority* in the recursive system. Low-ranking IO-DEP can compel violation of dominant *COMPLEX-CODA (so that (88b) bests (88a)) because the faithfulness violation is fatally incurred in the word that has ranking priority in the recursive grammar.

Briefly review the results of this section. Underapplication of epenthesis in jussive/2fs truncation paradigms is forced by a transderivational faithfulness constraint, OO_J-DEP, ranked above a markedness constraint, *COMPLEX-CODA. This OO-Identity constraint is distinct from the IO-DEP constraint on input-output relations, which ranks

below *COMPLEX-CODA, as evidenced by the general ban on complex codas and the canonical epenthesis repair observed in the language at large. Coda clusters are possible in truncated words because a faithfulness constraint proper to the OO-correspondence relation in the truncation paradigm outranks the markedness constraint.

(89) Underapplication of Epenthesis OO_J-DEP >> *COMPLEX-CODA >> IO-DEP

As discussed earlier, only a limited set of coda clusters are permitted in truncated words: the cluster must have the unmarked level or falling sonority profile expected of a syllable coda. A more specific constraint against rising sonority codas has to be satisfied, even at the expense of OO-Identity, as set out below.

4.3.2 Rising Sonority Clusters: The Emergence of the Relatively Unmarked (TETRU)

Not all truncated jussive/2fs stems show the underapplication effect. Epenthesis applies normally, where it is properly conditioned, if the base contains a consonant sequence with a rising sonority profile.[64] In (90), where the base contains a stop-liquid sequence, epenthesis avoids a complex coda in the truncated word.

(90)
OO_J-Identity
[yiɣlē] → [yiɣel]
IO-Faith ↑ ↑
/ya-glē/ /ya-glē-TRUNC/

The normal application of epenthesis in (90) disrupts identity in the paradigm. The truncated word contains a segment with no base correspondent, and OO_J-DEP is violated. A higher-ranked constraint has to compel this violation.

The descriptive generalization is simple: level or falling sonority codas are tolerated in truncated words, but rising sonority clusters are impossible. It is well established that the sonority contour of complex syllable margins is governed by a Sonority Sequencing Principle (see, e.g., Clements, 1990). In unmarked syllables, sonority rises up to the

64 The sonority scale is Vowel > Glide > Liquid > Nasal > Fricative > Stop.

syllable peak and then levels or falls off in the coda. For present purposes, I employ a sonority sequencing constraint, or a set of constraints, called SON-CON, for ‘sonority contour’. Only the condition on coda sonority is relevant here. A more refined understanding of this system of constraints would also forbid onsets that fall in sonority. (For work toward deriving sonority sequencing from primitive constraints, see Smolensky, 1995; Hironymous, 1996.)

(91) SON-CON “Syllable codas do not rise in sonority.”

Epenthesis occurs in truncated jussive/2fs stems when SON-CON demands it; that is, when failure to epenthesize entails a sonority reversal. The sonority sequencing constraint must outrank the anti-epenthesis constraint: SON-CON >> OO$_J$-DEP. Tableau (92) evaluates the jussive paradigm [yiɣ.lē yi.ɣəl] 'uncover' to make this ranking argument.

(92) Normal Application SON-CON >> OO$_J$-DEP

	candidate (a)	[yi.ɣə.lē] [yi.ɣel]
☞	candidate (b)	[yiɣ.lē] [yi.ɣel]
	candidate (c)	[yiɣ.lē] [yiɣl]

Recursion (A)

/ya-glē/	SON-CON	OO$_J$-DEP	IO-DEP	>>
a. yi.ɣə.lē			*!	
b. ☞ yiɣ.lē				
c. yiɣ.lē				

Recursion (B)

>>	/ya-glē-TRUNC/	SON-CON	OO$_J$-DEP	IO-DEP
	a’. yi.ɣel			*
	b'. ☞ yi.ɣel		*	*
	c’. yiɣl	*!		

Both (92a) and (92c) satisfy the OO-Identity constraint, while optimal (92b) does not. Candidate paradigm (92a) is the overapplication candidate, which satisfies OO$_J$-DEP by overapplying epenthesis in the base. This candidate is ruled out by the recursive ranking; it violates low-ranking IO-DEP, but incurs this violation in the dominant recursion of the constraints. Paradigm (92c) shows underapplication: OO$_J$-DEP is satisfied by failing to

epenthesize a vowel in the truncated word. Underapplication is not optimal because of the sonority profile of the consonants involved: SON-CON is fatally violated by (92c). The normal application paradigm (92b) best satisfies the ranking. OO-Identity is violated under domination by SON-CON, and epenthesis applies.

Tableau (92) shows that to generate normal application in a grammar with high-ranking OO-Identity, paradigms have to be evaluated recursively. Recursion rules out the back-copying overapplication candidate (92a) [yi.ɣə.lē yi.ɣel], which might be expected to win under the OO-Identity >> IO-Faith ranking.[65] Without recursive evaluation, epenthesis would apply in both words, even though it is conditioned in the derived word only, to satisfy the dominant OO-Identity constraint.

In sum, not all coda clusters are treated equally by the Tiberian Hebrew grammar. Some complex codas emerge in truncated words, but coda clusters that rise in sonority are absolutely prohibited, and an epenthesis repair must apply.

(93) The Emergence of the Relatively Unmarked (TETRU)

SON-CON >> OO$_J$-DEP >> *COMPLEX-CODA >> IO-DEP

The ranking in (93) generates *The Emergence of the Relatively Unmarked* (TETRU), which is similar to a reduplicative phenomenon that McCarthy & Prince (1994a) dub *The Emergence of the Unmarked* (TETU). In McCarthy & Prince's TETU theory, unmarked structure emerges in a special morphological domain through differential ranking of faithfulness constraints. A ranking of IO-Faith >> M >> BR-Identity dictates that structure marked with respect to the constraint M occurs generally in the language (because IO-Faith >> M), but M-violation is not tolerated in reduplicants (because M >> BR-Identity). An example of reduplicative TETU comes from Balangao, where coda consonants are freely allowed everywhere except in reduplicants: [tagta-tagtag, *tagtag-tagtag] (see McCarthy &

65 Direct conflict between IO-Faith and OO-Identity is not demonstrated here; their relative rank is established by the intervention of *COMPLEX-CODA. Other normal application cases show a direct conflict and ranking between IO-Faith and OO-Identity constraints (see the discussion of Tiberian Hebrew imperative truncation in §4.6 and English affixation in §5).

Prince, 1994a and §1.3.1 above). In Balangao, TETU is produced by ranking two faithfulness constraints differently with respect to a markedness requirement. IO-MAX >> NOCODA >> BR-MAX ensures that the preference for unmarked structure (here, open syllables) emerges in the reduplicative domain.

TETRU, in contrast, involves the emergence of *marked* structure, but the marked structure is restricted such that only *the least-marked of the marked* structures emerge. In Tiberian Hebrew, complex codas emerge in jussive/2fs truncation. Coda clusters are not allowed anywhere else in the language, but they can occur in truncated words because of the differential ranking of faithfulness constraints: OO_J-DEP >> *COMPLEX-CODA >> IO-DEP. This emergent markedness is of course simply the underapplication of epenthesis. But this underapplication is restricted in that only level or falling sonority clusters are allowed. The most highly-marked coda clusters, those that rise in sonority, are prohibited absolutely. Thus, some complex codas emerge in truncated words, but they are *relatively unmarked* complex codas.

Another way to describe TETRU is as the emergence of a markedness relation. A markedness relation is established by the two markedness constraints in the TETRU hierarchy, which are related to one another as specific and general: one markedness constraint penalizes a subset of the structures that are marked by the other. *COMPLEX-CODA assigns a mark to all coda clusters, while SON-CON marks only the coda clusters that rise in sonority. This establishes the markedness relation: rising sonority coda clusters are universally more marked than other coda clusters because they violate both SON-CON and *COMPLEX-CODA, while level and falling sonority coda clusters violate just *COMPLEX-CODA.[66] This markedness relation is not visible generally in Tiberian Hebrew, because no complex codas of any kind occur in non-truncated words. It emerges in truncation because

66 When a subset-of-violation relation does not obtain, a markedness relation can be established by a universal ranking of M_1 >> M_2. Thus, *LAB >> *COR defines a markedness relation even though a coronal segment does not incur a subset of the marks against a labial segment.

OO-Identity ranks above the general ban on complex codas but below the specific constraint against rising-sonority codas.

TETRU is an elaboration of underapplication identity effect; to see emergence of the relative markedness of two marked structures, one of them has to emerge in the first place, by underapplication of the expected repair. A TETRU ranking places a restriction on underapplication: marked structure emerges through underapplication, but only the less-marked members of the marked set of structure are permitted.

In this section and the preceding one I established that the avoidance of complex codas by epenthesis underapplies in truncated words because OO-Identity is dominant, except when the consonant sequence rises in sonority, and I analyzed the "except when" description as a TETRU effect. Next I turn to another set of cases in which paradigmatic identity is disrupted by epenthesis, and show that OO_J-DEP is dominated by another constraint on syllable structure.

4.3.3 Guttural Codas and ANCHORing

OO-Identity in jussive/2fs paradigms is disrupted by epenthesis when the base word contains a guttural-obstruent sequence, as in (94).

(94) Epenthesis in Falling-Sonority Guttural-Obstruent Sequences

Base	2fs Stem	
šā.maʕ.tī	šā.ma.ʕat	'I/you (f) heard'
šā.laħ.tī	šā.la.ħat	'I/you (f) sent'

Base	Jussive Stem	
*yiħ.dē (not attested)	yi.ħad	'rejoice'

Gutturals are glides, so the guttural-obstruent sequences fall in sonority. The SONCON >> OO_J-DEP ranking already established cannot be responsible for epenthesis in (94). Instead, guttural-obstruent codas are ruled out by a ban on gutturals in syllable codas. Epenthesis applies and OO-Identity is violated so that a guttural coda is avoided.

In an analysis of epenthesis in Tiberian Hebrew, McCarthy & Prince (1993b:42) demonstrate a coda condition against guttural or pharyngeal consonants (on CODA-CONDs see Itô, 1986; Prince & Smolensky, 1993; Itô & Mester, 1994). This CODA-COND demands epenthesis of the underlined vowels in (95).

(95) CODA-COND[PHAR] "Gutturals cannot be parsed as syllable codas."
*[pharyngeal])$_\sigma$

/ya-ʔsōp/	ye.ʔe.sōɸ	'he will gather'
/ya-hpōk/	ya.ha.ɸōx	'he will turn'
/ya-ʕmōd/	ya.ʕa.mōd	'he will stand'
/ya-ħzaq/	ye.ħe.zaq	'he is strong'

If it forces epenthesis, the CODA-COND against pharyngeals has to dominate anti-epenthesis constraints of the DEP family, including IO-DEP.[67]

(96) Epenthesis Avoids Guttural Codas CODACOND[PHAR] >> IO-DEP

/ya-ʔsōp/	CODACOND	IO-DEP
a. yeʔ.sōɸ	*!	
b. ☞ ye.ʔe.sōɸ		*

CODACOND dominates IO-DEP, so it is more harmonic to epenthesize a vowel and parse the guttural as its onset than to syllabify the guttural as a coda.

The CODACOND against pharyngeals is not always satisfied. Guttural codas appear if they are word-final, or root-final preceding a consonant-initial suffix.

(97)

/rēʕ/	rēʕ	'companion'
/yadaʕ-tem/	yə.ðaʕ.tem	'you knew'
/šalaħ-tī/	šā.laħ.tī	'I sent'
/šamaʕ-tī/	šā.maʕ.tī	'I heard'

McCarthy & Prince propose that these CODACOND violations are compelled by an ALIGN constraint, which requires every root to be right-aligned with some syllable.

(98) ALIGN-R "Every root is aligned at its right edge with
Align (Root, R, σ, R) the right edge of some syllable."

Parsing gutturals into codas in (97) ensures that the roots are properly right-aligned with syllables. ALIGN-R dominates and forces violation of CODACOND.

67 The example in (96) is an affixed word, related by OO_A-correspondence to an output base. Affixed words show canonical phonology because OO_A-Identity constraints have the same rank as their IO-Faith counterparts.

For reasons set out shortly below, I recast the ALIGN constraint in (98) as the ANCHOR constraint in (99). ANCHOR was introduced by McCarthy & Prince (1993a) as a family of reduplication-specific constraints that require base-initial (or final) segments to have initial (or final) correspondents in the reduplicant – the two strings must be anchored at an edge. With the development of Correspondence Theory, McCarthy & Prince suggest that some of the phenomena attributed to ALIGNment constraints should be understood as ANCHORing effects. These constraints have the general form ANCHOR(Cat_1, Cat_2, P) where Cat_1, Cat_2 range over morphological categories (root, affix word, etc.) and prosodic categories (syllable, foot, PrWd, etc.), and position P may be Initial, Final or Head. The high-ranking ANCHOR constraint in Tiberian Hebrew is (99).[68]

(99) ANCHOR(Root, σ, Final) If α is an element of S_1,
β is an element of S_2,
α and β are correspondents, and
α is final in the root,
then β is final in a syllable.

This ANCHOR constraint says that when the root-final segment has an output correspondent, that output segment is syllable-final.

ANCHOR is a faithfulness constraint; it demands faithfulness to the edgemost position of a correspondent segment. Like all faithfulness constraints, ANCHOR constraints are keyed to a particular correspondence relation – for instance, constraints that demand reduplicative anchoring are BR-ANCHOR constraints. In Tiberian Hebrew an input-output faithfulness constraint, IO-ANCHOR(Root, σ, Final), plays an active role.

IO-ANCHOR dominates and forces violation of CODACOND in the words in (97). The anti-deletion constraint IO-MAX must also be high-ranking, to prevent satisfaction of CODACOND by deletion of the guttural. Tableau (100) makes these ranking arguments with evaluation of [rēʕ] 'companion'.

68 Not all ALIGN constraints can be understood as ANCHOR requirements. As a faithfulness constraint, ANCHOR is implicated in MCat-PCat alignment effects, like the one discussed here (see also McCarthy, 1997b). Other functions of ALIGN constraints, in particular the PCat-PCat alignments that induce iterative footing (McCarthy & Prince, 1993b), cannot be subsumed under faithfulness theory.

(100) No Epenthesis Word-Finally IO-MAX, IO-ANCHOR >> CODACOND

/rēʕ/	IO-MAX	IO-ANCHOR	CODACOND
a. rē	*!		
b. rē.ʕa		*!	
c. ☞ rēʕ			*

The candidates in (100a-b) satisfy CODACOND but violate one of the higher-ranked constraints. Candidate (100a) fails to provide an output correspondent for the root-final guttural and incurs a fatal violation of IO-MAX. IO-ANCHOR is vacuously satisfied by this deletion candidate, since there is no output correspondent of the root-final segment (vacuous ANCHOR satisfaction is discussed shortly below). Candidate (100b) epenthesizes a vowel at the end of the root and violates IO-ANCHOR, since the final segment in the root, the guttural, is not final in a syllable.[69] Candidate (100c) realizes all input segments and is properly anchored, so it is optimal in spite of its guttural coda.

Gutturals are also forced into codas when a root-final guttural precedes a consonant-initial suffix, as in (101). Deletion of the guttural (101a) or epenthesis and onset syllabification of the guttural (101b) are not optimal, even though these candidates satisfy CODACOND. The CODACOND violator (101c) realizes all input segments and the root-final segment is syllable-final, so it is optimal.

(101) No Epenthesis Root-Finally before C-Initial Suffix
IO-MAX, IO-ANCHOR >> CODACOND

/šamaʕ-tī/	IO-MAX	IO-ANCHOR	CODACOND
a. šā.ma.tī	*!		
b. šā.ma.ʕa.tī		*!	
c. ☞ šā.maʕ.tī			*

Epenthesis fails to occur, and a guttural is parsed as a coda, when this leads to good ANCHORing of roots with syllables.

69 Candidate (101b) also violates IO-DEP, but this is not the fatal violation, because IO-DEP ranks below CODACOND (see (96)).

If candidates tie on dominant IO-ANCHOR, then CODACOND >> IO-DEP is decisive and epenthesis is optimal. Tableau (102) evaluates the same word shown in tableau (96). All candidates satisfy ANCHOR (the root-final labial stop is syllable-final in all candidates). CODACOND >> IO-DEP forces epenthesis between the guttural and the following obstruent.

(102) Morpheme-Internal Epenthesis
IO-MAX, IO-ANCHOR >> CODACOND >> IO-DEP

/ya-ʔsōp/	IO-MAX	IO-ANCHOR	CODACOND	IO-DEP
a. ye.sōɸ	*!			
b. ☞ ye.ʔe.sōɸ				*
c. yeʔ.sōɸ			*!	

When IO-ANCHOR does not compel its violation, CODA-COND is satisfied at the expense of IO-DEP.

Tableaux (100-102) show that when a guttural cannot be both root-final and syllable-final, epenthesis occurs. Given this analysis of epenthesis after gutturals, it is clear why epenthesis occurs in guttural-obstruent sequences in truncated jussive/2fs stems. Epenthesis avoids a CODA-COND violation. The truncation data are repeated in (103).

(103) OO_J-Identity Violation: Epenthesis in Guttural-Obstruent Sequences

UR	Base	2fs Stem		
/šamaʕ-tī/	šā.maʕ.tī	šā.ma.ʕat	*šā.maʕt	'I/you (f) heard'
/šalaħ-tī/	šā.laħ.tī	šā.la.ħat	*šā.laħt	'I/you (f) sent'

Epenthesis must take place in the 2fs stems because the CODA-COND outranks OO-Identity: CODA-COND >> OO_J-DEP. Note that ANCHOR is violated whether or not epenthesis applies, because the root-final guttural is not syllable-final in any competitive form of the 2fs word. In optimal [šā.ma.ʕat] the guttural is the onset to the epenthetic vowel, and in the closest competitor, the underapplication candidate *[šā.maʕt], the guttural is non-final in its syllable.[70] These candidates tie on ANCHOR, so the decision falls to the

70 As noted earlier, high-ranking *APPENDIX and HEADEDNESS constraints prevent the word-final consonant from being outside of syllable structure. One or both of these constraints is fatally violated by the ANCHOR satisfier *[šā.maʕ.t].

CODA-COND >> OO_J-DEP ranking, which selects the epenthetic candidate. Thus the ranking in (100-102), with OO_J-DEP bottom-ranked with IO-Faith, generates epenthesis in the truncated words in (103). Before I can demonstrate this in a tableau, one final piece of the analysis must be put into place.

Consider why ALIGN-R (98) is recast as an ANCHOR constraint (99). As noted below tableau (100), ANCHOR is vacuously satisfied by deletion of the root-final segment (when this segment is a guttural, deletion also ensures satisfaction of CODACOND). This is a crucial difference between the ANCHOR and ALIGN formulations of the active constraint: deletion of an edgemost segment violates ALIGN (McCarthy & Prince, 1993b) but it does not violate ANCHOR. That deletion violates ALIGN follows from the PARSE-FILL theory of faithfulness proposed in Prince & Smolensky (1993) and assumed in Generalized Alignment theory, with its principles of Containment (GEN cannot delete material; inputs are contained in outputs) and Consistency of Exponence (GEN cannot alter morphological analysis). With Containment, every input segment must be literally contained in the output, so deletion is underparsing by prosodic structure. A deleted segment is present in the output representation, but it is not affiliated to any prosodic position and therefore is not pronounced. For example, deletion of the guttural in the root /rēʕ/ produces the output [rē<ʕ>]. By Consistency of Exponence, the underparsed guttural is analyzed as root material, whether or not it is parsed into prosodic structure. Thus, [rē<ʕ>] violates ALIGN-R(Root, σ) because the underparsed root-final guttural is not rightmost in a syllable (it is not in any syllable at all). Under PARSE-FILL faithfulness, deletion of an edgemost segment necessarily violates ALIGN.

It is unclear how ALIGN violations should be calculated under Correspondence Theory, which allows literal deletion and insertion of segments. Depending on how the root-edge is defined, deletion of the root-final guttural in /rēʕ/ may or may not be an ALIGN-R violation. If the rightmost segment in the input form of the root has to be syllable-final, then deletion violates ALIGN-R, since the root-final segment in the input /rēʕ/ is not

syllable-final in the output [rē]. However, if it is the output form of the root that matters, then deletion does not violate ALIGN-R. In the output [rē], the vowel is syllable-final, and it is also root-final – it is not followed by any other root material. ALIGN-R should be satisfied.

Prince & Smolensky's PARSE-FILL faithfulness theory holds that input and output are two levels in the derivation of the same string – the output is the prosodified stage of the input, and the morphological analysis of the string does not change. The edges of morphological constituents are fixed, and deletion or underparsing of an edgemost segment is necessarily misaligning. Correspondence Theory, in contrast, holds that input and output are distinct strings, related to one another by a correspondence relation. If both strings have a morphological analysis, either may define the root's edge. Consequently ALIGN may or may not be violated by deletion of an edgemost segment. Recasting ALIGN constraints as ANCHOR constraints on a correspondence relation resolves the ambiguity that correspondence-based faithfulness introduces to alignment theory. As stated in (99), ANCHOR is violated only if the input (or base) segment in question has a correspondent and that correspondent is not edgemost. ANCHOR is vacuously satisfied by deletion.

The correspondence-based ANCHOR formulation makes it possible to distinguish two logically independent imperatives that are subsumed in ALIGN constraints. Since deletion is misaligning, ALIGN constraints demand that (i) an edgemost segment is realized (pronounced), and (ii) it is realized as edgemost in some domain. ANCHOR constraints enforce only provision (ii), that the correspondents of edgemost segments are themselves edgemost. Provision (i) of the ALIGN formulation, that edgemost segments be realized, is an independent requirement.

Realization of prominent elements, including edgemost segments, is enforced by Positional Faithfulness constraints (see Alderete, 1995; McCarthy, 1995; Lombardi, 1995a; and especially Beckman, in prep.). Roughly, this theory holds that elements in prominent positions are subject to special faithfulness requirements that, through ranking, ensure special treatment of prominent elements (e.g., licensing greater segmental contrasts in stressed syllables or in onsets, maintaining contrasts word-initially, preserving lexical or base prosody, etc.). Borrowing constraint names from Alderete (1995), I posit MAX and DEP constraints proper to edgemost segments. MAX-EDGE and DEP-EDGE require the segment at the edge of some domain to have a correspondent in the related string.

(104) Faithfulness to Edges

MAX-EDGE "A segment at the edge of S_1 has a correspondent in S_2."
DEP-EDGE "A segment at the edge of S_2 has a correspondent in S_1."

With a more precise formulation, MAX-EDGE and DEP-EDGE can be relativized to morphological and prosodic domains. For present purposes, the definitions in (104), which prohibit deletion and epenthesis at word edges, are sufficient.

Obviously, MAX-EDGE is violated in truncation under domination by whatever constraints force morphological shortening.[71] DEP-EDGE, on the other hand, plays a crucial role, preventing insertion of an epenthetic segment in the position vacated by the morphologically-suppressed material. This is a general result for truncation theory: because of the positional faithfulness requirements, phonological insertion cannot repair phonotactic violations produced by morphological deletion (cf. Prince & Smolensky on FREE-V in Lardil, esp. (1993:fn. 62)).

In sum, the two provisions of ALIGN constraints – 'realize the edgemost element' and 'realize the edgemost element as edgemost' – are formally distinct. The former is required by MAX/DEP-EDGE, and the latter by ANCHOR. In support of this proposal, the Tiberian Hebrew truncations shows that these two provisions interact with one another: DEP-EDGE

[71] Weeda's (1991) catalogue of morphological truncation shows that a robust class of cases, the so-called subtractive truncation patterns, typically suppress V or CV strings. Minimal violation of MAX-EDGE may be responsible for limiting morphological deletion to relatively small amounts of material.

Also note that morphological truncation is peculiarly drawn to edges – it rarely (if ever) affects word-medial material (Weeda, 1991; cf. Aronoff, 1976). It may be that a constraint demanding domain-internal CONTIGUITY (Lamontagne, 1996) prevents truncation of non-edgemost segments. If truncation is produced by concatenation of an abstract TRUNC morpheme (analogous to the RED morpheme in McCarthy & Prince's theory of reduplication), then the tendency toward edgemostness may follow from general constraints requiring prefixation or suffixation of affixal morphemes. Of course, this begs the question of why a TRUNC morpheme is not infixed, effecting deletion of word-medial material, since this could lead to better satisfaction of markedness (e.g., syllabification) constraints.

dominates and forces violation of ANCHOR. As shown below, dominant DEP-EDGE makes it impossible to avoid an ANCHOR violation by replacing the truncated vowel with an epenthetic one.

Consider a 2fs paradigm in which the base has a heterosyllabic guttural-obstruent sequence. The truncated word shows epenthesis, with the guttural parsed as an onset to the epenthetic vowel. Epenthesis disrupts paradigmatic identity: the epenthetic vowel has no correspondent in the base, in violation of OO_J-DEP.

(105) *OO_J-Identity*

[šā.maʕ.tī] → [šā.ma.ʕat]

IO-Faith ↑ ↑

/šamaʕ-tī/ /šamaʕ-t-ī-TRUNC/

Epenthesis is forced by the CODACOND against guttural codas, as shown in tableau (106). The candidate paradigms in (106) all have the base [šā.maʕ.tī], which is deemed optimal by the higher-ranked recursion of constraints (other base candidates are shown in (101) above). This base is paired with with four different forms of the truncated 2fs stem. The CODACOND against pharyngeals, ranked above OO_J-DEP, selects optimal (106d).[72]

[72] Epenthesis also violates IO-DEP, so both IO-DEP and OO_J-DEP rank below the guttural CODA-COND. In fact all of the faithfulness constraints in (106) can be either IO-Faith or OO-Identity constraints, with the same optimal result. With respect to the markedness constraint against guttural codas, OO_J-Identity constraints and IO-Faith constraints rank equally.

(106) Normal Application of Epenthesis

OO_J-MAX, OO-DEP-EDGE >> IO-ANCHOR >> CODACOND >> OO_J-DEP, IO-DEP

	candidate (b)	[šā.maʕ.tī]	[šā.maʕ]
	candidate (c)	[šā.maʕ.tī]	[šā.maʕ.ta]
	candidate (a)	[šā.maʕ.tī]	[šā.maʕt]
☞	candidate (d)	[šā.maʕ.tī]	[šā.ma.ʕat]

Recursion (A)

/šamaʕ-tī/	OO_J-MAX	OO-DEP-EDGE	IO-ANCHOR	CODA COND	OO_J-DEP
a. šā.maʕ.tī				*	
b. šā.maʕ.tī				*	
c. šā.maʕ.tī				*	
d. ☞ šā.maʕ.tī				*	

Recursion (B)

/šamaʕ-t-ī-TRUNC/	OO_J-MAX	OO-DEP-EDGE	IO-ANCHOR	CODA COND	OO_J-DEP
a'. šā.maʕ.	**!			*	
b'. šā.maʕ.ta.	*	*!		*	*
c'. šā.maʕt	*		*	*!	
d'. ☞ šā.ma.ʕat	*		*		*

Candidate paradigms (106a) and (106b) satisfy IO-ANCHOR, but violate higher-ranked constraints. Paradigm (106a) gets the root-final guttural into syllable-final position by deleting two segments from the truncated word, and fatally violates OO_J-MAX. In (106b) the base's final vowel is morphologically suppressed and an epenthetic vowel is inserted in its place. This satisfies ANCHOR, since the root-final guttural is final in the penultimate syllable, but violates dominant EDGE-DEP, since the epenthetic vowel at the word edge does not correspond to any segment in the input or the base. Together, OO_J-MAX and DEP-EDGE make it impossible for the truncated word to satisfy IO-ANCHOR. Of the ANCHOR violators in (106c-d), the ranking CODA-COND >> OO_J-DEP selects (106d), in which the guttural is parsed as an onset to an epenthetic vowel.

Epenthesis in guttural-obstruent sequences in truncated words is simply normal application of the repair of CODA-COND violations. OO_J-DEP must be ranked alongside

IO-DEP in the markedness hierarchy, below the guttural CODA-COND. Throughout the language, the CODACOND against gutturals is satisfied unless ANCHOR(Root, σ, Final) forces its violation. For truncated words, this means that it is better to epenthesize a vowel and violate paradigmatic identity than to parse a guttural as the non-final segment in a complex coda.

4.3.4 Epenthesis Summary

Expected phonology may fail under the force of paradigmatic identity requirements. In truncated jussive/2fs stems, a high-ranking OO_J-Identity constraint forces complex coda clusters to surface by blocking the epenthesis alternative. This OO_J-DEP constraint is distinct from the general anti-epenthesis constraint IO-DEP, which is roundly violated in the language. Two anti-epenthesis constraints have different rank with respect to the markedness constraint *COMPLEX-CODA in an underapplication ranking: OO-Identity >> M >> IO-Faith. Although OO_J-DEP is high-ranking in Tiberian Hebrew, it is not inviolable. It is optimally violated under domination by two markedness constraints, one that prohibits rising-sonority coda clusters, and another that bans guttural glides from coda position.

(107) Epenthesis Summary Ranking[73]

CODA-COND, SON-CON >> OO_J-DEP >> *COMPLEX-CODA >> IO-DEP

This hierarchy produces underapplication of epenthesis unless certain specific conditions hold. Epenthesis fails to prevent a complex coda except when underapplication would produce a coda cluster with rising sonority. Underapplication is also restricted by the CODA-COND against gutturals, which demands epenthesis in guttural-obstruent sequences. In truncated words, as in the rest of the language, guttural codas are marked.

73 EDGE-DEP >> ANCHOR(Root, σ, Final) stands at the top of this hierarchy, above the CODACOND.

When epenthesis is forced by CODA-COND or SON-CON, truncated jussive/2fs stems show a second underapplication identity effect: post-vocalic spirantization is blocked so that words in paradigms are more alike.

4.4 Spirantization

Truncated jussive and 2fs stems show underapplication of post-vocalic spirantization. In the language at large, non-emphatic singleton stops /p, t, k, b, d, g/ are in complementary distribution with spirants /ɸ, θ, x, β, ð, ɣ/. Spirants appear post-vocalically, and stops appear elsewhere.

(108) Post-Vocalic Spirantization

kāθaβ	'write (perf.)'	yixtōβ	'write (imperf.)'
pāɣaš	'meet (perf.)'	yiɸgaš	'meet (imperf.)'
bāħar	'choose (perf.)'	yiβħar	'choose (imperf.)'
ʔāβað	'to perish'	ʔibbað	'to kill'
qāðēš	'to be holy'	qiddaš	'to sanctify'

There are two exceptions to this generalization. One is the class of so-called opacity cases, where spirantization is triggered by a vowel that does not appear in the surface form, yielding a post-consonantal spirant. In §4.4.3, I show that opaque spirantization is not driven by paradigmatic identity. The other class of exceptions to the canonical pattern are jussive and 2fs stems. Unlike any other words of Tiberian Hebrew, truncated jussive/2fs stems can have post-vocalic stops. In the examples in (109), epenthesis takes place in the truncated word to prevent an illicit complex coda (one with a non-final guttural). As a result of the epenthesis the final consonant in the truncated word is post-vocalic, but it is not spirant. It is identical to its base correspondent, a stop.

(109) Underapplication of Spirantization

<u>1s Base</u>		<u>2fs Stem</u>	
šāmaʕtī	'I heard'	šāmaʕat	'you (fs) heard'
šālaħtī	'I sent'	šālaħat	'you (fs) sent'
<u>Imperfective Base</u>		<u>Jussive</u>	
*yiħ.dē	(not attested)	yi.ħad	'rejoice'

The failure of spirantization in (109) is identity-driven underapplication. Because spirantization does not take place, correspondent segments in related words are identical. The OO_J-IDENT[CONT] constraint that demands identity of continuancy in jussive/2fs paradigms takes precedence over constraints that require post-vocalic stops to spirantize.

The spirantization analysis proceeds as follows. The canonical stop/spirant alternation (108) is analyzed in §4.4.1, and the underapplication identity effect in truncated words (109) is examined in §4.4.2. Section 4.4.3 briefly addresses opaque spirantization, to demonstrate that the opaque phonology in Tiberian Hebrew is not driven by paradigmatic identity constraints.

4.4.1 Canonical Post-Vocalic Spirantization

I do not propose an analysis of the spirantization phenomenon – it may be spread of a vowel's [+continuant] feature onto a following stop. I focus instead on the distribution of stop and spirant allophones in Tiberian Hebrew words. In the canonical pattern, spirants appear after vowels, and stops appear elsewhere.

(110) Post-Vocalic Spirantization

kāθaβ	'write (perf.)'	yixtōβ	'write (imperf.)'
pāɣaš	'meet (perf.)'	yiɸgaš	'meet (imperf.)'
bāhar	'choose (perf.)'	yiβhar	'choose (imperf.)'

Spirantization is allophonic, predictable on purely phonological grounds. One allophone is required in a specific phonological context, and the other appears everywhere else. Like all allophonic alternations, spirantization is fully determined by markedness constraints. A context-sensitive constraint requires the more-marked allophone to appear in a specific environment, and context-free markedness demands the less-marked allophone in the general case (McCarthy & Prince, 1995).

For the purposes of this analysis, spirants are assumed to be more marked than stops. Constraints against each segment type, ranked as *SPIR >> *STOP, determine the relative markedness of the allophones.[74]

(111) Context-Free Markedness

*SPIR	"Non-strident fricatives are prohibited."
*STOP	"[-cont, -son] segments are prohibited."
*SPIR >> *STOP	"Spirants are more marked than stops."

Stops are preferred because they violate a lower-ranked constraint. Spirants appear only when forced by a constraint, or set of constraints, against stops in post-vocalic context. The *V-STOP constraint in (112) is unlikely to be a universal primitive of grammar, but for present purposes it stands in for the constraints responsible for lenition after vowels.

(112) Context-Sensitive Markedness

*V-STOP "Post-vocalic stops are prohibited."

The *V-STOP constraint has to outrank *SPIR so that spirants are optimal post-vocalically. When *V-STOP is irrelevant – when the segment is word-initial or post-consonantal – the markedness subhierarchy *SPIR >> *STOP is decisive, and less-marked stops are optimal.[75]

[74] Without an analysis of the spirantization phenomenon, the choice of a more-marked allophone is somewhat arbitrary. Unlike the case of oral and nasal vowels in Sundanese, the cross-linguistic facts are inconclusive. The standard analysis is that less-marked stops become spirants post-vocalically (see Prince (1975) and references therein), but in other languages it appears that basic spirants harden into stops (see Bakovic (1995) on Spanish fortition). Also, the analysis itself can influence the choice of a more-marked alternant; for example, if spirantization is assimilation to a [+cont] vowel, spirants could be more-marked because of the feature-sharing, rather than by a ban on non-strident fricatives.

The relative markedness of allophones has little impact on the analysis of the misapplication effect. If stops are more marked than spirants, then (i) the alternation-inducing constraint penalizes spirants that follow consonants instead of post-vocalic stops, and (ii) this *C-SPIR constraint ranks equally with OO_J-IDENT[CONT], rather than below it. Descriptively, truncation paradigms would show overapplication of a spirant-to-stop change instead of underapplication of a stop-to-spirant alternation.

[75] A full analysis of spirantization has to explain a number of other facts, including why stops become spirants and not sonorant consonants or [+strident] fricatives, and why vowel-stop sequences are not avoided by epenthesis or deletion. Constraints ranked above *SPIR must rule out all alternative repairs of *V-STOP violation.

Like all allophony, the stop/spirant alternation is fully determined by markedness. The hierarchy *V-STOP >> *SPIR >> *STOP requires more-marked spirants after vowels, and less-marked stops elsewhere. Faithfulness to the underlying form plays no role at all: spirants appear post-vocalically because markedness demands them, and not because all post-vocalic obstruents happen to be spirants in underlying forms. Markedness also demands that obstruents are stops when not post-vocalic. IO-Faith is irrelevant. The constraint on continuancy in (113) is crucially dominated in Tiberian Hebrew.

(113) Faithfulness

IO-IDENT[CONT] "Input-output correspondents are identical in [±cont]."

IO-IDENT[CONT] is bottom-ranked and never determinate. Its low rank follows from *Richness of the Input* (Prince & Smolensky 1993:191ff.), the principle that prohibits language-particular restrictions on input strings. The set of possible inputs is universal, or rich. Output-oriented OT cannot stipulate a "basic" allophone, so either allophone may be presented by the input form. Markedness constraints, ranked above faithfulness to the rich input, produce complementary distribution in output words.

The tableaux in (114) demonstrate the canonical stop/spirant alternation. They present the same candidate set, and differ only in what is posited as the input form of the word. In tableau (i) the input contains only stops, in tableau (iv) the input contains only spirants, and in tableaux (ii-iii) a mixture of input stops and spirants is presented. All of these inputs converge on the same optimal output [kāθaβ] 'write (perf.)', in which all and only post-vocalic consonants are spirant.

(114) Post-V Spirantization: *V-STOP >> *SPIR >> IO-IDENT[CONT]

(i) input stops

/katab/	*V-STOP	*SPIR	IO-IDENT[CONT]
a. kātab	**!		
b. xāθaβ		***!	***
c. ☞ kāθaβ		**	**

(ii) input stops and spirants

/xataβ/	*V-STOP	*SPIR	IO-IDENT[CONT]
a. kātab	**!		**
b. xāθaβ		***!	*
c. ☞ kāθaβ		**	**

(iii) input stops and spirants

/kaθab/	*V-STOP	*SPIR	IO-IDENT[CONT]
a. kātab	**!		*
b. xāθaβ		***!	**
c. ☞ kāθaβ		**	*

(iv) input spirants

/xaθaβ/	*V-STOP	*SPIR	IO-IDENT[CONT]
a. kātab	**!		***
b. xāθaβ		***!	
c. ☞ kāθaβ		**	*

The (a) candidate in each tableau contains three stops and fatally violates *V-STOP, since two of these stops are post-vocalic. All consonants in the (b) candidates are spirant, but the initial consonant is not post-vocalic, so it is not compelled to be spirant by *V-STOP, and the (b) candidates incur a fatal violation of *SPIR. Optimal (c) satisfies *V-STOP by minimally violating *SPIR. Violations of low-ranking IO-IDENT[CONT] are low-ranking and irrelevant.

(115) Post-Vocalic Spirantization *V-STOP >> *SPIR >> IO-IDENT[CONT]

A distinct OO_J-IDENT[CONT] constraint is ranked above this hierarchy, forcing violation of *V-STOP in truncated words, as set out below.

4.4.2 Spirantization in Truncated Words

Truncated jussive/2fs stems can surface with post-vocalic stops.

(116) Post-Vocalic Stops in Truncated Words

1s Stem		2fs Stem	
šāmaʕt͡i	'I heard'	šāmaʕat	'you (fs) heard'
šālaħt͡i	‘I sent'	šālaħat	‘you (fs) sent'

This deviation from the canonical pattern is a paradigmatic identity effect. Spirantization is blocked so that the base's stop corresponds to a stop in the truncated word.

(117) *OO_J-Identity*

[šāmaʕt͡i] → [šāmaʕat]

IO-Faith ↑ ↑

/šamaʕ-t͡i/ /šamaʕ-t͡i-TRUNC_{2FS}/

Spirantization is not conditioned in the base's post-consonantal stop, but the corresponding segment in the truncated word is post-vocalic (due to epenthesis into the guttural-obstruent sequence) and should be a spirant. Spirantization fails to apply because it is not conditioned in the base. An OO-Identity constraint takes precedence over the constraints that drive the process; specifically, OO_J-IDENT[CONT] dominates and forces violation of *V-STOP.

Paradigms are evaluated against ranked recursions of the spirantization hierarchy in tableau (118). The base is evaluated against the dominant recursion, and the derived word is assessed by the lower-ranked recursion of the constraints. In each of the candidate paradigms shown, the truncated word contains an epenthetic vowel forced by the CODACOND against guttural codas (see (106) above). These OO_J-DEP violations are ignored here, and the candidates are evaluated against the spirantization ranking.

(118) Underapplication of Spirantization

OO$_J$-IDENT[CONT] >> *V-STOP >> *SPIR >> IO-IDENT[CONT]

candidate (a) [šāmaʕθī] [šāmaʕaθ]
candidate (b) [šāmaʕtī] [šāmaʕaθ]
☞ candidate (c) [šāmaʕtī] [šāmaʕat]

Recursion (A)

/ šamaʕ-tī/	OO$_J$-IDENT[CONT]	*V-STOP	*SPIR	IO-IDENT[CONT]	>>
a. šāmaʕθī			*!	*	
b. šāmaʕtī					
c. ☞ šāmaʕtī					

Recursion (B)

>>	/ šamaʕ-tī-TRUNC$_{2fs}$/	OO$_J$-IDENT[CONT]	*V-STOP	*SPIR	IO-IDENT[CONT]
	a'. šāmaʕaθ			*	*
	b'. šāmaʕaθ	*!		*	*
	c'. ☞ šāmaʕat		*		

Candidate paradigm (118a) is eliminated by the *SPIR constraint in the dominant recursion of constraints, because its base [šāmaʕθī] contains a spirant that is not forced to appear by dominant *V-STOP. Paradigms (118b-c) have the maximally harmonic base [šāmaʕtī], and survive the dominant recursion. Candidate (118b) satisfies *V-STOP by spirantizing the final segment in the truncated form, and fatally violates the top-ranked OO-Identity constraint. Paradigm (118c) is optimal. It is more harmonic to have correspondents that match in continuancy than to avoid a post-vocalic stop.

As discussed, underapplication is produced by recursive evaluation of paradigms. In a non-recursive evaluation, the grammar incorrectly generates overapplication of spirantization in the base word, as in (119a = 118a).

(119) Wrong Result from a Non-Recursive Hierarchy

/šamaʕ-tī/ /šamaʕ-tī-TRUNC$_{2fs}$/	OO$_J$-ID[CNT]	*V-STOP	*SPIR	IO-ID[CNT]
a. 💣 šāmaʕθī šāmaʕaθ			**	**
b. šāmaʕtī šāmaʕat		*		

Both candidates satisfy OO-Identity; they differ with respect to the rest of the spirantization hierarchy. The overapplication paradigm in (a) violates low-ranked constraints, context-free markedness and IO-Faith, while underapplication (b) violates higher-ranked *V-STOP. The difference is in the location of the violation: in the failed paradigm OO-Identity constraint forces violation (of *SPIR) in the base, and in the optimal paradigm it forces the derived word to violate dominant *V-STOP. Recursive evaluation of paradigms in (118) makes the base's violation more costly, and rules out the overapplication option. The base has ranking priority, and obeys the canonical patterns of the language, so underapplication in the derived word is the only possible result.

Misapplicational spirantization in jussive/2fs stems is naturally dependent on the epenthesis pattern: when syllabic constraints (SON-CON or the CODACOND) force epenthesis in the truncated words, making them less like their bases, the importance of OO-Identity emerges in the spirantization effects. This shows that paradigmatic identity is just like input-output faithfulness, in that each dimension of the representation is evaluated by a separate faithfulness constraint. Each faithfulness constraint in the grammar interacts with the markedness constraints it comes into conflict with. In Tiberian Hebrew, two faithfulness constraints conflict with the spirantization markedness hierarchy.

(120) Underapplication of Spirantization

OO$_J$-IDENT[CONT] >> *V-STOP >> *SPIR >> IO-IDENT[CONT]

Because spirantization is allophonic, Tiberian Hebrew makes a clear case that OO-Identity is formally distinct from IO-Faith. Given the logic of an output-oriented theory, IO-IDENT[CONT] ranks at the bottom of the hierarchy, and dominant markedness derives the predictable [±cont] features in non-strident obstruents from unrestricted input strings. The OO$_J$-IDENT[CONT] constraint on paradigms ranks at the top, above the markedness constraints, so that the stop/spirant alternation fails to apply in truncated words simply because it is not properly conditioned in the base.

In §4.6 a second OO_I-IDENT[CONT] constraint, proper to a distinct OO-correspondence relation in imperative truncation paradigms, is introduced and ranked in the spirantization hierarchy. But first I briefly address another kind of exception to the canonical spirantization pattern in Tiberian Hebrew, called opaque spirantization.

4.4.3 Opaque Spirantization

In the forms in (121) spirants appear after consonants. These cases are familiarly known as *opacity effects* because, in serial terms, the conditioning context for spirantization has been eradicated, or made opaque, by further derivation (Kiparsky, 1971, 1973). In the word [malxē] 'kings', for example, the underlying vowel that conditions spirantization of the velar obstruent does not survive into the surface form. Spirantization takes place before syncope eliminates its conditioning context.[76]

(121) Opaque Spirantization

malxē	'kings'	from /malak-ē/		
bixθōβ	'when writing'	from /ba-ktő̄b/	cf. kəθōβ	'write'
liɤβūl	'to a boundary'	from /la-gbūl/	cf. gəbūl	'boundary'

Descriptively, opaque spirantization is overapplication – a process applies where it is not phonologically conditioned.[77] But opacity is not driven by paradigmatic identity. Opaque spirantization cannot be understood as an effort to maintain identity between morphologically-related words because opacity effects are not consistent across any kind of morphological paradigm.

In a procedural theory, opacity and paradigmatic overapplication get similar analyses: both involve crucial ordering of rules. In opacity, two phonological rules have to be ordered, as spirantization precedes syncope in (121): /malak-ē/ --> malax-ē --> malxē.

[76] Opaque spirantization can be conditioned by any vowel, whether epenthetic or underlying. In Prince's analysis of the opaque forms [bixθōβ] and [liɤβūl], a vowel is epenthesized before spirantization applies and is deleted afterward (1975:§1.6).

[77] Counterbleeding opacity resembles overapplication, while counterfeeding opacity looks like underapplication. In Icelandic, epenthetic high round vowels fail to trigger umlaut in preceding low vowels, even though underlying high round vowels do cause umlaut: /akr/ --> [akur], *[ökur] 'field' but /svang-u/ –> [svöngu], *[svangu] 'hungry' (Anderson, 1974). Umlaut underapplies because it is an early rule counterfed by later epenthesis.

Misapplication in a paradigm is also produced by rule-ordering, but it is an ordering between a phonological rule and a morphological rule. Underapplication of spirantization in jussive/2fs stems entails that spirantization precedes morphological truncation: the base doesn't condition spirantization, and by the time truncation takes place and epenthesis creates its environment, it is too late for spirantization to apply. Because phonology interacts with morphology in this way, surface patterns are consistent across morphological paradigms. All words that bear a certain type of morphology exhibit the same misapplication identity effects. Opacity, on the other hand, occurs haphazardly across paradigms. No matter how paradigms are defined – as "all words that bear affix α" or as "all words that contain root β" – opacity occurs sporadically.

Consider the derivatives of 'king' in (122). Only the possessed plural [malxēhem] shows an opacity effect, surfacing with a post-consonantal spirant.

(122) Opacity is Not Identity-Driven

a.	melex	'king'	malkəhem	'their (masc) king'
b.	məlāxīm	'kings'	malxēhem	'their (mascl) kings'

The singular forms in (122a) are derived from the root /malk/. In the unpossessed singular [melex] 'king', epenthesis prevents a complex coda and the post-vocalic velar is spirant, and in the possessed singular [malkəhem] 'their king' the velar is post-consonantal and a stop, as expected. The plural forms in (122b) are derived from the augmented root /malak/ (Prince, 1975). The velar is spirant in both plurals, even though it is post-consonantal in the possessed plural [malxēhem] 'their kings'.

Suppose that the overapplication of spirantization in [malxēhem] is a paradigmatic identity effect – this word misbehaves in order to maintain identity with its base [məlāxīm] 'kings'. Suppose further that morphology defines phonological paradigms as I propose it does, so that formation of the possessive by affixation triggers an OO-correspondence relation, and a high-ranking constraint on this relation forces overapplication of spirantization in the subparadigm [məlāxīm malxēhem] in (122b). But if this is true, how can spirantization apply normally and violate OO-Identity in the subparadigm [melex malkəhem] in (122a)? These words are also related by possessive affixation, and should obey the same OO-Identity requirements. In a paradigmatic analysis of the opaque "overapplication" of spirantization, it is not clear why two paradigms created by the same morphological derivation do not behave the same way.

Defining paradigms as a pair of words built from the same root is not helpful either, since spirantization sometimes overapplies and sometimes applies normally in the various words built from the root 'king'. Similarly, some but not all words built from the root 'write' show the opacity effect: [bixθōβ] 'when writing' tolerates a post-consonantal spirant, but [kəθōβ] 'write' and [lixtöβ] 'to write' do not.

In short, opaque spirantization does not reliably achieve identity between words that contain the same root or words created with the same affix. The facts do not support a principled transderivational analysis. I conclude that opaque phonology requires a separate treatment. McCarthy (1997) proposes a correspondence-based analysis of opacity effects. Briefly, Sympathy theory holds that the optimal opaque form is compared to a suboptimal member of the candidate set. The most harmonic candidate that satisfies a faithfulness constraint that the actual output violates is designated a sympathetic form, and it can influence the harmony of the output via a correspondence relation. In the Tiberian Hebrew word [malxē] 'kings of' (< /malak + e/), the opaque output is faithful to the spirant in the sympathetic candidate ❀[malaxē], which receives its reference mark by virtue of its perfect satisfaction of IO-MAX. Thus, opacity is an identity effect produced by high-ranking constraints on the sympathetic ❀-correspondence relation. The critical difference between the domain of Sympathy and that of TCT is that opaque phonological interactions are produced by a correspondence relation between *possible* outputs, while paradigmatic overapplication results from comparison of two *actual* outputs of the grammar.

4.5 Summary: Underapplication

The spirantization facts, like the epenthesis facts, show that an expected phonological alternation may fail to apply in a derived word simply because the alternation is not conditioned in the related base. Paradigmatic identity takes precedence over the constraints that induce the alternation.

The Tiberian Hebrew cases demonstrate that paradigmatic identity is regulated in surface forms, by an OO-correspondence relation. Truncated jussive/2fs stems mimic surface properties of their bases: allophonic spirantization and the absence of epenthetic vowels. The *Richness of the Input* principle makes it impossible to determine that the base's stop consonant is a stop underlyingly; rich inputs to the Tiberian Hebrew grammar may present either stops or spirants without regard to context. The [-cont] feature of the base's stop is reliably present only in the output, where it is required by an output constraint (*SPIR). The truncated word mimics this stop, so it must be related to the base's surface form. Similarly, the absence of an epenthetic vowel in the base is only reliably determined in its syllabified output. When the truncated word mimics the absence of an epenthetic vowel, it is being faithful to the base's output form.

The Tiberian Hebrew facts also show that paradigmatic identity is violable. In the epenthesis case, OO-Identity violation is forced by two markedness constraints, SON-CON and CODACOND. The latter is independently known to be active in Tiberian Hebrew, and the former is universally highly-ranked, encoding the universal dispreference for rising-sonority coda clusters. These patterns are good evidence that there is nothing special about the derivation of truncated words; that is, OO-Identity constraints interact with the same markedness constraints evidenced in input-output mappings. This follows naturally from TCT, in which there are no levels of derivation or subgrammars. All words are evaluated against the same fixed ranking of OO-Identity, IO-Faith and markedness constraints.

Paradigmatic identity in Tiberian Hebrew is not an all-or-nothing proposition. When epenthesis is forced in a truncated word (by SON-CON or CODACOND) and OO_J-

DEP is violated, another OO_J-Identity constraint asserts itself and post-vocalic spirantization underapplies. The epenthesis-spirantization interaction is evidence that paradigmatic identity, like input-output faithfulness, is regulated by a full complement of faithfulness constraints on independent aspects of the representation.

Finally, the underapplication cases show the need for recursive evaluation of paradigms. Because underapplication involves a conflict between OO-Identity and high-ranking markedness, and overapplication does not, underapplication is possible only if overapplication entails non-canonical phonology in the base. The base is evaluated against a dominant recursion of constraints, so paradigms with non-canonical bases can never be optimal. If the choice is between overapplication in the base and underapplication in the derived word, recursion ensures that underapplication is the only possible outcome.

4.6 Imperative Truncation

I turn now to another set of Tiberian Hebrew truncated words, the imperatives, which show different surface patterns than jussive/2fs stems. In particular, imperatives do not show underapplication of epenthesis and spirantization. They do, however, show misapplication of other processes, including nasal-stop assimilation, vowel-glide coalescence and a vowel raising rule. My proposal is that imperative truncation and jussive/2fs truncation trigger distinct OO-correspondence relations. Ranked differently in the same markedness hierarchy, constraints on each of these OO-correspondence relations derive the different surface patterns shown by each class of truncated words.

Imperatives are formed by suppressing the initial-CV of the related imperfective (Prince, 1975). Epenthesis and post-vocalic spirantization apply normally in imperative paradigms: all complex syllable margins are prevented by epenthesis, and all and only post-vocalic stops are spirantized. As a result of normal application of the phonology, the imperatives in (123) are not identical to the final string of their imperfective bases.

(123) Imperative Truncation

Root	Imperfective	Imperative	
/ktb/	yixtōβ	kəθōβ	'write'
/šmʕ/	yišmaʕ	šəmaʕ	'hear'
/ṣḥq/	yiṣḥaq	ṣəḥaq	'laugh'
/lmd/	yilmað	ləmað	'learn'

Imperative morphology suppresses the initial-CV of the imperfective base, and phonology applies to make the related words even less alike. Consider the paradigm in (124).

(124) Imperative Truncation

OO_I-Identity

yixtōβ → kəθōβ

↑ ↑

/ya-ktōb/ /TRUNC$_{IMP}$ - ya-ktōb/

The first two base segments have no correspondents in the truncated word, as a result of morphological truncation. The next two base segments [xt] have correspondents in the truncated word, but not faithful ones: their correspondents are non-adjacent, and unfaithful in [±continuant] features. Epenthesis applies to prevent a complex onset and separates the coronal and velar obstruents in the truncated word. Spirantization also applies where it is properly conditioned, affecting all and only post-vocalic obstruents, so that the base's [x] and [t] correspond to [k] and [θ], respectively. Identity is not optimal in (124); the markedness constraints that drive epenthesis and spirantization force violation of paradigmatic identity requirements.

In fact, there is no evidence in (123-124) that imperatives are derived from prefixed imperfectives rather than directly from the underlying root. Since paradigmatic identity is not decisive, it is not obvious that imperatives enter into an OO-correspondence relation with imperfectives. There are, however, imperative paradigms that demonstrate the OO_I-correspondence relation. Three misapplication identity effects observed by Prince (1975) are described in §4.6.1. Once it is established that imperatives are truncated versions of imperfectives, I focus in §4.6.2 on the spirantization facts, and argue that imperative morphology triggers an OO_I-correspondence relation that is distinct from the OO_J-correspondence relation in jussive/2fs paradigms. Two OO-Identity constraints on [±cont] features rank differently in the spirantization hierarchy. The OO_J-IDENT[CONT] constraint on jussive/2fs paradigms is high-ranking and forces underapplication of spirantization, while the OO_I-IDENT[CONT] constraint is low-ranking and allows identity-disrupting normal application in imperatives paradigms. The two types of truncating morphology are subcategorized by distinct OO-correspondence relations. Section 4.6.3 considers some of the implications of this proposal.

4.6.1 Imperatives are Truncated Words

Under certain conditions, misapplication identity effects are forced by the OO_I-Identity constraints on imperative paradigms. Three patterns described by Prince (1975) show that imperatives are truncated versions of the related imperfective stem, and not simply generated from underlying roots. Imperatives are faithful to surface properties of the imperfective, and phonology over- or underapplies.

One misapplication pattern involves imperatives of glide-initial roots. The paradigms in (125) show overapplication of a coalescence process that blends a low vowel and a high glide into a long mid vowel, [ay] --> [ē̌].

(125) Overapplication of Coalescence

	Imperfective	Imperative	
/ya + ydaʕ/ >	yēðaʕ	daʕ	'know'
/ya + ysēb/ >	yēšēβ	šēβ	'dwell'

In the imperfective base stems, the low vowel of the imperfective prefix /ya-/ coalesces with the root-initial glide. Truncatory imperative morphology suppresses the initial CV of the imperfective, producing a biconsonantal imperative stem. The absence of the root-initial glide in the imperative is overapplication – the imperative does not condition coalescence, since it does not have a prefixal low vowel, but coalescence nevertheless obliterates the root-initial glide. Very simply, the root-initial glide cannot appear in the imperative because it does not appear in the imperfective base.

In Prince's rule-ordering analysis (1975:121ff.), coalescence precedes imperative truncation.

(126) Rule Ordering: Coalescence Precedes Truncation

UR	/ya + ydaʕ/
coalescence	yēdaʕ
truncation	daʕ
Imperative SR	daʕ

If this order is reversed, as in (127a) below, or if imperatives are derived directly from the underlying root without the imperfective prefix, as in (127b), loss of the root-initial glide is unexplained. Instead, a triconsonantal imperative is expected.[78]

(127) Failed Rule-Base Alternatives

a. Truncation Precedes Coalescence

UR	/ya + ydaʕ/
truncation	ydaʕ
coalescence	
epenthesis	yədaʕ
Imperative SR	*yədaʕ

b. Imperative Derived from Root UR

UR	/ydaʕ/
epenthesis	yədaʕ
Imperative SR	*yədaʕ

In a rule-based analysis, imperatives are derived from the related imperfective and not generated directly from the underlying root because coalescence of the imperfective prefix and the root-initial glide has to precede imperative truncation.

In non-serial TCT, imperatives are "derived from" or related to both the input root and the imperfective output base. The imperatives in (125) are more faithful to the imperfective base than to the underlying root because constraints on the OO_I-correspondence relation outrank IO-Faith constraints.

Without developing a full analysis of the coalescence pattern, it can be shown how OO_I-Identity takes precedence over IO-Faithfulness. OO_I-DEP has to be ranked above IO-MAX ensures that [yēðaʕ daʕ] is a better imperative paradigm than its competitor *[yēðaʕ yəðaʕ], in which the truncated word is more faithful to the underlying root (by realizing the root-initial glide). To aid in the exposition, these candidates are presented schematically, with arbitrary subscripts indicating the IO-correspondences between

[78] Epenthesis satisfies the undominated ban on complex onsets.

segments. OO-correspondences are not explicitly indicated in (128). IO- and OO-correspondence relations are formally distinct, so a different set of subscripts would be required to indicate the OO-relations in the optimal paradigm [y$_a$ē$_b$ð$_c$a$_d$ʕ$_e$ ð$_c$a$_d$ʕ$_e$] and the failed paradigm [y$_a$ē$_b$ð$_c$a$_d$ʕ$_e$ yəð$_c$a$_d$ʕ$_e$].

(128) Two Candidate Paradigms

(a) the optimal paradigm y$_1$ē$_{2,3}$ð$_4$a$_5$ʕ$_6$ → d$_4$a$_5$ʕ$_6$

↑ /y$_1$a$_2$-y$_3$d$_4$a$_5$ʕ$_6$/ ↑ /TRUNC$_{IMP}$ - y$_1$a$_2$-y$_3$d$_4$a$_5$ʕ$_6$/

(b) a failed paradigm y$_1$ē$_{2,3}$ð$_4$a$_5$ʕ$_6$ → y$_3$əð$_4$a$_5$ʕ$_6$

↑ /y$_1$a$_2$-y$_3$d$_4$a$_5$ʕ$_6$/ ↑ /TRUNC$_{IMP}$ - y$_1$a$_2$-y$_3$d$_4$a$_5$ʕ$_6$/

The truncated imperative in the failed paradigm in (128b) realizes more of the input string; it provides a correspondent for the root-initial glide, and the optimal imperative does not. However, the truncated word in (128b) has segments without correspondents in the base, and fatally violates OO$_I$-DEP. Because OO$_I$-DEP >> IO-MAX, the biconsonantal imperative [daʕ] in (128a) is more harmonic than triconsonantal *[yəðaʕ].[79]

(129) Truncated Candidates Related to the Base [yēðaʕ] (< UR /ya + ydaʕ/)

	OO$_I$-DEP violation	IO-MAX violation
a. ☞ daʕ	none	*** (y$_1$a$_2$-y$_3$)
b. yəðaʕ	** (yə) !	* (a$_2$)

Realization of the root-initial glide in (129b) is fatal, because the root-initial glide does not surface in the base [yēðaʕ]. It is better for the truncated word to MAX less of the input than to realize segments that do not correspond to base material.[80]

The initial [y] glide in the roots in (125) is historically [w], so these roots are members of the I-w class. A smaller set of [y]-initial roots, which are historically I-y, do not

[79] Epenthesis in the truncated word in (129b) violates both OO$_I$-DEP and IO-DEP. The IO-DEP violation is not fatal, however, because IO-DEP ranks below IO-MAX to force epenthesis generally in the language. A third candidate not shown in (127), *[yðaʕ], violates undominated *COMPLEX-ONSET as well as incurring greater OO$_I$-DEP violation than the optimal form [daʕ].
[80] The OO-DEP >> IO-MAX ranking plays a similar role in English cluster simplification: because the root-final coronal nasal is not realized in a word like *condemn*, it cannot appear in related affixed words like *condemnable*, *condemning* (see §5.3).

undergo coalescence with prefixal low vowels. No imperatives of I-y roots are attested, but the analysis predicts that the imperative of an I-y root would realize the root-initial glide and undergo schwa epenthesis. If coalescence does not occur in the imperfective (e.g., [y$_a$a$_b$y$_c$CVC]), then that root-initial glide should also surface in the related imperative (e.g., [y$_c$əCVC]). A similar pattern involving nasal assimilation suggests that this hypothesis is correct.

The imperatives of the nasal-initial roots in (130a) show overapplication of nasal-stop assimilation. Total assimilation of the root-initial nasal to a following stop is conditioned in the imperfective stems, so that the underlying string /ya + ntēn/ yields [yittḗn].[81] Truncation of the imperfective's initial CV and word-initial degemination produce the imperative [tēn].[82] As in the vowel-glide coalescence case, the truncated form is faithful to a surface property of its base – if there is no root-initial nasal in the imperfective, then there is no root-initial nasal in the truncated word. This is shown in (130a). When nasal assimilation does not apply in the base, nasals surface in imperative stems, as shown in (130b). Nasals do not assimilate to gutturals, so the root-initial nasal surfaces in imperfectives like [yinhāg]. And because it surfaces in the base, the root-initial nasal is also realized in the truncated word [nəhāg].

(130) Nasal-Stop Assimilation

			Imperfective	Imperative		
a.	/ya + ntēn/	>	yittḗn	tḗn	*nətḗn	'give'
	/ya + ngaš/	>	yiggaš	gaš	*nəgaš	'approach'
b.	/ya + nhāg/	>	yinhāg	nəhāg	*hāg	'drive; lead'
	/ya + nḥal/	>	yinḥal	nəḥal	*ḥal	'obtain property'

A rule-based analysis of (130) would rely on serial ordering: nasal assimilation precedes the truncation rule, in a derivation similar to coalescence case in (126): /ya + ntēn/ --> yittḗn --> ttḗn --> [tḗn]. In constraint-based TCT, loss of the root-initial nasal in (130a) is

[81] The change of the prefix's underlying /a/ to /i/ is discussed shortly below.
[82] As noted earlier, Tiberian Hebrew orthography does not distinguish geminates from non-spirant singleton stops. Thus, degemination may or may not apply in the imperative [tēn].

overapplication of nasal-stop assimilation. The crucial ranking is again OO$_I$-DEP >> IO-MAX. The constraint against against complex onset clusters, which is never violated in Tiberian Hebrew, also plays a role.

(131) Truncated Candidates Related to the Base [yittēn]

	*CMPLX-ONS	OO$_I$-DEP	IO-MAX
a. ttēn	*!		** (ya)
b. ntēn	*!		** (ya)
c. tətēn		* (ə) !	** (ya)
d. nətēn		* (ə) !	** (ya)
e. ☞ tēn			*** (ya-n)

The ranking OO$_I$-DEP >> IO-MAX dictates that loss of the root-initial nasal (131e) is preferred to realizing it before an epenthetic vowel.[83]

When nasal assimilation does not take place in the base, the truncated word is required to provide a correspondent for the root-initial nasal. OO$_I$-MAX forces realization of the nasal in the truncated word.[84]

(132) Truncated Candidates Related to the Base [yinhāg]

	*CMPLX-ONS	OO$_I$-MAX	OO$_I$-DEP	IO-MAX
a. nhāg	*!	** (yi)		** (ya)
b. ☞ nəhāg		** (yi)	* (ə)	** (ya)
c. hāg		*** (yin) !		*** (ya-n)

Because OO$_I$-MAX dominates OO$_I$-DEP, realization of base segments is preferred, even when epenthesis is required to accommodate them in the truncated word.

Both the nasal assimilation case and vowel-glide coalescence case show that underlying consonants can be realized in imperatives only if those consonants have correspondents in the imperfective base. OO$_I$-DEP >> IO-MAX forces this result. Moreover, if a root consonant appears in the imperfective, it must have a correspondent in

83 If degemination does not apply in this case, so that the optimal imperative is [ttēn] instead of [tēn], then *COMPLEX-ONSET is dominated by OO$_I$-MAX (or OO$_I$-MAX-MORA or OO$_I$-IDENT-C-WEIGHT, depending on how one analyzes gemination and faithfulness to consonant length; see, e.g., Morén, 1997)).

84 IO-MAX is too low-ranking to force the nasal to appear; recall that OO$_I$-DEP dominates IO-MAX.

the imperative, even when this entails identity-disrupting epenthesis (because OO$_I$-MAX >> OO$_I$-DEP). Clearly, if the imperative mimics surface properties of the imperfective, there must be an OO-correspondence relation between them. One more misapplication identity effect noted by Prince (1975) cements this result.

Imperative truncation shows underapplication of a process Prince calls A-to-I (also known as the Barth-Ginsberg Gesetz), which raises a low vowel to a high front vowel in initial closed syllables. A-to-I affects the imperfective prefix /ya-/ in stems like [yixtōv] (< /ya - ktōb/) and may also affect root material, as in perfectives like [giddēl] 'magnify' or [limmād] 'teach' (cf. the imperfectives in (133)). Imperatives are the only words that fail to undergo A-to-I and surface with low vowels in initial closed syllables. Instead of obeying the A-to-I constraints, imperatives are faithful to vowel quality in the imperfective.

(133) Underapplication of A-to-I

imperfective	imperative		
yəgaddēl	gaddēl	*giddēl	'magnify'
yəlammēd	lammēd	*limmēd	'teach'

A-to-I underapplies to preserve paradigmatic identity – because A-to-I is not conditioned in the imperfective base, where the low-vowel is not in an initial closed syllable, A-to-I fails to apply in the truncated imperative.

Full analyses of the identity effects in imperative paradigms are not presented here because they are relatively complex, and they would not add anything new to the TCT proposal. It is clear that misapplication is produced by high-ranking constraints on an OO-correspondence relation governing imperfective-imperative subparadigms.

4.6.2 Spirantization in Truncated Imperatives

The OO-correspondence relation that links imperatives and imperfectives is not the same as the OO-relation in jussive/2fs truncation paradigms. The spirantization facts demonstrate this.[85] Unlike jussive/2fs truncation, where spirantization underapplies, imperative truncation sacrifices OO-Identity to the spirantization constraints. All and only post-vocalic segments are spirantized in imperatives, no matter what effect this has on identity with the imperfective base. In (134), two out of three pairs of corresponding obstruents do not agree in continuancy.

(134) Imperative Truncation

yixtōβ	→ (OO_I-*Identity*)	kəθōβ
↑		↑
/ya-ktōb/		/TRUNC$_{IMP}$ - ya-ktōb/

Spirantization applies normally in imperative truncation. The top-ranked spirantization constraint *V-STOP is satisfied, and the context-free constraint *SPIR is minimally violated, even when this entails violation of OO_I-IDENT[CONT].

(135) Normal Application of Spirantization in Imperative Truncation

*V-STOP >> *SPIR >> OO_I-IDENT[CONT], IO-IDENT[CONT]

candidate (a) [yikθōβ kəθōβ]
candidate (b) [yixtōβ xətōβ]
☞ candidate (c) [yixtōβ kəθōβ]

Recursion (A)

/ya - ktōb/	*V-STOP	*SPIR	OO_I-IDENT[CONT]	IO-IDENT[CONT]	>>
a. yikθōβ	*!	**		**	
b. yixtōβ		**		**	
c. ☞ yixtōβ		**		**	

Recursion (B)

>>	/TRUNC$_{IMP}$ - ya - ktōb/	*V-STOP	*SPIR	OO_I-IDENT[CONT]	IO-IDENT[CONT]
	a'. kəθōβ		**		**
	b'. xətōβ	*!	**		**
	c'. ☞ kəθōβ		**	**	**

[85] The epenthesis facts do not make the same argument, because epenthesis is forced by a different markedness constraint in each truncation pattern – *COMPLEX-CODA drives the epenthesis that underapplies in jussive/2fs truncation, and *COMPLEX-ONSET induces epenthesis in imperatives.

In (135a) and (135b), corresponding segments in related words agree in continuancy. Paradigm (135a) satisfies the OO-Identity constraint by underapplying spirantization in the base, which fatally violates *V-STOP in the dominant recursion of constraints. Candidate paradigm (135b) satisfies OO_I-IDENT[CONT] by both over- and underapplying spirantization in the truncated word: the root-initial velar is spirant but not post-vocalic (overapplication) and the medial coronal is a post-vocalic stop (underapplication). The *V-STOP violation is fatal to (135b). Optimal (135c), in which correspondents are not identical, violates OO_I-Identity to satisfy dominant *V-STOP.

In (135) it is not possible to demonstrate that OO_I-IDENT[CONT] ranks below *SPIR, because OO-Identity cannot be satisfied without violating *V-STOP. But a different imperative paradigm can establish this ranking. In imperatives of the glide-initial roots discussed earlier, coalescence of the glide with the low vowel of the imperfective prefix yields imperfectives like [yēðaʕ], with a medial post-vocalic spirant. Truncation alters the environment of this base's spirant: its correspondent in the truncated version [daʕ] is word-initial and a stop. Identity in the paradigm is sacrificed to limit marked spirantization.

(136)

*V-STOP >> *SPIR >> OO_I-IDENT[CONT], IO-IDENT[CONT]

candidate (a) [yēðaʕ ðaʕ]
☞ candidate (b) [yēðaʕ daʕ]

Recursion (A)

/ya - ydaʕ/	*V-STOP	*SPIR	OO_I-IDENT[CONT]	IO-IDENT[CONT]	>>
a. yēðaʕ		*		*	
b. ☞ yēðaʕ		*		*	

Recursion (B)

>>	/TRUNC$_{IMP}$ - ya- ydaʕ/	*V-STOP	*SPIR	OO_I-IDENT[CONT]	IO-IDENT[CONT]
	a'. ðaʕ		*!		*
	b'. ☞ daʕ			*	

Both candidates satisfy *V-STOP. Overapplication of spirantization in the truncated word in paradigm (136a) satisfies OO_I-IDENT[CONT], but fatally violates dominant *SPIR. To minimize marked spirantization, the optimal paradigm (136b) has non-identical correspondents. In imperatives, *SPIR violation can be compelled only by *V-STOP, and not by the lower-ranked OO$_I$-Identity constraint.

4.6.3 Two Distinct OO-Correspondence Relations

Imperative truncation and jussive/2fs truncation behave differently with respect to post-vocalic spirantization: in jussive and 2fs stems spirantization underapplies, while in imperatives spirantization applies normally. If they show different surface patterns, jussive/2fs truncation and imperative truncation must be ruled by distinct grammatical principles (e.g., ranked and violable constraints). My proposal is that the two classes of words behave differently because they are governed by distinct OO-correspondence relations. Thus, the Tiberian Hebrew grammar includes three faithfulness constraints on the [±continuant] feature, each proper to a distinct faithfulness relation. IO-IDENT[CONT] coexists in the ranking with the OO$_J$-IDENT[CONT] constraint on jussive/2fs truncation and the OO$_I$-IDENT[CONT] constraint on imperative paradigms.

(137) Spirantization

OO$_J$-ID[CONT] >> *V-STOP >> *SPIR >> OO$_I$-ID[CONT], IO-ID[CONT]

The spirantization markedness constraints *V-STOP >> *SPIR dominate IO-IDENT[CONT], and post-vocalic spirantization is the canonical pattern in the language. High-ranking OO$_J$-ID[CONT] ensures that jussive and 2fs stems are faithful to their bases' stops, even if the stop is post-vocalic in the truncated word. Truncated imperatives have spirants always and only in post-vocalic context because OO$_I$-ID[CONT] is bottom-ranked, along with IO-Faith.

Differentiating faithfulness relations between different types of strings – e.g., distinguishing input-output (IO) from base-reduplicant (BR) and output-output (OO) relations – is the basic premise of McCarthy's & Prince's Correspondence Theory. This idea is taken a step further with the proposal that distinct OO-correspondence relations can be instantiated in the same grammar. Reduplication sets a precedent for distinguishing

multiple relations of the same basic type. Urbanczyk (1995, 1996) demonstrates that two different reduplications in Lushootseed are governed by distinct BR-correspondence relations (see §1.3.3 above). In this language, diminutive reduplication copies only the initial CV of the base string; fuller copying is prevented by the ranking NOCODA >> BR$_{DIM}$-MAX. Distributive reduplication, in contrast, copies a CVC string, so its BR$_{DIST}$-MAX constraint must outrank NOCODA. The two reduplicants invoke distinct BR-correspondence relations with distinct MAX constraints. My analysis of Tiberian Hebrew draws the same conclusion: the two truncations in Tiberian Hebrew invoke two distinct OO-correspondence relations, governed by distinct OO-Identity constraints.

Drawing on Generalized Template Theory (McCarthy & Prince, 1994b), Urbanczyk attributes the distinction between the two Lushootseed reduplicants to morphology: diminutive reduplication has the canonical CV affix shape, while distributive reduplication is a canonical CVC root. The idea is that each reduplicant invokes a distinct BR-correspondence relation because they are morphologically distinct. No similar morphological argument can be made about paradigms. Distinct OO-correspondence relations in the same language are not necessarily correlated with morphological features or types. In Tiberian Hebrew, the distinction between imperative truncation and jussive/2fs truncation is, from a morphological point of view, entirely arbitrary. Neither class can have its phonological behavior explained morphologically because they are too similar; both are truncated words containing root (and sometimes affixal) material. This suggests that the morpheme-class phenomenon in Tiberian Hebrew is purely phonological; that is, jussive/2fs stems and imperatives stems belong to distinct *phonological classes*. Under the present proposal, phonological classhood gets a phonological explanation: words formed with different morphemes subscribe to different phonological patterns simply because they are governed by different faithfulness relations.

In the limit, TCT allows morpheme-specific phonological behavior. However, it is rarely the case that each morpheme in a language is associated with a unique phonological pattern. Instead, there appear to be two basic types: languages in which a small number of morphemes pattern apart from the majority, as in Tiberian Hebrew and Javanese (Benua, 1997a), and those in which all affixal morphemes fall into a small number of classes, as in English (§6) and other Germanic languages, Kannada (Aronoff & Sridhar, 1983) and Hausa (Newman, 1986). The tendency is to limit the number of distinct faithfulness relations instantiated in a language, and hence to limit the number of possible phonological patterns. It is clear that learnability demands this: the more OO-correspondence relations instantiated, the greater the number of distinct phonological patterns, and the harder it is for the learner to master the grammar.

In the faithfulness-based analysis of morpheme classhood, a grammar consists of a single total ordering of constraints. There are no subgrammars or levels of derivation. Class behavior results from distinct faithfulness constraints, rather than distinct constraint rankings. The subgrammar alternative is explored in the following section. As in §3.5 above, I make the case that the TCT proposal is more internally consistent and more empirically predictive than subgrammar theory.

4.7 Serial Alternatives

This section considers possible analyses of Tiberian Hebrew misapplication that rely on serial ordering in the derivation of truncated words. Section 4.7.1 presents a rule-based theory of the truncation patterns, and §4.7.2 discusses a serial OT analysis.

4.7.1 Rule-Based Theory

The Tiberian Hebrew truncations entail a complicated set of rule-orderings, with two truncation operations ordered among the phonological rules (see Prince, 1975). In a rule-based analysis, phonological processes that over- or underapply in truncated words have to take place early in the derivation, before the truncation operation. By the time truncation creates the rule's conditioning environment, it is too late for the rule to apply (in

underapplication) or it is too late for the early rule to be undone (in overapplication). Processes that apply normally in truncated words are ordered after the truncation rule.

Given this logic, imperative truncation is an early rule, and jussive/2fs truncation is a late rule. Imperative truncation precedes epenthesis and spirantization, so these rules apply normally in imperative stems. But imperative truncation is ordered after other phonological rules, including vowel-glide coalescence (ay --> ē), nasal assimilation (nt --> tt) and the rule that changes [a] to [i] in initial closed syllables, since these processes misapply in imperative stems.

(138)				
	Input	/ya-ktōb/	/ya-ydaʕ/	/ya-lammēd/
	coalescence	----	yēdaʕ	----
	A-to-I	yiktōb	----	----
	Imperative truncation	ktōb	daʕ	lammēd
	epenthesis	kətōb	----	----
	spirantization	kəθōβ	----	----
	Output	kəθōβ	daʕ	lammēd
		'write!'	'know!'	'learn!'

The first derivation in (138) shows the normal application of epenthesis and spirantization: the imperative 'write!' has no complex syllable margins and spirants appear always and only in post-vocalic context, because the epenthesis and spirantization rules apply after truncation creates their conditioning contexts. The other derivations show misapplication. The second column shows that overapplication of vowel-glide coalescence results from ordering the coalescence rule before truncation: coalescence eliminates the root-initial glide before truncation suppresses the initial CV, producing the biconsonantal imperative [daʕ]. The third derivation shows underapplication of the A-to-I rule: because it precedes truncation, A-to-I cannot apply after truncation derives a low vowel in an initial closed syllable.

The final-V truncation that marks jussives and 2fs stems happens at a later point in derivations, after the epenthesis and spirantization rules. As a result, epenthesis and spirantization underapply in jussives and 2fs stems: by the time truncation creates their conditioning contexts, it is too late for these rules to apply. However, epenthesis actually does occur in jussive/2fs stems under certain conditions. Two special epenthesis rules are required, one that inserts a vowel between consonants that rise in sonority, and one that breaks up guttural-consonant sequences.

(139)			
Input	/ya-šbē/	/ya-glē/	/šamaʕ-tī/
general epenthesis	----	----	----
spirantization	----	yiɣlē	----
Jussive/2fs Truncation	yišb	yiɣl	šāmaʕt
sonority-based epenthesis	----	yiɣel	----
guttural-C epenthesis	----	----	šāmaʕat
Output	yišb	yiɣel	šāmaʕat
	'let him take captive'	'let him uncover'	'you (f) heard'

Epenthesis fails to apply in the first column of (139) because the general epenthesis rule, which prevents all complex syllable margins, precedes and is blind to the truncation rule. The general epenthesis rule does not apply in the second and third columns of (139) either, but in these cases, the special epenthesis rules are triggered by truncation, so that rising-sonority and guttural-obstruent codas are eliminated. Underapplication of spirantization is shown in the third column: the epenthesis rule that prevents guttural codas inserts a vowel before the word-final obstruent, but it is too late for spirantization, and a post-vocalic stop surfaces. Putting (138) and (139) together gives the following rule ordering.

(140) Rule-Ordering

coalescence, nasal-assimilation, A-to-I
imperative truncation
general epenthesis
spirantization
jussive/2fs truncation
sonority-based epenthesis, guttural-C epenthesis

This ordering theory has some complications. One has to do with the rule that epenthesizes a vowel in guttural-consonant sequences: ø --> a /guttural __ C. This rule does the work of the CODA-COND in the constraint-based analysis, preventing guttural codas.[86] The interesting problem is the interaction of the post-guttural epenthesis rule and the spirantization rule. Guttural codas are dispreferred throughout the language, and the

86 The formulation of this rule is very rough. Like the CODA-COND, the guttural-C epenthesis rule has to be blocked if the guttural can be both root-final and syllable-final (a dominant ANCHOR constraint has this blocking effect in the constraint-based theory). There are two ways to achieve this with rules. The structural description of the rule can be elaborated such that it applies only when the guttural is not root-final: ø --> a /guttural __ $C]_{Root}$. An alternative is to posit another rule to delete epenthetic vowels when the guttural is root-final: a --> ø /guttural$]_{Root}$ __.

guttural-C epenthesis rule applies generally, to both truncated and non-truncated words. However, only truncated (jussive/2fs) words show underapplication of spirantization after epenthetic vowels inserted by this rule. In non-truncated words, obstruents that follow epenthetic vowels are properly spirantized, as in [ya.ha̠.ɸōx] (< /ya-hpōk/) 'he will turn'. The ordering in (140) predicts the underapplication shown by truncated words: by the time guttural-C epenthesis inserts a vowel, it is too late to spirantize the following stop. The normal application of spirantization in non-truncated words requires the spirantization rule to apply again, after guttural-C epenthesis, to produce [ya.ha̠.ɸōx] instead of *[ya.ha̠.pōx]. It is unclear why truncated jussive/2fs stem do not also undergo this second pass of the spirantization rule.

The other special epenthesis rule in (140) is truly a special rule, which applies only to truncated jussive/2fs words. This sonority-based epenthesis rule eliminates tautosyllabic rising-sonority clusters, and since all coda clusters are prohibited in non-truncated words, the sonority-based rule has effect only in truncated jussive/2fs stems. This rule is essentially a late clean-up of the derivation, eliminating a certain subset of clusters created by the jussive/2fs truncation rule. But note that this late clean-up role is inconsistent with the universal content of the sonority-based epenthesis rule, which has the central job of prohibiting a universally highly-marked structure, rising sonority codas. It is surprising that such a fundamental rule of syllable structure could be ignored for so much of the Tiberian Hebrew derivation.

A similar problem concerns the spirantization rule. Post-vocalic spirantization is an automatic rule (the only exceptions are truncated words). It applies across the board, even between words. By the standard criteria of Lexical Phonology, spirantization should be a post-lexical rule, and unable to interact with word-forming morphology. Nevertheless, the data show that spirantization takes place relatively early in the derivation, and is followed by both morphological and phonological rules.

This objection can be stated more generally: the Tiberian Hebrew truncation patterns require an arbitrary ordering of rules. This arbitrariness is undesirable, because ordering theory strives to find natural expressions of relations among phonological processes. Constraint ranking, on the other hand, is inherently arbitrary. In OT, there is no expectation that a process that applies between words is unable to interact with word-formation morphology or is required to be exceptionless. In a theory of ranking, any constraint may outrank, and potentially obscure the effect of, any other constraint.

I conclude that the rule-based analysis of Tiberian Hebrew truncation has both mechanical and conceptual shortcomings. It clearly does not improve on the TCT proposal. I turn next to a constraint-based theory that retains the basic premise of the rule-based model, that over- and underapplication are products of derivational ordering.

4.7.2 Serial Optimality

In a serial elaboration of OT, the output deemed optimal by one subgrammar can be input into a second level of derivation, which differs from the first in its constraint ranking. As discussed in some detail in §3, serial OT models misapplication identity effects by deriving the base word at the first level of derivation, and using that output as input to a second level of derivation, where the complex word is evaluated. Faithfulness is promoted in the second subgrammar, so that the derived word is faithful to its base.

Tiberian Hebrew would have a first level of derivation in which complex codas are prohibited by a ranking of *COMPLEX-CODA >> DEP. If all non-truncated words are derived at this level 1, then all non-truncated words will show epenthesis instead of complex codas. Truncated jussive/2fs stems are evaluated at a later level of derivation, which has the opposite ranking of DEP >> *COMPLEX CODA. Because the faithfulness constraint is promoted, epenthesis fails to apply in these truncated words.

(141) Serial OT: Re-Ranking Faithfulness

Level 1: *COMPLEX-CODA >> DEP

/sipr/	*COMPLEX-CODA	DEP
a. sēϕr	*!	
b. ☞ sē.ϕər		*

/ya- šbē/	*COMPLEX-CODA	DEP
a. yi.šə.bē		*!
b. ☞ yiš.bē		

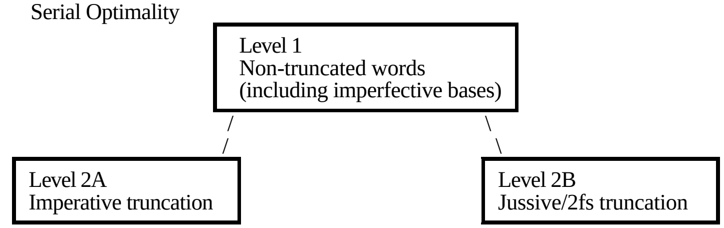
Level 2: DEP >> *COMPLEX-CODA

[yiš.bē] + TRUNC	DEP	*COMPLEX-CODA
a. yi.šeb	*!	
b. ☞ yišb		*

Promotion of the faithfulness constraint at the second level of derivation produces the underapplication of epenthesis in truncated words.

A full serial OT analysis of the Tiberian Hebrew truncation data requires two distinct non-initial levels of derivation. Schematically, the system of subgrammars in Tiberian Hebrew looks something like (142). At the first level of derivation, non-truncated words would be evaluated against a constraint-ranking. Some outputs of this level are input into level 2A, where imperative truncation takes place. Other outputs of level 1 are input into level 2B, where jussive/2fs truncation takes place.

(142) Serial Optimality



Each subgrammar consists of a different constraint ranking. At Level 1, all processes apply, including epenthesis, spirantization, A-to-I, vowel-glide coalescence, and so on. The markedness constraints that drive these processes outrank faithfulness at Level 1. At Level 2A, where imperative truncation takes place, faithfulness dominated by epenthesis and spirantization constraints, producing normal application of these processes, but promoted above the A-to-I, coalescence and nasal assimilation markedness constraints, forcing these processes to misapply in truncated imperatives. At Level 2B, faithfulness is promoted above the epenthesis and spirantization constraints, producing underapplication of these processes in jussive/2fs stems.

The differences between the levels of derivation are in the ranking of faithfulness constraints; none of the various surface patterns requires a unique ranking of markedness constraints. But given that this theory is based on constraint re-ranking, it is unclear why faithfulness constraints can change rank between levels but markedness constraints cannot. The undesirable consequences of allowing markedness constraints to re-rank between levels were reviewed in some detail in the Sundanese case study, and I will not repeat them here. It is sufficient to note that serial OT leaves the similarities between the Tiberian Hebrew subgrammars unexplained.

The Tiberian Hebrew case requires a more complicated subgrammar structure than the Sundanese case does. In Sundanese, just two levels are necessary, and these levels are in a simple feeding order: the output of Level 1 is input to Level 2. Tiberian Hebrew requires (at least) three distinct levels of derivation. Moreover, two of the three are not in a feeding order: words derived at Level 2A have nothing whatsoever to do with words derived at Level 2B. Allowing a proliferation of levels, which may or may not interact with one another, increases the indeterminancy of the serial OT model.

TCT obviates these typological problems by evaluating all words against the same fixed ranking of constraints. Consistencies among the surface patterns observed in a language, and ways in which they differ, fall out naturally if multiple sets of faithfulness constraints coexist in a markedness ranking.

4.8 Summary

Identity-driven misapplication in Tiberian Hebrew is sensitive to both phonological and morphological context. The underapplication of epenthesis responds to phonological context, in that underapplication fails if it would produce a structure that is too highly marked, violating the universally highly-ranked SON-CON constraint, or the language-particularly high-ranking CODACOND against gutturals. The misapplication identity effects are also sensitive to morphology, in that different processes misapply in different morphological classes of words; imperatives behave one way, and jussive/2fs stems behave differently. I proposed that phonology is made sensitive to morphology by way of the subcategorization mechanism: OO-correspondence relations subcategorize the language's morphology. Paradigms constructed by each class of morphemes (or morphological operations) are governed by an OO-correspondence relation, and each OO-correspondence relation is governed by its own set of OO-Identity constraints. As a result, different classes of words show different surface patterns. Further support for this proposal comes from the study of English affixed words presented in the next chapter.

CHAPTER 5

ENGLISH

5.1 Introduction

Morphologically-complex words of English show a number of transderivational identity effects, involving both over- and underapplication of phonological alternations. Affixes in English fall into two groups: class 1 (*-al, -ate, -ic, -ity, -ous, in-* etc.) and class 2 *(-able, -er, -ful, -ist, -ness, un-*, etc.) (Siegel, 1974). These classes are distinguished by the surface phonological patterns of the words that contain them; that is, words with class 1 affixes and words with class 2 affixes behave differently. Both classes show misapplication identity effects, but different ones: words with class 2 affixes are highly faithful to their bases, copying main stress and various derived segmental properties, while words with class 1 affixes are less faithful, and copy their bases only in the placement of nonprimary stress feet. Two distinct OO-correspondence relations are instantiated in English, each associated with an affix class.

(143) Two OO-correspondence Relations

a. Class 1 *damn damnation*			b. Class 2 *damn damning*		
	OO_1-Identity			**OO_2-Identity**	
[dæm]	→	[dæmneyšʌn]	[dæm]	→	[dæmɪŋ]
↑		↑	↑		↑
/dæmn/		/dæmn + eyšʌn/	/dæmn/		/dæmn + ɪŋg/

Class 1 affixes like *-(a)tion* trigger an OO_1-correspondence relation, and class 2 affixes like *-ing* are subcategorized by an OO_2-correspondence relation. Each relation is governed by a set of identity constraints: OO_1-Identity constraints evaluate class 1 paradigms (*damn damnation*) and OO_2-Identity constraints rule class 2 paradigms (*damn damning*). Both sets of OO-Identity constraints are ranked in the English hierarchy of markedness and IO-Faith constraints. When analogous OO_1-Identity and OO_2-Identity constraints have different rank in the grammar, the two classes of affixed words pattern differently .[87]

[87] This case study deals with affixation only. Other modes of morphological derivation, such as compounding or truncation, are not discussed. I have not made a study of English compounding, but my

The reliable diagnostic of an affix's class membership is the phonology of the words it appears in. The familiar descriptions are that class 2 affixation is invisible to stress (or "stress-neutral") and similarly irrelevant to other phonological rules, while class 1 affixation is "stress-affecting" and subject to a variety of segmental alternations. In the analysis proposed here, these facts follow from the high rank of OO_2-Identity and the low rank of OO_1-Identity constraints. For example, the base of the subparadigms in (143) *damn* cannot realize its coronal nasal [n] for syllabification reasons. This [n] also fails to appear in the class 2 affixed word *damning*, even though it could be accommodated in its syllable structure (see Marchand, 1960; Borowsky, 1986, 1993). The [n] is not realized in *damning* simply because it has no correspondent in the base *damn*. OO_2-Identity is high-ranking (above IO-MAX), and deletion overapplies in the affixed word. Class 1 affixation is different, because OO_1-Identity is lower-ranked. A word like *damnation* can and does fit the root-final [n] into its syllable structure, in spite of the violation of paradigmatic identity (see §5.3.2).

Identity is violated in the class 1 paradigm *damn damnation*, so this example provides no evidence of the OO_1-correspondence relation. But other class 1 paradigms demonstrate an identity effect in stress placement produced by high-ranking OO_1-Identity constraints.[88] Main stress in English appears on a heavy penult, else on the antepenultimate syllable. Secondary stress iterates from the left edge, creating initial dactyls in words like *Lòllapalóoza, Tàtamagóuchee, àbracadábra,* where three light syllables precede the main stress. Words with class 1 affixes disobey the secondary stress generalization. In *orìginálity, arìstocrátic, munìcipálity*, secondary stress appears on the second of three light pre-tonic syllables, rather than the first, because main stress appears on the corresponding

intuition is that it shows many of the same surface patterns as class 2 affixation, which suggests that compounding triggers the OO_2-correspondence relation. Diminutive truncation in English also patterns with class 2 affixation (see Benua (1995) on the behavior of truncated and class 2 affixed words with respect to æ-tensing in certain English dialects).

[88] The description of English stress presented here follows on Burzio's (1994) more thorough investigation. Burzio proposes that stress patterns in complex words are driven by principles of ANTI-ALLOMORPHY, which demand that related words have similar stress. Burzio has a different theory of prosodic organization, but my account essentially recapitulates his characterization of the facts.

vowel in the relevant base word: *orígin, arístocrat, munícipal.* OO_1-Identity takes precedence, and the leftward alignment of secondary stress underapplies.

Class 2 affixation is stress-neutral, or invisible to stress. Main stress is attracted to the right edge of the word, but in class 2 paradigms like *párent   párenthood* and *líberal   líberally*, stress does not appear farther right in the suffixed word than it does in the base. Identity in the paradigm is more important than rightward alignment of main stress. In §5.2 I propose that stress identity is enforced by OO-ANCHOR constraints, which require correspondence of the edges and heads of feet, in competition with (PCat-PCat) Alignment constraints, which demand right- or left- alignment of feet in their prosodic words. In stress-neutral class 2 affixation, OO_2-ANCHOR >> ALIGN(PrWd, R, Ft, R) and identity takes precedence over rightward foot alignment. Words in class 1 paradigms are made less alike by a rightward "shift" in main stress (*órigin   oríginal*, *eléctric   electrícity*) because ALIGN-R >> OO_1-ANCHOR, but they preserve identity of prosodic structure where they can, in secondary stress footing, because OO_1-ANCHOR dominates a left-alignment constraint. An abbreviated stress hierarchy is given in (144).

(144) English Stress

OO_2-ANCHOR >> ALIGN-R(PrWd, Ft) >> OO_1-ANCHOR >> ALIGN-L(Ft, PrWd)

The ALIGN-R >> ALIGN-L ranking established by the intervention of OO_1-ANCHOR is confirmed by the canonical English stress pattern: in words like *américa* (**ámerica*) or *callíope* (**cálliope*) stress is peninitial because ALIGN-R >> ALIGN-L.[89] As expected, OO-Identity constraints interact with an independently motivated constraint hierarchy. Simplex words and class 1 affixed words reflect the same ALIGN-R >> ALIGN-L ranking because all English words are generated by the same grammar.

In the stress hierarchy in (144), an OO_2-Identity constraint outranks the analogous OO_1-Identity constraint. The paradigms in (143) show the same relative rank of the two

89 A NONFINALITY constraint not shown in (144) prevents stress from appearing any farther to the right: in the failed candidates **americá*, **callióPe* the word-final syllable is (fatally) parsed into a stress foot (see §5.2).

kinds of OO-Identity constraints: OO_2-DEP outranks the constraints that derive word-final cluster simplification, forcing overapplication in *damn   damning*, while OO_1-DEP ranks below the cluster constraints and identity is sacrificed in *damn   damnation*. The high degree of faithfulness in class 2 affixation has led previous analysts to propose that stems are somehow "closed off" to class 2 affixation, and identity effects in class 2 paradigms are familiarly described as CLOSURE EFFECTS. The basic idea is that the stem adjacent to a class 2 affix is a phonologically complete word. I adopt this terminology and describe cluster simplification and similar class 2 misapplication cases as closure effects, but I reject the notion that there is any kind of phonological closure. The string adjacent to a class 2 affix looks like a word in isolation – that is, phonology applies as if the class 2 affix were not present – because high-ranking OO_2-Identity forces the affixed word to mimic derived properties of its base. By the same logic, class 1 affixes are visible to the phonology because OO_1-Identity constraints are lower-ranked. There is no structural or derivational closure of stems before class 2 affixes; the differences between class 1 and class 2 paradigms follow solely from the rank of the relevant faithfulness constraints.

Affix classhood is a purely phonological phenomenon: determining what class an affix belongs to simply requires checking to see whether or not stress and segmental alternations misapply. Attempts to relate class membership to inherent properties of the affix, such as its etymology, morpho-syntactic features or prosodic shape, are unsuccessful. The traditional Latinate/Germanic distinction does not correlate with class membership: class 1 *-ous* and class 2 *-ment* are both Latinate, and class 1 *-al* can attach to either Latinate roots (*lingual*) or Germanic roots (*postal*) (Marchand, 1960). Morphosyntax is also an inadequate diagnostic, since affixes of either class can mark the same category or serve the same grammatical function: class 1 nominalizing *-al* exists alongside class 2 nominalizing *-ness*, and class 1 plural *-en* coexists with class 2 plural *-s* (cf. Kiparsky, 1982a). Also, affixes of either class can be prosodically subminimal, lacking an onset consonant (class 1 -

ic, class 2 *-er*) (cf. Lamontagne & Sherer, 1993). Inherent properties of the affix do not predict its class membership.[90]

Membership in a phonological class is arbitrary, and the primary diagnostics of class membership are the misapplication patterns in paradigms. My proposal is that affixes are subcategorized by one of two distinct OO-correspondence relations, dubbed OO_1-correspondence and OO_2-correspondence. The strong claim is that all correlates of affix class membership follow from the rank of the constraints on the two OO-correspondence relations. Two robust correlates of affix classhood in English, stress patterns and segmental closure effects like cluster simplification, are analyzed in §5.2 and §5.3, respectively. A third diagnostic is the affix's (in)ability to attach to bound roots. Class 1 affixes can concatenate with morphologically-bound material (*electr-ic*, *con-cept-ion*), and class 2 affixes cannot (**electr-ness*, **con-cept-hood*). In §5.4 I argue that this is an aggressive closure effect, produced by the same OO_2-DEP >> IO-MAX >> OO_1-DEP ranking implicated in cluster simplification. Words with class 2 affixes cannot realize material that is not also present in the base, and class 1 affixed words can. A bound root cannot stand alone as a licit word, and when a bound root is input to the grammar it is assigned a null or empty output string (the "null parse"; Prince & Smolensky, 1993). The OO_2-DEP >> IO-MAX ranking forces class 2 words to be similarly phonologically null. Class 1 affixes are permitted to attach to bound roots by the IO-MAX >> OO_1-DEP ranking, which makes realizing the underlying string more important. Thus, the affixation-to-a-bound-root diagnostic, like the stress and closure effect diagnostics of classhood, follows from the relatively high rank of OO_2-Identity and the relatively low rank of OO_1-Identity constraints.

Most previous accounts of affix class behavior in English and other languages can be described, in two overlapping groups, as representational and serial theories. *SPE* (Chomsky & Halle, 1968) and work that followed it (Siegel, 1974; Allen, 1978) made the

[90] The distinction between inflection and derivation, if it is relevant to formal theory at all, does not correlate with phonological classhood. Derivational morphology can be either class 1 or class 2, and inflectional morphology can too (e.g., class 1 plural *-en* and plural *-s*).

representational assumption of boundary markers: the '+' boundary appears between a class 1 affix and its stem, and a '#' boundary occurs in class 2 affixation, and phonological rules are sensitive to these symbols. Other representational proposals have connected affix class behavior to morphological or phonological constituency. Selkirk (1982, 1984) invokes morphological domains, proposing that class 1 affixes attach to roots and class 2 affixes attach to words, and phonological processes target the root or word domain. Strauss (1982), Guerssel (1983), Sproat (1985) and Orgun (1995, 1997) make similar proposals in which phonological processes are made sensitive to morphological bracketing or syntactic constituent structures. Halle & Vergnaud (1987ab) offer a somewhat more abstract representational theory, in which class 1 (cyclic) affixes invoke a separate phonological plane, while class 2 (noncyclic) affixes appear on the same plane as the stem, and misapplication results in the merger of planes (see also Halle & Kenstowicz, 1991).[91] Another group of representational theories focuses on prosodic domains, holding (roughly) that class 1 affixes are inside, and class 2 affixes are outside of the stem's prosodic constituent structure. Because they are prosodically separate from the stem, class 2 affixes are irrelevant to the application of phonological rules (e.g., Liberman & Prince, 1977; Aronoff & Sridhar, 1983; Sproat, 1985; Inkelas, 1989; Moltmann, 1990; McCarthy & Prince, 1993b; Cohn & McCarthy, 1995; Cole, 1995; Merchant, 1997). In these analyses, "closure" of a stem inside a class 2 affix is PROSODIC CLOSURE.

A second line of analysis, often employed in conjunction with the first, is serialism. Starting with Siegel (1974), it is commonly held that class 1 affixes attach early in the derivation, before phonological rules apply, and class 2 affixes attach later, after phonology has already taken place. This is one of the fundamental premises of Lexical Phonology (Pesetsky, 1979; Kiparsky, 1982ab, 1985b; Mohanan, 1982, 1986; Strauss, 1982; Rubach, 1984; Halle & Mohanan, 1985; Borowsky, 1986, 1993; among others). In a Lexical

[91] In Halle & Vergnaud's system the misapplication of stress in class 1 words is produced by a rule that copies the stem's stress onto the class 1 affix's plane. Misapplication in class 2 paradigms is formally different, in that it is the product of cyclic rule application on a single plane.

Phonology analysis of several misapplication identity effects in English (including the cluster simplification case) Borowsky (1993) proposes that class 2 affixation takes place at the end of the lexical phonology, after all word-level processes have applied. Thus, phonological closure is DERIVATIONAL CLOSURE. Class 2 affixes are invisible to phonology because they are attached after the phonological derivation is complete.

TCT accounts for affix class behavior without representational or serial assumptions. Both kinds of affixes can be prosodically integrated into the stem, and all words can be derived in parallel, without intermediate stages. The differences between class 1 and class 2 words follow from the rank of identity constraints on two distinct OO-correspondence relations.

One of the advantages of this proposal is that it gives a unified analysis of "level-ordering" and "true cyclicity". In the terminology of Lexical Phonology, the cluster simplification facts in (143) are a product of level-ordering: class 1 affixes enter the phonology at level 1 and bleed the deletion rule, while class 2 affixes appear at level 2, after deletion has already applied. Misapplication of secondary stress in class 1 words like *orìginálity* has to get a separate treatment, because all pieces of this word (the root and two class 1 affixes) are available at level 1. Therefore, two rule types are posited: cyclic rules, which apply repeatedly in the same level, and non-cyclic rules, which apply once, after all morphemes of that level have been introduced. Misapplication in class 1 words is the product of cyclicity at level 1, not the level-ordering hypothesis. Of course, once identity of related words is recognized as one the goals of the phonological derivation, it becomes clear that "level-ordering" effects and "truely cyclic" patterns are the same thing: misapplication identity effects forced by paradigmatic identity constraints.

Stress patterns and closure effects are the primary diagnostics of affix classhood in English, and the bulk of this case study is focused on those facts. In an effort not to stray from the main points, I ignore a significant number of exceptions to the patterns described. For instance, final stress in *racóon* or *guitár* and the failure of stress shift in class 1 *nátion* *nátional* (compare *párent* *paréntal*), and idiolectal variation (e.g., pronunciation of *condemnable* or *damnable* with or without the root-final *n*) are not discussed. I also do not discuss some purported diagnostics of affix classhood, including consonantal alternations like spirantization and velar softening, and vowel changes like trisyllabic laxing, because they are less reliable than the stress and closure facts. These processes do not apply in all class 1 words (compare *sane* *sanity* [seyn sænity] with *nice* *nicety* [nays naysɪtiy, *nɪsɪtiy]) and may apply in class 2 words (compare class 1 *electric* *electricity* [ʌlɛktrɪk ʌlɛktrɪsɪtiy] with class 2 *mystic* *mysticism* [mɪstɪk mɪstisism]) (see Marchand, 1960).

Another familiar but imperfect generalization concerns the ordering of affixes in multiply-affixed words. Class 2 affixes typically do not appear inside of class 1 affixes. This was noted by Siegel (1974) and dubbed the Affix Ordering Generalization (AOG) by Selkirk (1982). There are, however, a significant number of violations of the AOG, in which a class 2 affix appears inside of a class 1 affix both linearly (*dependability, hedonistic, governmental*) and hierarchically (*misrepresentation, ungrammaticality*). The AOG is therefore not a reliable diagnostic of affix classhood (see Strauss, 1982; Sproat, 1985; Halle & Kenstowicz, 1991). Fabb (1988) argues convincingly that the order of affixes is not phonologically determined, and that permissible affix combinations are governed only by selectional restrictions. I adopt Fabb's position and argue that the AOG, to the extent that it holds true, it is not a phonological generalization. The phonology places no restrictions on the order of affixation, so any ordering of class 1 and class 2 affixes is phonologically possible (see §5.6.2).

The discussion of bracketing paradoxes brings up a more general point: unlike previous theories of affix classhood, TCT has no commitment to any symmetry or synchronicity between the morphological and phonological components of grammar. Other theories expect morphology and phonology to act in concert, either because affixes of the same class are parsed into the same morphosyntactic or prosodic word structures, or because affixes of the same class become available in the same morpho-phonological stratum (or both). In TCT, affix classhood is just a phonological fact. Affixes in a class are those that are subcategorized by a phonological identity relation. There is no phonological reason to expect that affixes in the same class share morphological properties (although they are free to do so, in accordance with morphological or lexical principles).

Morphology and phonology are less tightly coupled in TCT than in Lexical Phonology, and morphemes can be grouped arbitrarily into phonological classes. In this sense, the interface between the components is less restricted in TCT, but the typological predictions of the parallel theory are tighter than the predictions of serial ones, which have to allow levels of derivation to vary. Earlier discussion has shown that serial OT re-ranks constraints between levels, and that the re-ranking is always promotion of faithfulness constraints. The ill effects of permuting markedness constraints have been discussed. In §5.7 I consider why faithfulness is never demoted at later levels (in rule-based terms, why rules are turned off at later levels but never turned on), and show that the results of demoting faithfulness cannot be achieved in parallel TCT.

The rest of the chapter is organized as follows. Stress patterns are discussed in §5.2, segmental closure cases are analyzed in §5.3, affixation to bound roots is discussed in §5.4, and the results up to that point are summarized in §5.5. Other correlates of affix classhood, namely semantic compositionality, productivity and the affix ordering generalization, are discussed in §5.6. Section 5.7 addresses some issues facing serial analyses of the English facts, and §5.8 reviews and concludes the case study.

5.2 Stress

One of the diagnostics of affix classhood in English is stress placement in affixed words: class 1 affixation is stress-affecting, and class 2 affixation is stress-neutral. To put it

differently, class 2 affixed words are fully faithful to stress on their bases, and words with class 1 affixes are not.[92]

(145) Main Stress in Affixed Words

a. Class 1 affixation			b. Class 2 affixation		
órigin	oríginal	(*óriginal)	óbvious	óbviousness	(*obvíousness)
párent	paréntal		párent	párenthood	
úniverse	univérsal		sórdid	sórdidness	
pópular	populárity		inhábit	inhábitable	
contínue	continúity		artículate	artículator	
grámmar	grammárian		astónish	astónishingly	
ópera	operátic		wónder	wónderfulness	

Main stress is tropic to the right edge of words. Class 1 paradigms show normal application of rightward main stress, so that stress appears farther to the right in the class 1 suffixed word than in the base. But in class 2 suffixation paradigms, stress does not shift rightward; instead, corresponding vowels in related words bear stress. Rightward main stress underapplies in class 2 affixed words. Paradigmatic identity takes precedence, and the constraints that demand rightward stress are violated.

Class 1 affixed words are unfaithful to their bases in main stress, but they are not free to ignore the base's prosodic organization entirely. In class 1 words of sufficient length, the base's main stress is preserved as a secondary stress, as in (146).

(146) Secondary Stress in Class 1 Paradigms

oríginal	orìginálity	(*òriginálity)	cf. Lòllapalóoza
arístocrat	arìstocrátic		
theátrical	theàtricálity		
àuthéntic	àuthèntícity		

Canonically, secondary stress aligns with the left edge of the word, as shown by the initial dactyls in monomorphemes with three light pretonic syllables, such as *Tàtamagóuchee, Wìnnepesáukee, àbracadábra, Lòllapalóoza*. Class 1 affixed words of the same shape do not have the expected word-initial stress; instead, secondary stress appears on the peninitial syllable. This is a faithfulness effect: leftward alignment of secondary stress underapplies to preserve identity in class 1 affixation paradigms.

92 As noted ealier, my characterization of English stress as identity-driven follows Burzio (1994).

To model the misapplication of stress in paradigms I need a working analysis of English stress. A full treatment of stress is obviously impossible here, so the scope of the following analysis is limited, primarily to stress in nouns and adjectives. The main line of argument is compatible with any formal analysis of English stress, but I adopt a foot-based theory framed in terms of Generalized Alignment (McCarthy & Prince, 1993b), as set out in §5.2.1. Once the ranking that determines canonical stress is established, stress in affixed words is analyzed in §5.2.2.

5.2.1 Stress in Unaffixed Words

In most nouns and adjectives, main stress appears on heavy penults, else on the antepenultimate syllable, and secondary stress iterates from the left edge of the word (see Chomsky & Halle 1968; Liberman & Prince 1977; Hayes 1980 [1985], 1984; McCarthy & Prince 1986, 1993b; Halle & Vergnaud, 1987; Kager, 1989; Halle & Kenstowicz, 1991; Burzio, 1994; Pater 1995; among others). Feet are moraic trochees. Well-formedness of feet is enforced by constraints that include FTBIN ("feet are binary on a syllabic or moraic analysis") and TROCHEE ("feet have initial prominence"). Main stress is drawn to the right edge of the word by the ALIGN-R constraint in (147a), which requires the head of the prosodic word (PrWd) to be at the right edge. Stress is prevented from being absolutely final by dominant NONFINALITY, defined in (147b) as a ban on footing word-final syllables.[93]

(147) Main Stress Constraints

a.	ALIGN-R ALIGN ((Hd)PrWd, R, PrWd, R)	The head of the prosodic word is aligned at the right edge of the prosodic word (main stress is at the right).
b.	NONFINALITY	Word-final syllables are not footed.

[93] On these and other stress constraints, see Prince & Smolensky (1993), McCarthy & Prince (1993ab), and Hung (1993), among others.

Together with the constraints that govern well-formedness of feet, the ranking NONFINALITY >> ALIGN-R produces main stress on a heavy penult, as in (148i), or on the antepenultimate syllable, as in (148ii).[94]

(148) Main stress placement FTBIN, TROCHEE, NONFINALITY >> ALIGN-R

i. heavy penult *indepéndent*

	TROCHEE	NONFINAL	ALIGN-R
a. in.(dé.pen).dent	*!		*
b. in.de.(pén.dent)		*!	
c. ☞ in.de.(pén).dent			*

ii. light penult *órigin*

	FTBIN	NONFINAL	ALIGN-R
a. o (rí) gin	*!		*
b. o (rí.gin)		*!	*
c. ☞ (ó.ri) gin			**

The (a) candidates have ill-formed feet; in (148ia) the weak member of the foot is heavy, and in (148iia) the foot is monomoraic. The (b) candidates violate NONFINALITY by footing the final syllable. The optimal (c) candidates fare worse on ALIGN-R than the competing (b) forms, but satisfy the higher-ranked constraints and are optimal.[95]

Secondary stress placement is governed by the ALIGN-L constraint in (149), which demands that every PrWd begin with a foot. The ALIGN-L constraint is responsible for the initial dactyls in monomorphemes like *Lòllapalóoza* and *Tàtamagóuchee*.[96]

[94] Unfooted candidates, which vacuously satisfy all constraints in (148), are not considered. A prosodic word is required to be present and properly headed by a stressed foot by high-ranking constraints like LEX PRWD and HEADEDNESS (Prince & Smolensky, 1993; Selkirk, 1995).

[95] ALIGN violations here and elsewhere are calculated in terms of syllables. For example, the head syllable of the PrWd in (148iic) is separated from the right edge of the PrWd by two syllables, so this candidate incurs two violations of ALIGN-R.

[96] Reversing the arguments in the ALIGN-L constraint produces the same result: ALIGN(Ft, L, PrWd, L), which requires every foot to be left aligned with some PrWd, similarly selects (b) over (a) in tableau (149) (and, ranked below PARSE-SYLL-TO-FT, it also produces iterative secondary stress footing (McCarthy & Prince, 1993b)). I choose to show the ALIGN(PrWd, L, Foot, L) constraint as a matter of convenience only, because it does not require assessing the alignment of each foot in a candidate parse.

(149) Secondary Stress

a. ALIGN-L — Every PrWd is aligned at its left edge with the left edge of some foot.
ALIGN(PrWd, L, Foot, L)

b. Initial Dactyls: *Lòllapalóoza*

	ALIGN -L
a. lo (là.pa) (lóo) za	*!
b. ☞ (lò.la) pa (lóo) za	

The constraint that places main stress, ALIGN-R, takes precedence over the ALIGN-L constraint, as shown by words composed of four light syllables, like *América*. Rightward placement of main stress is more important than left-alignment of feet with the PrWd.

(150) Rightward Main Stress Overrides Leftward Footing

	NONFINAL	ALIGN-R	ALIGN -L
a. (à.me)(rí.ca)	*!		
b. (á.me) ri. ca		***!	
c. ☞ a (mé.ri) ca		**	*

The markedness ranking in (150) fully determines the canonical stress pattern shown by most nouns and adjectives. Faithfulness to the prosodic organization of underlying forms plays no role in predictable stress.[97] Following McCarthy (1997b), I assume that faithfulness to prosodic organization is enforced by ANCHOR constraints like the one in (151) (see also §4.3.3 above).

(151) Prosodic Faithfulness

IO-ANCHOR(FOOT, FOOT, I) — If αRβ (α and β are correspondent segments) and
α is initial in a foot,
then β is initial in a foot.

ANCHOR constraints require correspondent segments to be identical in prosodic role.[98] The constraint in (151) says that the correspondent of a foot-initial segment is similarly foot-

[97] While there is undoubtedly some lexically-marked stress in English, the forms considered here have fully predictable stress patterns, which must be determined by a Markedness >> IO-Faithfulness ranking.

[98] ANCHOR constraints require faithfulness to an edge position or a head position (see McCarthy, 1995, 1997b; Alderete, 1995, 1996b). Without a full analysis of English stress, including lexically-marked or exceptional stress, the use of the edge ANCHOR constraint in (151) is arbitrary. With respect to the data considered here, an ANCHOR constraint on heads (requiring the correspondent of a head segment to be similarly in a head) will produce the same optimal results.

initial. The IO-ANCHOR constraint in (151) is low-ranking in English, below the NONFINALITY and ALIGN constraints that govern the predictable placement of stress feet. The ranking in (152) produces the canonical pattern of rightward but nonfinal main stress and left-aligned secondary stress.

(152) Summary Ranking: Stress in Unaffixed Words

NONFINALITY >> ALIGN-R >> ALIGN-L >> IO-ANCHOR

5.2.2 Stress in Affixed Words

Words with class 2 affixation are fully faithful to stress placement in the base. In optimal class 2 paradigms, main stress does not appear further to the right in the affixed word than it does in the base, even when a class 2 suffix adds material at the right edge of the word, and stress could shift rightward without violating NONFINALITY. The class 2 word is faithful to the base's prosodic organization because the constraint that demands rightward main stress, ALIGN-R, is dominated by OO_2-ANCHOR. The high-ranking OO-Identity constraint forces the correspondent of a foot-initial segment to be similarly foot-initial, as in (153).

(153) Class 2: Underapplication of Main Stress — OO_2-ANCHOR >> ALIGN-R

a. ob (ví.ous) ob (ví.ous) ness — *overapplication*
b. (ób) vi.ous ob (ví.ous) ness — *normal application*
☞ c. (ób) vi.ous (ób) vi.ous.ness — *underapplication*

Recursion (A)

/obvious/	NONFINAL	OO_2-ANCHOR	ALIGN-R	>>
a. ob (ví.ous)	*!			
b. (ób) vi.ous			**	
c. ☞ (ób) vi.ous			**	

Recursion (B)

>>	/obvious+ness/	NONFINAL	OO_2-ANCHOR	ALIGN-R
	a'. ob (ví.ous) ness			**
	b'. ob (ví.ous) ness		*!	**
	c'. ☞ (ób) vi.ous.ness			***

Stress does not move rightward in the affixed word because OO_2-ANCHOR >> ALIGN-R. In candidate paradigm (153a), foot-initial segments in each word correspond, but this is achieved by overapplying rightward stress placement in the base, which fatally violates NONFINALITY. Candidate (153b) is the normal application candidate; both words in the paradigm have regular antepenultimate stress. This satisfies ALIGN-R better than optimal (153c) does, but it fatally violates dominant OO_2-ANCHOR, because the foot-initial segment in the derived word does not correspond to the foot-initial segment in the base. Satisfying identity is more important than achieving rightward main stress.

In class 1 paradigms, rightward main stress placement applies normally, and paradigmatic identity is disrupted. ALIGN-R takes precedence over OO_1-ANCHOR.

(154) Class 1: Normal Application of Main Stress ALIGN-R >> OO_1-ANCHOR

- a. o (rí.gin) (ó.ri) gi nal *overapplication*
- ☞ b. (ó.ri) gin o (rí gi) nal *normal application*
- c. (ó.ri) gin (ó.ri) gi nal *underapplication*

Recursion (A)

/origin/	NONFINAL	ALIGN-R	OO_1-ANCHOR	>>
a. o (rí.gin)	*!			
b. ☞ (ó.ri) gin		*		
c. (ó.ri) gin		*		

Recursion (B)

>>	/origin+al/	NONFINAL	ALIGN-R	OO_1-ANCHOR
	a'. o (rí gi) nal		**	
	b'. ☞ o (rí gi) nal		**	*
	c'. (ó.ri) gi nal		***!	

Paradigm (154a) is eliminated by high-ranking NONFINALITY. The competition between (154b) and (154c) is decided by ALIGN-R, which selects paradigm (154b) because main stress is closer to the right edge of the affixed word, and in spite of the fact that foot-initial segments in the related words do not correspond. Rightward stress alignment overrides OO_1-ANCHOR, and the non-identical, normal application paradigm (154c) is optimal.

The OO_1-ANCHOR constraint is violated under domination by ALIGN-R, but it is high-ranking enough to compel violation of lower-ranked ALIGN-L. As discussed, secondary stress canonically aligns with the left edge of the word, but secondary stress is not left-aligned in class 1 affixed words like *orìginálity* or *arìstocrátic*. Leftward alignment of secondary stress underapplies because an OO_1-Identity constraint dominates the leftward footing constraint: OO_1-ANCHOR >> ALIGN-L.

The misapplication of secondary stress occurs only in words that have enough material to support more than one placement of a secondary stress foot to the left of the primary stress. Such words often bear more than one affix, like *orìginálity*, *àuthèntícity*, *theàtricálity*. Multiply-affixed words are part of extended paradigms like the *órigin oríginal orìginálity* paradigm shown schematically in (155).

(155) An Extended Paradigm

	OO_1-1dentity		OO_1-Identity	
(ó.ri) gin	→	o (rí.gi) nal	→	o (rì.gi)(ná.li) ty
↑		↑		↑
/origin/		/origin + al/		/origin + al + ity/

Each affix subcategorizes for an OO-correspondence relation, so that the words are related in pairs or subparadigms: *órigin oríginal* and *oríginal orìginálity*. Thus, evaluation of the multiply-affixed word involves assessment of two OO-correspondence relations. In the *órigin oríginal* subparadigm, OO_1-ANCHOR is violated under domination by ALIGN-R, and the related pair of words is not prosodically identical (see tableau (154) above). But in the *oríginal orìginálity* subparadigm, OO_1-ANCHOR is satisfied by violating ALIGN-L, as shown in tableau (156) below.

Each OO-correspondence relation in an extended paradigm is associated with a recursion of the constraint hierarchy, so tableau (156) consists of three ranked recursions of the stress constraints. Each recursion evaluates one word in the extended paradigm.

(156) Underapplication of Leftward Secondary Stress OO_1-ANCHOR >> ALIGN-L

a. o (rí.gin) o (rí. gi) nal o (rì. gi) (ná.li) ty
b. (ó.ri) gin (ó.ri) gi nal (ò.ri) gi (ná.li) ty
c. (ó.ri) gin o (rí gi) nal (ò.ri) gi (ná.li) ty
☞ d. (ó.ri) gin o (rí gi) nal o (rì. gi) (ná.li) ty

Recursion (A)

/origin/	NONFINAL	ALIGN-R	OO_1-ANCHOR	ALIGN-L	>>
a. o (rí.gin)	*!	*		*	
b. (ó.ri) gin		**			
c. (ó.ri) gin		**			
d. ☞ (ó.ri) gin		**			

Recursion (B)

>>	/origin+al/	NONFINAL	ALIGN-R	OO_1-ANCHOR	ALIGN-L	>>
	a'. o (rí. gi) nal		**		*	
	b'. (ó.ri) gi nal		***!			
	c'. o (rí gi) nal		**	*		
	d'. ☞ o (rí gi) nal		**	*		

Recursion (C)

>>	/origin+al+ity/	NONFINAL	ALIGN-R	OO_1-ANCHOR	ALIGN-L
	a". o (rì. gi) (ná.li) ty		**	*	*
	b". (ò.ri) gi (ná.li) ty		**	*	
	c". (ò.ri) gi (ná.li) ty		**	**!	
	d". ☞ o (rì gi) (ná.li) ty		**	*	*

In candidate paradigm (156a), all three words have a foot aligned with the peninitial syllable, so both subparadigms satisfy OO_1-ANCHOR, but (156a) fatally violates NONFINALITY by overapplying rightward main stress in the unaffixed base *o(rígin)*. Paradigm (156b) is eliminated by the middle recursion of constraints because its singly-affixed word **óriginal*, while prosodically identical to its base *órigin*, violates ALIGN-R worse than competitors do. Because ALIGN-R >> OO_1-ANCHOR, stress "shifts" rightward in *oríginal* in the surviving paradigms (156c) and (156d). These differ only in the footing of the multiply-affixed word *originality*. Optimal (156d) violates ALIGN-L but satisfies dominant OO_1-ANCHOR, because the foot-initial segment in the base has a correspondent that is similarly foot-

initial.[99] Thus, although ALIGN-R >> OO_1-ANCHOR forces stress to shift rightward in the subparadigm *órigin oríginal*, the OO_1-ANCHOR >> ALIGN-L ranking forces underapplication of the leftward placement of secondary stress in the *oríginal orìginálity* subparadigm.

I have presented only a brief sketch of stress in affixed words, but it is sufficient to show that both classes of affixed words are involved in the paradigmatic identity effects, and that the paradigmatic effects are different in each class of words. Words with class 2 affixation are fully faithful to the prosodic organization of the base, mimicking the base's main stress foot, while words with class 1 affixes are only partially faithful to base prosody. Two OO-ANCHOR constraints have different rank in the stress hierarchy.

(157) Summary Ranking: Stress
OO_2-ANCHOR >> ALIGN-R >> OO_1-ANCHOR >> ALIGN-L >> IO-ANCHOR

The OO_2-Identity constraint outranks both ALIGN constraints, so class 2 affixation is stress-neutral. The OO_1-Identity constraint ranks below ALIGN-R and above ALIGN-L, so class 1 affixes shift main stress, but leftward secondary stress footing misapplies. By the ranking of two distinct OO-ANCHOR constraints, class 2 affixed words are more faithful to the prosodic organization of their bases than class 1 affixed words are.

The next section shows that class 2 affixed words are also highly faithful to their bases' segmental properties, unlike words with class 1 affixation. Again, the rank of two sets of OO-Identity constraints produces the different behavior of the two classes of affixed words.

5.3 Closure Effects

Class 2 affixed words are highly faithful to their bases, and a variety of segmental alternations that apply normally in class 1 words misapply in class 2 affixation. The

99 Each paradigm in (156) incurs a mark against OO_1-ANCHOR in the lowest-ranked recursion because the initial segment of the main-stressed foot in the multiply-affixed word (the *n*) has a correspondent that is not foot-initial. Paradigm (156c) gets two marks on OO_1-ANCHOR in the lowest recursion because neither foot-initial segment in *[(ò.ri)gi(náli)ty] corresponds to a foot-initial segment in [o(rígi)nal].

familiar observation is that phonology is sensitive to class 1 affixes but insensitive to class 2 affixation, so that alternations proceed as if the class 2 affix were not present in the word. Typically (but not always), the stem inside a class 2 affix has the surface phonology of a word in isolation. Misapplication in class 2 paradigms has been analyzed as the effect of phonological closure of the stem, and I adopt closure as a descriptive term. However, I argue that there is no phonological closure at all; misapplication of phonology in class 2 paradigms is simply produced by high-ranking OO_2-Identity constraints.

Harris (1990) and Borowsky (1993) present a number of closure cases. One comes from English dialects spoken in New York City and Philadelphia that show an alternation known as æ-tensing. In syllables closed by certain consonants, the low front vowel [æ] is realized as a higher "tenser" vowel, indicated here as [E].[100]

(158) Closed Syllable æ-Tensing[101]

a.	manage	[mæ.nəǰ]	b.	man	[mEn]
	Janice	[jæ.nIs]		plan	[plEn]
	cafeteria	[kæ.fə.ti.ria]		laugh	[lEf]
	mathematics	[mæ.θə.mæ.tIks]		psychopath	[say.ko.pEθ]
	cannibal	[kæ.nə.bl]		mandible	[mEn.dI.bl]
	planet	[plæ.nIt]		plan it	[plEn#It]

Affixed words show the closure effect. Words with class 1 affixation behave normally with respect to æ-tensing, so that when the root-final consonant is parsed as an onset to a vowel-initial class 1 suffix, the preceding vowel is lax in an open syllable, as expected. But when a vowel-initial class 2 suffix opens the root's final syllable, the root vowel is tense. The æ-

[100] A large literature on æ-tensing includes Ferguson, 1972; Kahn, 1976; Payne, 1980; Labov, 1981; Borowsky, 1986; Dunlap, 1987; Schwarzchild, 1985; Benua, 1995; Morén, 1996; among others. The set of coda consonants that trigger æ-tensing varies among dialects, but it typically includes (non-velar) sonorants, and may include voiced or continuent obstruents (i.e., the triggering set of codas never includes voiceless stops). The character of the "tense" vowel is unclear. Ferguson (1972) and Labov (1981) describe it as a broken or diphthongized vowel, while Morén (1996) argues that [E] is shorter than its lax counterpart. Most analysts agree that [E] is higher than [æ], but other differences are in dispute.

The nature of the alternation has also been questioned. Most analysts see æ-tensing as predictable, although all note a significant number of (monomorphemic) exceptions. Morén (1996) claims that the [æ/E] contrast is distinctive, and that the contrast is neutralized to [æ] before voiceless stops. I assume that æ-tensing is allophonic (see fn. 103), although this is not crucial. Under any analysis of the canonical pattern, paradigmatic identity constraints are responsible for the the minimal contrasts between the two classes of affixed words in (159).

[101] It seems likely that the consonants that follow [æ] in (158a) are ambisyllabic, rather than simply in the onset. The conditioning context of æ-tensing treats syllables closed by ambisyllabic consonants like open syllables, and differently from syllables closed by consonants that are exclusively in coda.

tensing process overapplies in class 2 affixation so that *m[E]ssable* is identical in vowel quality to its base *m[E]ss*.

(159) Normal Application in Class 1, Overapplication in Class 2 Affixation

unaffixed base tense in closed syllable		class 1 affixation lax in open syllable		class 2 affixation tense in open syllable	
class	[klEs]	classic	[klæ.sik]	classy	[klE.si]
mass	[mEs]	massive	[mæ.siv]	massable	[mE.səbl]
pass	[pEs]	passive	[pæ.siv]	passing	[pE.siŋ]

The different behavior of class 1 and class 2 affixed words follows from the rank of two distinct sets of OO-Identity constraints in the hierarchy of æ-tensing constraints. Normal application of æ-tensing disrupts identity in class 1 paradigms like *m[E]ss* *m[æ]ssive*, because an OO_1-Identity constraint on vowel quality is violated under domination by the *E constraint that penalizes marked tense vowels.[102] In class 2 affixation, however, paradigmatic identity takes precedence over markedness: words in the subparadigm *m[E]ss* *m[E]ssable* agree in vowel quality, even though this requires the affixed word to have a marked tense vowel in an open syllable and violate *E. The two patterns exhibited by the two classes of affixed words entail different rankings of paradigmatic identity constraints with respect to a markedness constraint: OO_2-Identity ranks above *E, and OO_1-Identity ranks below it.

Harris and Borowsky analyze other cases from other English dialects. In London Vernacular English the vowel in words like *pause, sauce, water* is a "closing" diphthong [ou]. In word-final position, this vowel is centralized to [ɔə]. The centering variant also appears in non-word-final position when it is followed by a class 2 "inflectional, derivational or compound boundary" (Harris, 1990:96). Thus the simplex word *pause* has the closing vowel, and the derived word *paws* has the centering diphthong. The derived word takes the

[102] In allophonic æ-tensing, *E is violated under domination by a context-sensitive markedness constraint that bans less-marked lax [æ] from closed syllables. The hierarchy $*æC]_\sigma$ >> *E >> *æ requires tense [E] in closed syllables, and lax [æ] everywhere else (see Benua, 1995).

centering diphthong in non-final position to match its base *paw*, where centralization is properly conditioned in the word-final vowel.

(160) London Vernacular English [ou] --> [ɔə] / __#

non-final position, closing diphthong [ou]		word-final position, centering diphthong [ɔə]		overapplication in class 2 non-word-final [ɔə]	
pause	board	paw	bore	paws	bored
sauce	water	poor[103]	saw	poorly	poured
lord	dawn	soar	draw	soars	draws

Another case comes from Northern Irish English, where the [ɪə] diphthong in *fate, vain, cater* is realized word-finally as a long vowel [ɛː]. The long vowel also appears in non-final position if it precedes a class 2 affix or the second member of a compound. There is a minimal contrast in this dialect between *staid* and *stayed*; the former has the expected diphthong, and the latter has a long vowel in agreement with its base *stay*, where the long vowel is properly conditioned.

(161) Northern Irish English [ɪə] --> [ɛː] / __#

non-final position, diphthong [ɪə]		word-final position, long vowel [ɛː]		overapplication in class 2 non-word-final [ɛː]	
fate	face	say	play	stayed	playful
vain	cater	day	stray	ray-gun	days
station	staid				

Scottish English has a similar closure pattern. In this dialect, vowel length is ruled by Aitken's Law: vowels are long in word-final position, and short elsewhere. However, long vowels occur non-finally in words with class 2 affixation, so this dialect has the minimal pair *brood*, with a short vowel, and *brewed*, in which the vowel is long.

(162) Scottish English, Aitken's Law [+syll] --> [+long] / __#

non-final position, short vowel		word-final position, long vowel		overapplication in class 2 non-final long vowel	
brood	need	brew	knee	brewed	kneed

[103] London Vernacular is an r-dropping dialect, so words like *pore* and *soar* are vowel-final.

Again, a word with class 2 affixation deviates from a canonical pattern to achieve identity with its base. The vowel in Scottish English *brewed* must be long, even though it is not word-final, because the corresponding vowel is word-final and predictably long in *brew*.

These kinds of closure effects are common. In many languages, certain affixes appear to be irrelevant to the phonology, in that they fail to trigger or block expected phonological processes.[104] As discussed, most accounts of closure patterns rely on representational or serial assumptions. In a representational theory, class 2 affixes are outside of the adjacent stem's morphological or prosodic constituency, and therefore unavailable to phonological rules. In a theory of prosodic closure, for example, the class 1 words in (159) have lax vowels because the class 1 suffix is syllabified with the stem (e.g., *massive* [mæ.sɪv]), and the class 2 words have tense vowels because class 2 suffixes are not syllabified with the stem (e.g., *massing* [mEs.ɪŋ]). In a serial theory, there is derivational closure: class 1 affixation takes place early and bleeds the æ-tensing rule, but class 2 affixation takes place later, and the effects of æ-tensing in *mass* cannot be undone after the *-ing* affix appears.

The structural account and the serial theory are less than satisfying because there is evidence that (i) class 2 affixes are prosodified with the adjacent stem, just like class 1 affixes are, and (ii) phonological processes are fed by class 2 affixation. Two cases reported in Harris (1990) and Simpson (1980) provide some of this evidence (see also Borowsky, 1993). In London Vernacular English, syllable-final laterals cause rounding in a preceding mid-back diphthong; [ʌʊ] becomes [ɒʊ] before [l] in a coda position. Harris reports that "[w]herever the [ɒʊ] variant appears in an underived root, it is retained in related derived forms, even if the following [l] is no longer tautosyllabic on the surface." (1990:97). This overapplication identity effect occurs only in class 2 affixation and compounding.

[104] Closure effects occur in Arabic (Brame, 1974; Kiparsky, 1982a), German (Moltmann, 1990; Borowsky, 1993), Dutch (Rubach, 1984); Carib (Inkelas, 1989; Kenstowicz, 1995), Rotuman (Churchward, 1940; Blevins, 1994), Hausa (Newman, 1986) and Kannada (Aronoff & Sridhar, 1983), among others.

Class 1 affixation shows normal application of the rounding rule; the only class 1 example given is *polar*, which has the same unround vowel as monomorphemes like *Roland*.

(163) London Vernacular [ʌʊ] --> [ɒʊ] / __ [+lat]]$_{\sigma}$

heterosyllabic lateral, unround vowel [ʌʊ]		tautosyllabic lateral, round vowel [ɒʊ]		overapplication in class 2 round vowel [ɒʊ]	
Roland	cola	roll	goal	rolling roller	goalie

Harris claims that a root-final lateral is syllabified as onset to the vowel-initial class 2 suffix. Thus, the class 2 affix in *roller*, like the class 1 affix in *polar*, is prosodically integrated into the stem. This claim is supported by a similar case from a dialect spoken in Adelaide, Australia, which has an independent diagnostic of syllabification (Simpson, 1980; Borowsky, 1993). In this case, laterals are dark [ɫ] in coda and light [l] in onset position. Again, a rounding process is involved: non-low back tense vowels are rounded before a tautosyllabic dark [ɫ]. The round variant also appears before a light [l] in words with class 2 affixation, in an overapplication identity effect: rounding applies in words like *goalie*, *fooling* and *bowler* because rounding is properly conditioned by the coda [ɫ] in their bases *goal*, *fool* and *bowl*, and OO_2-Identity constraints on vowel quality are high-ranking in the grammar.

(164) Adelaide Dialect [ʌʊ, əʊ] --> [ɔu, uː] / __ ɫ]$_{\sigma}$

light [l], unround vowel		dark [ɫ], round vowel		overapplication in class 2 light [l], round vowel	
holy	[hʌʊ.liy]	goal	[gɔuɫ]	goalie	[gɔu.liy]
Julie	[ǰəʊ.liy]	bowl	[bɔuɫ]	bowler	[bɔu.lər]
bowler (hat)	[bʌʊ.lər]	fool	[fuː ɫ]	fooling	[fuː.lɪŋ]
		cool	[kuː ɫ]	cooler	[kuː.lər]

Class 2 paradigms like *goal* *goalie* and *fool* *fooling* are not entirely identical, since the base's dark coda [ɫ] corresponds with a light onset [l] in the derived word. Syllabification and the dark/light alternation in laterals apply normally, disrupting identity of related words, at the same time that the rounding process overapplies.

The Adelaide case shows that class 2 affixes are not prosodically separate from the adjacent stem, and that the stem in a class 2 affixed word does not necessarily have the phonology of a word in isolation – class 2 affixation feeds some phonological processes. While it is possible to model the Adelaide case with either a representational or a serial theory, by allowing some class 2 affixes to be syllabified with their stems or by ordering syllabification and other phonological processes after class 2 affixation (perhaps at a post-lexical level), these are elaborations of the basic claims of each theory.

TCT predicts cases like Adelaide English without modification. Representational assumptions are unnecessary, and both class 1 and class 2 affixes are syllabified with their stems. The different behavior of the two classes of words follows not from prosodic constituency, but from the ranking of faithfulness constraints: class 2 *roller* has a round vowel because its base *roll* has a round vowel and OO_2-Identity constraints on vowel quality are high-ranking, and class 1 *polar* has an unround vowel even though the corresponding round vowel in *pole* is round, because OO_1-Identity constraints are lower-ranked. That identity in the class 2 paradigm *roll* *roller* is merely partial – corresponding vowels are identical but corresponding laterals are not – is also predicted. Every variable dimension of the representation is evaluated by a separate faithfulness constraint. Some OO-Identity constraints are high-ranking and determine optimal outputs, and others are low-ranking and irrelevant.

In TCT, constraint interaction achieves what serial theory accomplishes by ordering phonological and morphological rules. When OO-Identity outranks an alternation-inducing markedness constraint, the process appears to "precede" class 2 affixation, and when OO-Identity is dominated by markedness, phonology is said to "follow" affixation. The differences between the ranking and the ordering theories of closure are significant. For one thing, arbitrariness of rule-ordering is troublesome, since one of the aims of ordering theory is to discover natural or independently-motivated orderings in the derivation. So, for example, if the dark/light alternation in laterals and rounding in vowels in Adelaide English are both word-level processes (i.e., they do not apply cyclically after each concatenation, and they do not apply between words), then the fact that one precedes and the other follows class 2 affixation is a difficulty. Constraint interaction, on the other hand, is inherently arbitrary. Ranking is free, and any constraint may rank above or below any conflicting constraint. In the Adelaide dialect, some faithfulness constraints rank above, and others rank below, the conflicting markedness requirements.

Two closure cases are analyzed below. The first is underapplication of dentalization in Northern Irish English (§5.3.1) and the second is overapplication of cluster simplification in standard English (§5.3.2).

5.3.1 Northern Irish Dentalization

An underapplication closure effect occurs in English dialects spoken in Northern Ireland (Harris, 1990). In the general case, the coronals [t, d, n, l] are pronounced as dentals [t̪, d̪, n̪, l̪] when they appear before dental fricatives (*eighth* [eyt̪θ], *tenth* [tɛn̪θ], *said that* [sɛd̪ ðæt], *will the* [wIl̪ ðə]) and rhotics [r, ər].

(165) Allophonic Dentalization [t, d, n, l] --> [t̪, d̪, n̪, l̪] / __ [θ, (ə)r]

a. Dental before θ and (ə)r		b. Alveolar elsewhere	
train	[t̪reyn]	tame	[teym]
drain	[d̪reyn]	loud	[laud]
matter	[mæt̪ər]	late	[leyt]
ladder	[læd̪ər]	dine	[dayn]
pillar	[pɪl̪ər]	kill	[kɪl]
anthem	[æn̪θəm]	element	[ɛləmənt]

Two classes of affixed words behave differently with respect to this alternation. Words with class 1 affixes show normal application of dentalization: when a class 1 suffix introduces a dentalization trigger, the process applies in the affixed word, as in (166a).[105] Words with class 2 affixes show underapplication of dentalization: when a class 2 suffix introduces a triggering rhotic, dentalization fails to apply, as in (166b).

[105] The initial vowel of the suffix *-ary* is dropped in these dialects, so that the coronal cluster in *element* is adjacent to the suffix's rhotic.

(166) Dentalization in Affixed Words

a. Class 1, normal application Dental before class 1 trigger		b. Class 2, underapplication Alveolar before class 2 trigger	
elementary	[ɛləmən̪t̪riy]	later	[leytər]
sanitary	[sænɪt̪riy]	louder	[laudər]
tenth	[tɛn̪θ]	diner	[daynər]
eighth	[eyt̪θ]	cooler	[kulər]
		killer	[kɪlər]
		bedroom	[bɛdrʊm]

This is a typical closure effect: the phonology is sensitive to the presence of the class 1 suffix, but insensitive to class 2 affixation. The stem inside the class 2 suffix is phonologically closed off, and behaves as if the suffixal rhotic were not present.

Dentalization underapplies in class 2 affixation to respect paradigmatic identity. Because the phonology underapplies, words in the class 2 paradigm *lou[d]* *lou[d]er* are identical with respect to dentalization – that is, both words contain an alveolar because OO_2-Identity outranks the constraints that demand dentals before rhotics. Class 1 affixation is different, and does not show any misapplication. Dentalization applies normally, and words in the class 1 paradigm *eleme[nt]* *eleme[n̪t̪]ary* are not identical. Identity constraints on class 1 affixation are low-ranking, below the constraints that demand dentals before rhotics.

(167) Two Distinct OO-Correspondence Relations

a. Class 1 Affixation

element → elementary (OO_1-Identity)
↑ ↑
/elemen̪t̪/ /elemen̪t̪ + ary/

b. Class 2 Affixation

loud → louder (OO_2-Identity)
↑ ↑
/loud̪/ /loud̪ + er/

Before I show how the two sets of OO-Identity constraints regulate dentalization in affixed words, I need a constraint-based analysis of the canonical dentalization pattern.

5.3.1.1 Canonical Allophonic Dentalization

I do not attempt an analysis of the dentalization process itself; for present purposes I assume it is an alternation in [±distributed] features. Dentalization appears to be assimilation to dental fricatives [θ, ð], but dissimilation from [-distributed] retroflex rhotics.

Also, the two triggers differ in their domains; assimilation to dental fricatives occurs between words, while dissimilation from rhotics does not. I leave these issues aside, and concentrate on the distribution of alveolars and dentals in surface forms. Since dental fricatives are rare in affix-initial position, I focus on dentalization before [r].[106]

In simplex words, the dental/alveolar alternation is determined positionally; if a coronal precedes [r] it is a [+distributed] dental, otherwise it is a [-distributed] alveolar. The underlying [±distributed] feature of the coronal is irrelevant, since its surface position determines what feature it has in the optimal output. Inputs are rich in non-contrastive [±distributed] features, and may present either feature in any context. Markedness constraints, ranked above IO-Faith, determine the predictable surface distribution. No matter what feature the input presents, coronals are dental before [r] and alveolar everywhere else.

In allophonic alternations, there is an interaction of markedness constraints: a context-free constraint prefers the less-marked alternant in the general case, and a higher-ranked constraint bans that less-marked alternant from a specific context (McCarthy & Prince, 1995). For present purposes, I make use of the following constraints.[107] The *DENT >> *ALV ranking in (168a) determines the relative markedness of the allophones; dentals are more marked because they violate a higher-ranked constraint. The structural constraint in (168b), *ALV-RHOTIC, prohibits less-marked alveolars from a particular context. Ranked above *DENT, *ALV-RHOTIC forces marked dentals to appear. The IO-Faith constraint in (168c) demands agreement of input-output correspondents in [±distributed] features.

[106] The dental fricative [θ] occurs as a class 1 suffix (in *width, length, health*, etc.), but no class 2 suffixes begins with this sound.
[107] Without an in-depth analysis of the dentalization process, the choice of a more-marked allophone and the formulation of the structural constraint are arbitrary. As usual, the shortcuts taken in the analysis of the canonical pattern have no real impact on the main line of argument – whatever produces canonical dentalization must be forced to underapply in affixed words by dominant OO-Identity constraints.

(168) Constraints

a. *DENT >> *ALV — Dentals are more marked than alveolars.
*[+DIST] >> *[-DIST]

b. *ALV-RHOTIC — Alveolar-rhotic sequences are prohibited.

c. IO-IDENT[±DIST] — Correspondents in an input-output relation agree in [±DIST].

Two simple interactions of these constraints produce the canonical dental/alveolar alternation. The hierarchy *DENT >> IO-IDENT[±DIST] states a general ban on marked dental allophones. The ranking *ALV-RHOTIC >> *DENT overrides that general ban, and forces more-marked dentals before [r]. Other constraints not shown in (169), including constraints against segmental deletion or insertion or change of major POA, must also dominate *DENT, making realization of a dental the most harmonic way to satisfy the high-ranking *ALV-RHOTIC constraint.

(169) Canonical Dentalization: *ALV-RHOTIC >> *DENT >> IO-IDENT[±DIST]

a. Dental in Pre-Rhotic Context

(i) input alveolar

/train/	*ALV-RHOTIC	*DENT	IO-IDENT[±DIST]
a. train	*!		
b. ☞ t̪rain		*	*

(ii) input dental

/t̪rain/	*ALV-RHOTIC	*DENT	IO-IDENT[±DIST]
a. train	*!		*
b. ☞ t̪rain		*	

b. Alveolar Elsewhere

(i) input alveolar

/loud/	*ALV-RHOTIC	*DENT	IO-IDENT[±DIST]
a. ☞ loud			
b. loud̪		*!	*

(i) input dental

/loud̪/	*ALV-RHOTIC	*DENT	IO-IDENT[±DIST]
a. ☞ loud			*
b. loud̪		*!	

In this grammar, dentals appear always and only before [r], no matter which alternant is presented by the input string. Inputs are rich in non-contrastive [±distributed] features, and IO-IDENT[±DIST] is low-ranking in the dentalization hierarchy.

5.3.1.2 Dentalization in Affixed Words

Words with class 1 affixation conform to the canonical dentalization pattern, and words with class 2 affixes do not. Pre-rhotic dentalization underapplies in class 2 affixed words because dentalization is not conditioned in the related base. The two different patterns, normal application in class 1 and underapplication in class 2, are produced by ranking two different OO-Identity constraints ranked in the dentalization hierarchy. OO_2-IDENT[±DIST] outranks *ALV-RHOTIC, so satisfying paradigmatic identity in *loa[*d*]* *loa[*d*]er* takes precedence over dentalizing the coronal before the rhotic suffix. OO_1-IDENT[±DIST] is lower-ranked, below *ALV-RHOTIC, and dentalization applies normally in the class 1 paradigm *eleme[nt]* *eleme[n̪t̪]ary*, even though this decreases identity of the related words.

Tableau (170) shows evaluation of a class 2 paradigm against recursions of the dentalization hierarchy. Candidate (170a) is the overapplication paradigm, in which dentalization applies in the base, where it is not conditioned. In candidate (170b) dentalization applies normally, always and only where it is expected. In optimal (170c), dentalization underapplies in the affixed word because dentalization is not conditioned in the base.

(170) Class 2: Underapplication

OO_2-IDENT[±DIST] >> *ALV-RHOTIC >> *DENT >> IO-IDENT[±DIST]

	candidate (a)	loa[d̪]	loa[d̪]er	*overapplication*
	candidate (b)	loa[d]	loa[d̪]er	*normal application*
☞	candidate (c)	loa[d]	loa[d]er	*underapplication*

Recursion (A)

/loa[d̪]/	OO_2-ID[±DIST]	*ALV-RHOTIC	*DENT	IO-ID[±DIST]	>>
a. loa[d̪]			*!		
b. loa[d]				*	
c. ☞ loa[d]				*	

Recursion (B)

>>	/loa[d̪]+er/	OO_2-ID[±DIST]	*ALV-RHOTIC	*DENT	IO-ID[±DIST]
	a'. loa[d̪]er			*	
	b'. loa[d̪]er	*!		*	
	c'. ☞ loa[d]er		*		*

The overapplication candidate (170a) has a subharmonic base, and is ruled out by its violation of *DENT in the dominant recursion of constraints. The competition between normal application (170b) and underapplication (170c) is decided by OO_2-IDENT[±DIST] ranked above *ALV-RHOTIC – underapplication is optimal because it satisfies the dominant identity constraint. The optimal paradigm's violation of the dentalization-inducing markedness constraint *ALV-RHOTIC is low-ranking and irrelevant.

As discussed, underapplication can be optimal only if paradigms are evaluated against a recursive hierarchy of constraints. Underapplication entails violation of an alternation-inducing markedness constraint – in this case, underapplication violates *ALV-RHOTIC – but overapplication satisfies it, and violates only lower-ranked context-free markedness or IO-Faith constraints. Non-recursive evaluation of paradigms can only produce overapplication.

(171) Wrong Result from a Non-Recursive Hierarchy

/loaD/ /loa[d̪] + er_2/	OO_2-ID[±DST]	*ALV-RHOT	*DENT	IO-ID[±DST]
a. 💣 loa[d̪] loa[d̪]er			* *	* *
b. loa[d] loa[d]er		*!		

The base of an OO-correspondence relation has priority over the derived word, in that the base must conform to the language's canonical patterns. The priority of the base is ranking priority in the recursive hierarchy – it is subject to higher-ranked constraints, and is always maximally harmonic. When a phonological process is properly conditioned in the derived word but not in the base, overapplication is ruled out and underapplication is ruled in by the recursive evaluation, as in (170).

Only class 2 paradigms in Northern Irish English show the underapplication identity effect. Class 1 affixed words conform to the canonical dentalization alternation, even when this entails non-identity of affixed word and base. Thus, when a coronal is followed by an [r] in a class 1 affix, it surfaces as dental, even though the corresponding segment in the base is alveolar. Dentalization takes precedence over paradigmatic identity; the constraint that demands dentals, *ALV-RHOTIC, dominates OO_1-IDENT[±DIST].

(172) Class 1: Normal Application

*ALV-RHOTIC >> OO_1-IDENT[±DIST], *DENT >> IO-IDENT[±DIST]

	candidate (a)	eleme[n̪t̪]	eleme[n̪t̪]ry	*overapplication*
☞	candidate (b)	eleme[nt]	eleme[n̪t̪]ry	*normal application*
	candidate (c)	eleme[nt]	eleme[nt]ry	*underapplication*

Recursion (A)

Input: /eleme[nt]/	*ALV-RHOTIC	OO_1-ID[±DIST]	*DENT	IO-ID[±DIST]	>>
a. eleme[n̪t̪]			**!	* *	
b. ☞ eleme[nt]					
c. eleme[nt]					

Recursion (B)

>>	Input: /eleme[nt]+ary/	*ALV-RHOTIC	OO_1-ID[±DIST]	*DENT	IO-ID[±DIST]
	a'. eleme[n̪t̪]ry				
	b'. ☞ eleme[n̪t̪]ry		* *	* *	* *
	c'. eleme[nt]ry	*!			

Candidate paradigm (172a), which overapplies dentalization in the base, is eliminated by its violation of *DENT in the dominant recursion. The normal application and underapplication paradigms in (172b-c) have the same maximally-harmonic base with word-final alveolars. The underapplication candidate in (172c) violates *ALV-RHOTIC by failing to dentalize in the affixed word, and this violation is fatal. Normal application in (172b) is optimal, in spite of its OO_1-Identity violation.

No ranking can be established between OO_1-IDENT[±DIST] and *DENT. It can only be shown that both rank below *ALV-RHOTIC, and that *DENT outranks IO-IDENT[±DIST]. The ranking of *DENT and OO_1-Identity could be established if dentalization is conditioned in the base and not in the derived word, the reverse of the situation in (172). Suppose class 1 morphology includes a truncation process that removes the word-final rhotic from *ladder*, producing *lad*. If dentalization overapplies and the truncated word surfaces with a dental [læd̪ər læd̪], then OO_1-IDENT[±DIST] >> *DENT, and if dentalization applies normally in the hypothetical class 1 truncation and *lad* surfaces with an alveolar, the opposite ranking holds.

Now suppose that the hypothetical *ladder* *lad* truncation belongs to class 2. Given the OO$_2$-IDENT[±DIST] >> *ALV-RHOTIC ranking established by underapplication in *loa[d̪]* *loa[*d*]er*, the optimal class 2 truncation is predicted to show overapplication, as in la*[d̪]er* *la[d̪],* since this satisfies both high-ranking constraints.

(173) Hypothetical Class 2 Truncation: Overapplication in *ladder* *lad*

OO$_2$-IDENT[±DIST] >> *ALV-RHOTIC >> *DENT >> IO-IDENT[±DIST]

	candidate (a)	la[d]er la[d]	*underapplication*
	candidate (b)	la[d̪]er la[d]	*normal application*
☞	candidate (c)	la[d̪]er la[d̪]	*overapplication*

Recursion (A)

/læ[d̪]er/	OO$_2$-ID[±DIST]	*ALV-RHOTIC	*DENT	IO-ID[±DIST]	>>
a. læ[d]er		*!			
b. læ[d̪]er			*		
c. ☞ læ[d̪]er			*		

Recursion (B)

>>	/loa[d̪]+er/	OO$_2$-ID[±DIST]	*ALV-RHOTIC	*DENT	IO-ID[±DIST]
	a'. læ[d]				*
	b'. læ[d]	*!			*
	c'. ☞ læ[d̪]			*	

Were this kind of truncation possible, some class 2 paradigms show underapplication (like *load* *loader*) and others would show overapplication (as in *ladder* *lad*), depending on which word in the paradigm properly conditions dentalization. This hypothetical case reinforces the point made earlier, that underapplication is optimal only when the alternative is non-canonical phonology in the paradigm's base. Overapplication is always more harmonic than underapplication, and it will win out whenever it can – namely, whenever it isn't prevented by the recursive evaluation.

To summarize, paradigmatic identity forces underapplication of dentalization in class 2 affixed words of Northern Irish English, while dentalization disturbs paradigmatic identity in class 1 affixation paradigms. The dentalization hierarchy is repeated in (174).

(174) Summary Ranking

OO$_2$-ID[±DIST] >> *ALV-RHOTIC >> OO$_1$-ID[±DIST], *DENT >> IO-ID[±DIST]

Class 2 affixed words are faithful to their bases and class 1 words are not, because two distinct OO-Identity constraints rank differently in the dentalization hierarchy. The constraint on the OO$_2$-correspondence relation is higher-ranked than its OO$_1$-Identity counterpart, as is typically true in English. In this specific example, the OO$_2$-Identity >> OO$_1$-Identity ranking is established by an intervening markedness constraint, *ALV-RHOTIC. In the cluster simplification case analyzed below, OO$_2$-Identity >> OO$_1$-Identity is established by intervention of an IO-Faith constraint.

5.3.2 Standard English Cluster Simplification

In all English dialects, certain consonant clusters are simplified in word-final position. For example, the root-final coronal nasal does not surface in *condemn* [kʌn.dɛm], presumably for syllabification reasons; both nasals cannot be part of the same coda cluster. The coronal nasal must be present in the underlying form of this root, because it surfaces in *condemnation* [kʌn.dɛm.ney.šʌn], where it is syllabified as an onset to a vowel-initial class 1 suffix. However, when the same root precedes a vowel-initial class 2 suffix, the coronal nasal fails to surface, even though it could be accommodated by the syllable structure in *condeming* [kʌn.dɛ.mɪŋ], *[kʌn.dɛm.nɪŋ]. This is an overapplication identity effect: cluster simplification applies in the class 2 affixed word, where it is not properly conditioned, because cluster simplification is properly conditioned in the unaffixed base. A number of other clusters show similar behavior (see Borowsky, 1986, 1993).

(175) Cluster Simplification

	Simplex Base *cluster simplifies*	Class 1 Affix *cluster surfaces*	Class 2 Affix *cluster simplifies*
a.	condemn	condemnation	condemning
	damn	damnify	damning
b.	bomb	bombard	bombing
	crumb	crumble	crumby
	thumb	Thumbelina	thumbing
c.	long	elongate	longing
	strong	strongest	strongly
d.	sign	signature	signer
	resign	resignation	resigning

The cluster resolution cases demonstrate a direct conflict between IO-Faith and OO-Identity constraints. In class 1 affixation, IO-Faith takes precedence over OO_1-Identity. The affixed word in the class 1 paradigm *condemn* *condemnation* realizes all input segments, in satisfaction of IO-MAX, even though one of these segments is not realized in the base, and OO_1-DEP is violated (the root-final [n] in the affixed word has no base correspondent). Thus, the ranking is IO-MAX >> OO_1-DEP. In class 2 affixation, on the other hand, IO-MAX is violated under domination by OO_2-Identity. In *condemn* *condemning*, the input root's [n] is not realized in the affixed word so that an OO_2-DEP violation is avoided. Class 2 affixed words are more faithful to their bases than class 1 affixed words are; in particular, class 2 affixed words can only realize root segments that are also realized in the base. The relevant ranking is OO_2-DEP >> IO-MAX.[108]

To demonstrate the conflict between IO-MAX and the two OO-DEP constraints, I need some analysis of the canonical cluster simplification phenomenon. Cluster simplification seems to be driven by syllabification constraints, but it is not immediately obvious what these constraints are. Sonority sequencing could play a role; the [gn] cluster in (175d) has a marked sonority rise, and the [mb] and [ŋg] clusters in (175b-c) may have an insufficient sonority fall, unlike the licit word-final clusters [mp] and [ŋk] (coronal [nd]

[108] Obviously, all affixed words violate OO-DEP by realizing affixal material. However, I assume a bifurcation of faithfulness into Root-Faith and Affix-Faith (McCarthy & Prince, 1994ab), and that OO_{Affix}-DEP constraints are violated under domination by IO_{Affix}-MAX and/or a MORPHDIS constraint that requires morphologically distinct forms to be phonologically distinguishable (see § 2.3.2). The OO-DEP constraints relevant to the cluster simplification analysis are OO_{Root}-DEP constraints.

appears to be exempt from such a sonority-distancing requirement). I leave these questions aside, and invoke a brute-force constraint specific to the *condemn* example that bans tautosyllabic [mn] clusters. The $*mn]_\sigma$ constraint has to outrank IO-MAX to force deletion of one of the nasals in the unaffixed word *condemn*.

(176) Canonical Cluster Simplification

/kandɛmn/	$*mn]_\sigma$	IO-MAX
a. kʌn.dɛmn	*!	
b. ☞ kʌn.dɛm		*

Class 2 affixation shows overapplication of the cluster simplification; the root-final cluster in *comdemning* is simplified even though the two nasals could be heterosyllabic in the affixed word. The OO_2-correspondence constraint that forces overapplication is OO_2-DEP, which requires all segments in the affixed word to correspond to a segment in the base. Ranked above IO-MAX, OO_2-DEP prevents realization of the root-final coronal nasal in the affixed word.

(177) Overapplication in Class 2 $*mn]_\sigma$, OO_2-DEP >> IO-MAX

a.	[kʌn.dɛmn]	[kʌn.dɛm.nɪŋ]	*underapplication*
b.	[kʌn.dɛm]	[kʌn.dɛm.nɪŋ]	*normal application*
☞ c.	[kʌn.dɛm]	[kʌn.dɛ.mɪŋ]	*overapplication*

Recursion (A)

/kandɛmn/	$*mn]_\sigma$	OO_2-DEP	IO-MAX	>>
a. kʌn.dɛmn	*!			
b. kʌn.dɛm			*	
c. ☞ kʌn.dɛm			*	

Recursion (B)

>>	/kandɛmn + ɪŋ/	$*mn]_\sigma$	OO_2-DEP	IO-MAX
	a'. kʌn.dɛm.nɪŋ			
	b'. kʌn.dɛm.nɪŋ		*!	
	c'. ☞ kʌn.dɛ.mɪŋ			*

Candiate paradigm (177a) is the underapplication candidate: cluster simplification fails to apply in the base [kʌn.dɛmn] because it is not conditioned in the affixed word [kʌn.dɛm.nɪŋ]. Underapplication in the base violates high-ranking markedness in the dominant recursion, and is not optimal. Candidate (177b) is the normal application candidate, in which cluster simplification applies always and only where it is properly conditioned, so both nasals surface heterosyllabically in the derived word. This candidate fatally violates OO_2-DEP, since the coronal nasal /n/ has no correspondent in the base. The optimal overapplication paradigm (177c) satisfies OO_2-Identity by failing to realize the coronal nasal in the derived word and violating lower-ranked IO-MAX.

In class 2 affixation, the root-final coronal nasal in /kandɛmn/ cannot be realized in the affixed word *condemning* simply because it is not realized in the output base *condemn*. Class 1 affixation is different. In class 1 paradigms like *condemn* *condemnation*, the root-final cluster must be realized in the affixed word in spite of the entailed violation of OO_1-Identity. Because IO-MAX >> OO_1-DEP, both nasals surface in the affixed word.

(178) Class 1: Normal Application $*mn]_\sigma$ >> IO-MAX >> OO_1-DEP

a. [kʌn.dɛmn] [kʌn.dɛm.ney.šʌn] *underapplication*

☞ b. [kʌn.dɛm] [kʌn.dɛm.ney.šʌn] *normal application*

c. [kʌn.dɛm] [kʌn.dɛ.mey.šʌn] *overapplication*

Recursion (A)

/kandɛmn/	$*mn]_\sigma$	IO-MAX	OO_1-DEP	>>
a. kʌn.dɛmn	*!			
b. ☞ kʌn.dɛm		*		
c. kʌn.dɛm		*		

Recursion (B)

>>	/kandɛmn + (ey)šʌn/	$*mn]_\sigma$	IO-MAX	OO_1-DEP
	a'. kʌn.dɛm.ney.šʌn			
	b'. ☞ kʌn.dɛm.ney.šʌn			*
	c'. kʌn.dɛ.mey.šʌn		*!	

The underapplication paradigm (178a) is not optimal because it violates $*mn]_\sigma$. The competition between normal application in (b) and overapplication in (c) demonstrates the IO-Faith >> OO_1-Identity ranking. Candidate (178b) satisfies OO_1-DEP, but incurs a

greater violation of IO-MAX than optimal (178c), since the affixed word does not provide a correspondent for one segment of the input root. The optimal paradigm shows normal application of cluster simplification because OO_1-Identity ranks lower than IO-Faith.

For words with class 1 affixation, it is more important to realize all input segments than to avoid a consonant without a base correspondent: IO-MAX >> OO_1-DEP. For words with class 2 affixation, identity with the base is paramount, and input material is not realized in the affixed word if it is not realized in the base OO_2-DEP >> IO-MAX. The cluster simplification hierarchy is summarized in (179).

(179) Cluster Simplification

$*mn]_\sigma$, OO_2-DEP >> IO-MAX >> OO_1-DEP

This ranking same of IO-Faith and OO-Identity constraints is responsible for another diagnostic of affix classhood in English: the possibility of affixation to bound roots.

5.4 Aggressive Closure: Affixation to Bound Roots

One of the differences between class 1 and class 2 affixes in English is whether or not they attach to bound roots: class 1 affixes can (*electric, inane*) and class 2 affixes cannot (**electriful*, **unane*).[109] This follows directly from the ranking of the faithfulness constraints in (179): OO_2-DEP >> IO-MAX >> OO_1-DEP. The cluster simplification case shows that root material cannot be realized in class 2 affixed words unless it is also present in the base. The inability of class 2 affixes to attach to bound roots is part of the same generalization: if there is no output base, there can be no class 2 affixed word.[110]

Bound roots, which require an affix or other morphological augmentation, must be distinguished from free roots, which can appear as words on their own. I assume that bound roots are lexically marked as such and prevented from surfacing on their own by an inviolable morpho-phonological constraint BOUNDROOT (roughly, "unaffixed bound roots

[109] The small number of exceptions to this generalization include *hapless, feckless, gruesome* and *fulsome* (see Allen, 1978).

[110] I am indebted to Eric Bakovic for making this clear to me.

cannot be words"). When an unaffixed bound root is fed into the grammar, BOUNDROOT >> IO-MAX ensures that the optimal output is the null parse, which I take to be an empty string [ø].

McCarthy & Prince (1993a:§7.2) characterize the null parse as a phonologically unanalyzed representation (see also Prince & Smolensky, 1993; Mester, 1994). The grammar is fed an input and gives back the unaltered string. Considering this in light of Correspondence Theory, I take the null parse to be a failure by the Gen function to supply any correspondent output segments to a string of input segments.

The null output of an input bound root can stand in an OO-correspondence relation with an affixed word, as shown in the schematics in (180).

(180) Affixation to Bound Roots

a. Class 1 affixation to a bound root

OO$_1$-Identity
ø → electric
↑ ↑
/electr/ /electr + ic/

b. Class 2 affixation to a bound root

OO$_2$-Identity
ø → ø (*electriful)
↑ ↑
/electr/ /electr + ful/

When the bound root /electr/ comprises the entire input string, the optimal output is a segmentally-empty string [ø]. When an affix is concatenated with the bound root, the affix subcategorizes for an OO-correspondence relation between the affixed output and the null output base. The class 1 paradigm *ø electric* in (180a) incurs a maximal violation of OO$_1$-DEP, since none of the segments in *electric* have correspondents in the empty base. The input /electr + ic/ must nevertheless be realized, because IO-MAX outranks OO$_1$-DEP in English (see (178) above). Class 2 affixation behaves differently because OO$_2$-DEP ranks above IO-MAX (see (177) above), so it is better to fail to realize the input /electr + ful/ than to have segments in a class 2 affixed word with no base correspondents.

Tableaux (181) and (182) show how the proposal works. Each tableau evaluates three paradigms: one in which both inputs have segmentally-contentful outputs, one in

which only the affixed word has output segmentism, and one in which neither input has corresponding output segments.

(181) Class 1: Affixation to Bound Root IO-MAX >> OO$_1$-DEP

a. electr electric
☞ b. ø electric
c. ø ø

Recursion (A)

/ electr /	BOUNDROOT	IO-MAX	OO$_1$-DEP	>>
a. electr	*!			
b. ☞ ø		******		
c. ø		******		

Recursion (B)

>>	/ electr + ic /	BOUNDROOT	IO-MAX	OO$_1$-DEP
	a'. electric			**
	b'. ☞ electric			********
	c'. ø		********!	

Candidate paradigm (181a) fatally violates BOUNDROOT by allowing the bound root to stand as a word on its own. The remaining candidates (181b) and (181c) have a null output base and survive evaluation by the dominant recursion of constraints. In candidate (181c), the affixed input string is not supplied with corresponding output segments. This satisfies the OO$_1$-Identity constraint, but it fatally violates dominant IO-MAX. It is more important to realize the /bound root + class 1 affix/ input than to achieve identity with the null output base.

In class 2 affixation, the rank of IO-Faith and OO-Identity is reversed, so that it is more important to achieve identity in the paradigm than to realize the affixed input string. As shown in (182), OO$_2$-DEP outranks IO-MAX.

(182) Class 2 Affixation to Bound Root OO_2-DEP >> IO-MAX

a. electr electriful

b. ø electriful

☞ c. ø ø

Recursion (A)

/electr/	BOUND ROOT	OO_2-DEP	IO-MAX	>>
a. electr	*!			
b. ø			******	
c. ☞ ø			******	

Recursion (B)

>>	/electr + ful/	BOUND ROOT	OO_2-DEP	IO-MAX
	a'. electriful		***	
	b'. electriful		********* !	
	c'. ☞ ø			*********

Again, the (a) candidate violates BOUNDROOT and is eliminated. Candidate paradigm (182b) supplies an output for the bound root only when it is affixed, which satisfies BOUNDROOT, and it also fares better on IO-MAX, but this *ø electriful* paradigm violates OO_2-DEP maximally, since none of the affixed word's segments have correspondents in the null base. This OO_2-DEP violation is fatal, because OO_2-DEP >> IO-MAX. The optimal paradigm is (182c) *ø ø*, in which neither input is realized as an output word. A /bound root + class 2 affix/ input cannot have output IO-correspondent segments because there are no OO-correspondent segments in the base.

The OO_2-DEP >> IO-MAX >> OO_1-DEP ranking that allows class 1 but not class 2 affixes to attach to bound roots is the ranking responsible for the cluster simplication patterns. In general, class 2 affixed words cannot realize root segments that are not also realized in the base. In the cluster simplification cases (*damn damning, bomb bombing*) the OO_2-DEP >> IO-MAX ranking demands overapplication segmental deletion, and in the bound root cases the same ranking forces non-realization of entire morphemes. Thus, inability of class 2 affixes to concatenate with bound roots is an aggressive closure effect, forced by an OO_2-Identity >> IO-Faith ranking.

Positing a correspondence relation between an affixed word and a null output base does not make it possible to generate misapplication identity effects – processes cannot over- or underapply in words like *electric* or *inane*. The observation in procedural terms is that bound roots are not cyclic domains (Brame, 1974; Kiparsky, 1982a, 1985b; Inkelas, 1989). In TCT, misapplication or "cyclic" effects cannot occur in words like *electric* because the base of the OO_1-correspondence relation has no segmentism. If the base has no phonology, the affixed word cannot mimic the base in an under- or overapplication identity effect.

In Lexical Phonology, these two observations about bound roots – (i) that they cannot be made into words by class 2 affixation, and (ii) that they are not cyclic domains – are handled by separate stipulations. The first follows from the requirement that the output of each cycle or level of derivation is a word (Brame, 1974) or a lexeme (Kiparsky, 1982a).[111] Bound roots like English *electr-* or *-ane* cannot undergo class 2 affixation at Lexical Phonology's level 2 simply because they cannot be output from level 1. The second observation, that bound roots are not cyclic domains, requires a separate stipulation, known as the Strict Cycle Condition (SCC) (Kean, 1974; Mascaró, 1976; Halle, 1979; Kiparsky, 1982a; Cole, 1995) or the (Revised) Alternation Condition (RAC) (Kiparsky, 1968). Since stress rules apply cyclically at level 1, the SCC/RAC is invoked to prevent rules from cycling on bound roots.[112]

[111] Lexemes include words and a subset of bound roots, namely those made into full words by obligatory inflection (see §6.3).

[112] The SCC/RAC does more than block cyclic rules on bound roots. It also prevents certain alternations from taking place in non-derived environments, so that, for example, simplex *nightingale* fails to undergo trisyllabic laxing even though the derived word *divinity* does (see Kiparsky (1993) and Cole (1995) for other examples). Non-derived environment blocking (NDEB) clearly does not follow from paradigmatic identity, since the "underapplication" of phonology occurs in simplex words, and there is no related derived form of *nightingale* that could (through violation of base-priority) impose its tense vowel (*nightingale-ish*?). The theory of phonological classhood developed here suggests a solution to NDEB effects. It is possible that distinct IO-correspondence relations are keyed to classes of simplex words, so that faithfulness to the underlying tense vowel is more important for *nightingale* than it is for *divinity*. Verhijde (in prep.) develops this kind of analysis of NDEB in Sanskrit, in which distinct rankings of IO-Faith constraints hold over (etymologically-defined) morpheme classes. Burzio (1997a) also analyzes NDEB as a faithfulness effect.

In TCT, both observations follow from the same assumption, that an affixed word built from a bound root does not have a segmentally-contentful output base. The base has no derived phonology that the affixed word can be faithful to, so there can be no cyclic effects in words built from bound roots. The lack of phonological content in the base can also prevent realization of the affixed word, if paradigmatic identity takes precedence over faithfulness to the input string.

5.5 Summary of Results: Closure and Stress

As mentioned at the outset of this chapter, I take stress patterns, closure effects and affixation to bound roots – i.e., the misapplication identity effects – to be the primary diagnostics of affix classhood in English. Other diagnostics have been proposed, and some of these are discussed in §5.6 below. First I briefly review the results of the analyses of the main class behaviors.

I have shown that there is no phonological closure, either prosodically or in serial terms. Classes of affixed words are not distinguished by their syllabification or by the order of steps in the derivation. Closure is an illusion produced by OO-Identity constraints, ranked above markedness or IO-Faith constraints. Closure occurs only in class 2 paradigms, because only OO_2-correspondence constraints are high-ranking enough to force them. The OO_1-correspondence constraints are lower-ranked, and cannot demand the same degree of faithfulness, although they can force misapplication of secondary stress in class 1 paradigms. As noted earlier, the identity-based analyses of stress and closure present a unified account of level-ordering and true cyclicity. There is no difference between the level-ordering effects on stress and segmental phonology in class 2 paradigms and the cyclic application of stress in class 1 words; both are misapplication identity effects.

The English cases also show that any phonological process can misapply. In Northern Irish English, for example, OO-Identity constraints force both morphophonemic cluster simplification and allophonic dentalization to misapply. I conclude that there is no

correlation between whether or not an alternation is distinctive and whether or not it can misapply in paradigms. This is a departure from Lexical Phonology, in which both the class 1/class 2 split and the phonemic/allophonic distinction are associated with certain stages of derivation.[113]

The cluster simplification case in English provides a new kind of evidence that OO-Identity constraints are distinct from IO-Faith constraints. In the Sundanese and Tiberian Hebrew case studies, this claim rested primarily on the *Richness of the Input* principle. Inputs are rich in allophones, so IO-Faith constraints must rank below the relevant markedness constraints, while analogous OO-Identity constraints are higher-ranked and force allophonic alternations to misapply. In the English cluster simplification case, there is direct conflict between OO-Identity and IO-Faith, which is resolved differently in each class of affixed words. The root in *condemnation* includes its final coronal nasal, demonstrating (i) that this (unpredictable) segment is present in the UR of the root, and (ii) that IO-MAX >> OO_1-DEP, while the root in *condemning* fails to realize the final nasal of the UR because OO_2-DEP >> IO-MAX. If the two types of faithfulness constraints interact directly, they must be distinct components of the same constraint hierarchy.

Two other points deserve mention. First, because they involve underapplication of phonology, the English stress and closure patterns rely on recursive evaluation of paradigms. I return to a discussion of recursion and base priority in §6.4. Also note that in all of the analyses presented, OO_2-Identity ranks higher than OO_1-Identity, and class 2 affixed words are more faithful to their bases than class 1 affixed words are. This suggests a meta-ranking of the English faithfulness constraints, such that OO_2-Identity constraints rank equal to or higher than their OO_1-Identity counterparts. Why the OO-Identity constraints cluster in this way is not clear. Given unrestricted ranking possibilities, class 2 affixation might be expected to be more faithful than class 1 affixation along some dimensions and less faithful along others. It is possible that the clustering effect facilitates

[113] See §5.7.2 for a brief discussion of the Structure Preservation principle.

learning, and is favored for this reason. I leave this as an open question, and turn next to facts which are consistent with (and possibly derived from) the OO_2-Identity >> OO_1-Identity meta-ranking.

5.6 Other Correlates of Affix Classhood

5.6.1 Compositionality and Productivity

In the general case, class 2 affixation is semantically more transparent or compositional and more productive than class 1 affixation. Kiparsky (1982a) suggests that class 2 affixes are not limited in productivity except by part-of-speech restrictions and blocking effects, so that, for example, plural *-s* attaches to all nouns except those with special (lexically-marked or class 1) plural morphology (e.g., *children*, *people*, etc.). Aronoff & Sridhar (1983) agree, claiming that "[p]ositive morphological conditions on productivity are found only with Level I affixes" (see also Aronoff & Anshen, 1979).

In a serial theory like Lexical Phonology, a connection can be made between class 2 affixation and productivity/compositionality by the serial metaphor itself. Class 2 affixation is more productive because it takes place "later", or closer to the surface form. Class 2 affixation is therefore less abstract, or more transparent. The idea is that it is easier for the speaker to access material (morphemes and rules) closer to the surface, so class 2 affixation should be more productive than class 1 affixation. This line of argument obviously does not go through in a parallel theory. Since there are only inputs and outputs, there is no sense in which anything is closer to the surface than anything else. Once the serial conception abandoned, the link between compositionality or productivity and affix classhood loses some of its motivation. Moreover, there are degrees of compositionality and productivity, and context often plays a role (e.g., deadjectival *-en* is productive with monosyllables only: *widen*, *redden* but **narrowen*, **purplen*). Overall, it is not easy to see how class-defining threshholds of productivity and compositionality could be determined.

I suggest that the connections between phonological transparency, semantic compositionality and productivity are either functional, or ruled formally by some component of grammar other than the phonology. The constellation of phonological transparency, productivity and compositionality is interesting and important, not least to language learning, but the semantic and morphological facts have no formal status in the phonological component. Membership in class 1 or class 2 is a phonological feature of an affix.

5.6.2 Affix Ordering

Unlike other theories of English affix classhood, TCT does not predict that multiply-affixed words show any special order of affixation. As far as the phonology is concerned, affixes of either class may be concatenated in any order.

Siegel (1974) was the first to claim that there is a necessary ordering between class 1 and class 2 affixation, such that class 1 affixes can appear inside of class 2 affixes (*non_2-il_1-legible, danger-ous_1-$ness_2$*), but class 2 affixes cannot appear inside of class 1 affixes (**in_1-non_2-legible*, **tender-$ness_2$-ous_1*). This Affix Ordering Generalization (AOG) is entailed by the serial theory assumed by Siegel and by Lexical Phonologists: class 1 affixes attach before class 2 affixes do, so class 1 affixes are always on the inside. Some representational theories of affix classhood are also committed to the AOG. Selkirk (1982), for instance, predicts the AOG structurally: class 1 affixes attach to roots, and class 2 affixes attach to words, and words dominate roots in morphological structure. AOG violations require a root to dominate a word (e.g., $*[[[[\text{tender}]_w\ \text{ness}]_w]_r\ \text{ous}]_w$) and are ungrammatical.

Because the AOG follows from fundamental premises of both Lexical Phonology and Selkirk's word-structure theory, violations of the AOG have received some attention. There are two kinds of AOG violations: (i) ordering paradoxes, in which a class 2 suffix appears inside a class 1 suffix (e.g., *depend-$able_2$-ity_1*, *standard-ize_2-$ation_1$*), and

(ii) bracketing paradoxes, in which selectional restrictions or scope facts show that a class 2 prefix is inside of a class 1 suffix (e.g., *[un*$_2$*-grammatical]-ity*$_1$, *[mis*$_2$*-represent]-ation*$_1$). Various solutions to the alleged paradoxes have been proposed. One is to assume that ordering paradoxes like *-ability* and *-mental* are entered in the lexicon as units. This seems plausible in some cases, but it misses generalizations: in particular it fails to capture the fact that *-ability* has the same selectional requirements as *-able*. Another way to resolve the ordering paradoxes is to suggest that the alleged class 2 affixes actually belong to class 1 (Aronoff, 1976; Selkirk, 1982; Kiparsky, 1982a). For the bracketing paradoxes, Kiparsky proposes that there is reanalysis of the morphological bracketing (or blocking of bracket erasure). Mohanan (1982, 1986) solves both kinds of paradoxes with the loop device, which allows the output of a later level to re-enter an early level of derivation.

TCT does not need to say anything special about the "paradoxical" cases, since there are no phonological restrictions on the order of affixation in a multiply-affixed word. In a parallel theory, the ordering paradoxes evaporate in an obvious way. There is no serial derivation, so there is no reason to expect that a class 2 suffix cannot appear inside of class 1 suffix. A multiply-affixed word like *dependability* is part of an extended paradigm.

(183) An "Ordering Paradox"

	OO$_2$*-1dentity*		*OO*$_1$*-Identity*	
depénd	→	depéndable	→	depèndabílity
↑		↑		↑
/depend/		/depend + able$_2$/		/depend + able$_2$ + ity$_1$/

The phonological relations in this extended paradigm are strictly local – that is, each pair of words is related by an OO-correspondence relation. In this case, the two affixes trigger different types of OO-correspondence: class 2 *-able* triggers an OO$_2$-correspondence relation between its affixed output *dependable* and its base *depend*, while the outermost suffix in *dependability* triggers an OO$_1$-correspondence relation with its output base *dependable*. Each subparadigm shows the phonological behavior expected from the rank of the appropriate OO-Identity constraints. Consider the stress facts: *depéndable* is faithful to

main stress on its base *depénd* because OO$_2$-ANCHOR >> ALIGN-R (i.e., **dependáble*), and *depèndabílity* preserves its base's stress foot as a secondary stress foot (**dèpendabílity*) because OO$_1$-ANCHOR >> ALIGN-L.

Because OO-Identity is evaluated locally, in pairs of words or subparadigms, attaching a class 2 affix inside of a class 1 affix is not problematic for the phonology. Bracketing paradoxes, like ordering paradoxes, fall by the wayside. The order of affixation in a word like *ungrammaticality* is free to reflect the selectional generalizations, so that the class 2 prefix *un-* attaches to the adjective *grammatical*, and the class 1 suffix *-ity* turns that adjective into a noun.

(184) A "Bracketing Paradox"

	OO$_2$*-1dentity*		*OO*$_1$*-Identity*	
grammátical	→	ùngrammátical	→	ùngrammàticálity
↑		↑		↑
/grammatical/		/un$_2$ + grammatical/		/[un$_2$ + grammatical]+ ity$_1$/

The extended paradigm consists of two subparadigms, each involving a different OO-correspondence relation: an OO$_2$-correspondence relation triggered by *un-* holds over the *grammatical ungrammatical* subparadigm, while the *ungrammatical ungrammaticality* subparadigm is governed by the OO$_1$-correspondence relation triggered by the outermost affix *-ity*. Tableau (185) evaluates the extended paradigm against the stress hierarchy established in §5.2.[114]

[114] The word *grammatical* is itself morphologically complex, and could be related to an output base by an OO-correspondence relation. However, the constituent(s) it contains (gramma- or grammatic) do not occur as free words in English. And because *grammatical* does not have a (segmentally-contentful) output base, OO-correspondence constraints are irrelevant to the determination of its surface phonology.

(185) a. Stress Constraints

NONFINALITY, OO_2-ANCHOR(Ft, Ft, L) >> ALIGN((Hd)PrWd, R, PrWd, R)
>> OO_1-ANCHOR(Ft, Ft, L) >> ALIGN(PrWd, L, Ft, L)
>> IO-ANCHOR(Ft, Ft, L)

b. Candidate Paradigms

a.	(grámma)tical	(ùn)(grámma)tical	(ùn)(gràmma)ti(cáli)ty
b.	gram(máti)cal	(ùn)gramma(tícal)	(ùn)gramma(tícal)ity
c.	gram(máti)cal	(ùn)gram(máti)cal	(ùn)gram(máti)cality
☞ d.	gram(máti)cal	(ùn)gram(máti)cal	(ùn)gram(màti)(cáli)ty

Recursion (A)

/grammatical/	NON FINAL	OO_2-ANCHOR	ALIGN-R	OO_1-ANCHOR	ALIGN-L	>>
a. (grámma)tical			***!			
b. gram(máti)cal			**		*	
c. gram(máti)cal			**		*	
d. ☞ gram(máti)cal			**		*	

Recursion (B)

>>	/un_2+grammatical/	NON FINAL	OO_2-ANCHOR	ALIGN-R	OO_1-ANCHOR	ALIGN-L	>>
	a'. (ùn)(grámma)tical			***			
	b'. (ùn)gramma(tícal)	*!	*!	*			
	c'. (ùn)gram(máti)cal			**			
	d'. ☞ (ùn)gram(máti)cal			**			

Recursion (C)

>>	/[un_2+grammatical]+ity_1/	NON FINAL	OO_2-ANCHOR	ALIGN-R	OO_1-ANCHOR	ALIGN-L
	a''. (ùn)(gràmma)ti(cáli)ty			**	*	
	b''. (ùn)gramma(tícal)ity			***		
	c''. (ùn)gram(máti)cality			****!		
	d''.☞(ùn)gram(màti)(cáli)ty			**	*	

The output *grammatical* is not compared to any output base, so it conforms to the canonical pattern of rightward but non-final main stress. The output *ungrammatical* is subject to paradigmatic identity constraints, in particular to the OO_2-ANCHOR triggered by the class 2 prefix. In candidate (185b), the subparadigm *gram(máti)cal (ùn)gramma(tícal)* fatally violates OO_2-ANCHOR (as well as NONFINALITY). The two candidates that survive the

second recursion contain the class 2 subparadigm *gram(máti)cal (ùn)gram(máti)cal*, which satisfies OO_2-Identity by violating lower-ranked ALIGN-R. In optimal paradigm (185d), identity of main stress is not achieved in the class 1 subparadigm *(ùn)gram(máti)cal (ùn)gram(màti)(cáli)ty* because ALIGN-R outranks the OO_1-ANCHOR constraint invoked by the outermost class 1 suffix.

With respect to stress, there are no ill effects of realizing a class 2 affix inside a class 1 affix. This is good, given the existence of AOG violations. I propose that the phonological component is not responsible for determining the legitimacy of affix combinations. Fabb (1988) argues that affix combinations are governed by selectional restrictions only. Fabb considers 43 English suffixes which, controlling for part-of-speech and prosodic selectional restrictions (e.g., *-ful* and *-al* require verbal bases with final stress), could give rise to 614 suffix pairs. If the AOG holds true and a class 2 suffix cannot appear outside of a class 1 suffix, 155 of these pairs are eliminated, leaving a predicted total of 459 legitimate suffix combinations. But only 50 of these pairs actually occur. Fabb concludes that level-ordering hypothesis is insufficient to explain the restrictions on affix combinations in English.[115]

Of the suffix combinations that Fabb discusses, four violate the AOG: *$ment_2$-al_1*, *ist_2-ic_1*, *ize_2-$ation_1$* and *$able_2$-ity_1*.[116] Although this is a small number, when taken together with the bracketing paradoxes it is enough to suggest that the AOG, if it is a formal principle of grammar, is a violable one. I contend that the AOG is enforced morphologically, not phonologically. The phonology is indifferent to the order of affixes in a multiply-affixed word.

In most cases, disobedience to the AOG has no bad effects on the phonology. However, there is a limited set of cases in which AOG violations are phonologically

[115] The largest subset of Fabb's 43 suffixes never attach to an already-suffixed word, and others select a particular suffix only. Only three suffixes (*-able*, deverbal *-er* and *-ness*) attach freely to other suffixes (modulo part-of-speech requirements).
[116] Fabb does not list all 50 combinations of the suffixes. Most of the discussion of ordering paradoxes in the literature focuses on these four suffix combinations.

problematic. These involve an IO-Faith >> OO_1-Identity ranking, which causes the multiply-affixed word to be more faithful to its input than to its base. This can result in "rephonologization" of the multiply affixed; for example, underlying material that does not appear in an unaffixed word *X* or in the class 2 affixed form *X-able* may show up in the *X-ability* word.[117] Consider the cluster simplification facts in the extended paradigm *condemn* *condemnable* *condemnability*.

(186) "Rephonologization" in AOG Violations

	OO_2-1dentity		*OO_1-Identity*	
kʌn.dɛm	→	kʌn.dɛ.mə.bl̥	→	*kʌn.dɛm.nə.bɪ.lɪ.tiy
↑		↑		↑
/condemn/		/condemn+ $able_2$/		/condemn+ $able_2$ + ity_1/

The class 2 word *condemnable* fails to realize the root-final [n] because it has no correspondent in the base *condemn* (because OO_2-DEP >> IO-MAX). However, the multiply-affixed class 1 word *condemnability* does realize the root-final [n], because IO-MAX >> OO_1-DEP. It should be more important to realize the [n] in the underlying form of the root in *condemnability* than to preserve identity with the base *condemnable*. Tableau (187) shows how the anomalous paradigm is generated.

[117] I am grateful to Paul Smolensky for pointing this out.

(187) i. Cluster Simplification Constraints
$*mn]_\sigma$, OO_2-DEP >> IO-MAX >> OO_1-DEP

ii. Candidate Paradigms

a.	kʌn.dɛmn	kʌn.dɛm.nə.bl̥	kʌn.dɛm.nə.bɪ.lɪ.tiy
b.	kʌn.dɛm	kʌn.dɛm.nə.bl̥	kʌn.dɛm.nə.bɪ.lɪ.tiy
c.	kʌn.dɛm	kʌn.dɛ.mə.bl̥	kʌn.dɛ.mə.bɪ.lɪ.tiy
💣 d.	kʌn.dɛm	kʌn.dɛ.mə.bl̥	kʌn.dɛm.nə.bɪ.lɪ.tiy

Recursion (A)

/condemn/	$*mn]_\sigma$	OO_2-DEP	IO-MAX	OO_1-DEP	>>
a. kʌn.dɛmn	*!				
b. kʌn.dɛm			*		
c. kʌn.dɛm			*		
d.💣 kʌn.dɛm			*		

Recursion (B)

>>	/condemn+ $able_2$/	$*mn]_\sigma$	OO_2-DEP	IO-MAX	OO_1-DEP	>>
	a'. kʌn.dɛm.nə.bl̥					
	b'. kʌn.dɛm.nə.bl̥		*!			
	c'. kʌn.dɛ.mə.bl̥			*		
	d'. 💣 kʌn.dɛ.mə.bl̥			*		

Recursion (C)

>>	/condemn + $able_2$ + ity_1/	$*mn]_\sigma$	OO_2-DEP	IO-MAX	OO_1-DEP
	a". kʌn.dɛm.nə.bɪ.lɪ.tiy				
	b". kʌn.dɛm.nə.bɪ.lɪ.tiy				
	c". kʌn.dɛ.mə.bɪ.lɪ.tiy			*!	
	d".💣 kʌn.dɛm.nə.bɪ.lɪ.tiy				*

In this case, violating the AOG entails that underlying material surfaces only in the most complex word in an extended paradigm. This rephonologization effect is possible, of course, because each word in the paradigm is directly related to an input string, so the underlying form of the root is as available to the multiply-affixed word as it is to any other word in the paradigm. Nevertheless, this kind of rephonologization is unattested, and *condemnability* is in fact pronounced without the root's final /n/.[118]

[118] While there is idiolectical variation in the cluster simplification facts (see, e.g., Kenyon & Knott, 1953) it seems highly unlikely that the same speaker would delete the /n/ in *condemnable* but pronounce it in *condemnability*, contra tableau (187).

Rephonologization is not always ungrammatical – shifting main stress rightward in *ungrammaticálity* from its position in the base *ungrámmatical* is a sort of rephonologization. The unattested kind of rephonologization is predicted only when IO-Faith >> OO_1-Identity, so that some contrastive property, ruled by a high-ranking IO-Faith constraint, is involved in the alternation. It is not clear to me what prevents this kind of rephonologization, so I leave this as a question for further research.

Summing up, I subscribe to Fabb's position that the AOG is not a phonological fact. It is, if anything, a morphological phenomenon. In the general case, violating the AOG has no impact on the phonology, since paradigmatic relations are evaluated locally, in pairs of words. I have also shown that in some cases (when IO-Faith >> OO_1-Identity) AOG violations lead to undesirable phonological results. It is worth speculating that these problematic cases contribute to the relative rarity of AOG-violating combinations.

5.7 Serial Alternatives

Serial analyses of English word formation are familiar from work in Lexical Phonology. Class 1 affixation occurs at the first level of derivation, where phonological rules (in particular, the stress rules) apply cyclically, to each morphological constituent available at that level. In the derivation of *orìginálity*, stress rules apply to the root *órigin*, then the class 1 *-al* suffix is attached and stress applies again to the constituent *oríginal*, and then *-ity* is attached and stress applies one more time to the full word *orìginálity* (and this third application of the stress rules partially respects the output of the second application). Concatenation of class 2 affixes takes place at a second level of derivation, where phonology is non-cyclic. All class 2 morphemes are attached to a root before the level 2 phonological rules apply.[119]

[119] Borowsky (1990) proposes that level 2 phonology takes place before class 2 affixes are attached. For this reason, word-level processes (cluster simplification, vowel alternations) misapply in class 2 words.

The literature on phonological word formation in English is vast, and I cannot do it justice in the available space. This section sketches in broad outline what a serial Optimality grammar of English would look like, comparing it to the serial OT grammars required in Sundanese (§3.5) and Tiberian Hebrew (§4.7). Of the three languages, the English case is the most complex. There are two non-initial levels of derivation, and these levels interact with one another, such that the subgrammar that produces class 1 words can supply an input to the class 2 subgrammar, and vice versa. Like the other languages studied, English's subgrammars differ only in the rank of faithfulness constraints with respect to conflicting markedness requirements. Faithfulness is promoted at later levels, and phonology appears to misapply in complex words.

One question that has not yet been addressed is why faithfulness is always promoted, and never demoted, at later levels of derivation. In rule-based frameworks, this phenomenon was characterized as the "turning off" of phonological rules (and a ban on turning rules on once the derivation has begun). Fewer rules apply, so there is less change – or unfaithfulness – in words derived at later levels. Kiparsky (cited in Borowksy (1986)) named this the Strong Domain Hypothesis (SDH), and Myers (1991b) relates SDH effects to Structure Preservation (Kiparsky, 1982a; 1985b). In §5.7.2, I review Myers' arguments about the SDH and Structure Preservation, and show that these promotion-of-faithfulness restrictions, which are stipulated in Lexical Phonology and serial OT, are the only possible outcome under TCT.

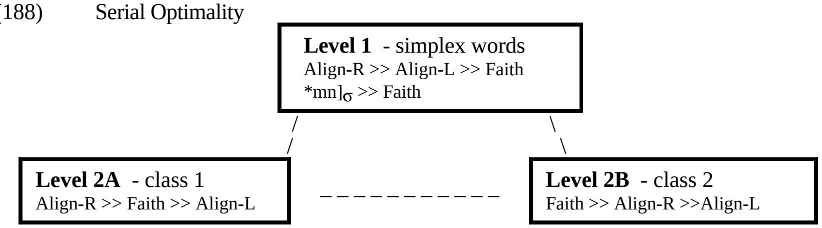
In §5.7.1, I argue that the English facts show up a fatal flaw in serial OT. The issue is the link, or the absence of a link, between a complex word and its underlying form. In a serial framework, each stage of the derivation is a one-step mapping, and each word has just one input: underlying forms are mapped to simplex words, and simplex words are concatenated with affixes and mapped to complex words. The trouble is that certain complex words in English need access to the underlying form of the root, as well as access to the derived base. Class 1 words paradigms are faithful to the level 1 outputs with respect to stress (*oríginal orìginálity*), but with respect to cluster simplification they are faithful to the underlying root (*dam<n> damnation*). Moreover, some class 1 words have to have it both ways at the same time: in *condèmnátion* a stress identity effect co-occurs with faithful realization of the underlying nasal cluster. If this word can only be related to one form, either the UR or the base *condém<n>*, it cannot be derived. A possible elaboration of the basic serial OT model that addresses this case looks very much like the transderivational system, as set out below (see also §6.4).

5.7.1 Serial OT

Phonologically, English words fall into three groups. Simplex words conform to the "canonical" stress generalizations (rightward but non-final primary stress and left-aligned secondary stress) and undergo segmental processes like word-final cluster simplification. Words with class 1 affixes have canonical rightward primary stress, but do not conform to the regular secondary stress pattern. Words with class 2 affixes disobey rightward main stress and several "word-level" segmental alternations. Serial OT associates each surface pattern with a constraint ranking, or subgrammar.

English has three patterns, so it instantiates three subgrammars, as in (188). Simplex words are generated at level 1, where faithfulness is low-ranking. Outputs of level 1 can be input into one of two non-initial levels. At level 2A, class 1 affixes are concatenated with level 1 outputs and input to a subgrammar that enforces cluster simplification and right-aligned main stress, but not leftward secondary stress, by promoting faithfulness over ALIGN-L. Class 2 affixed words are derived by another non-initial level, with a different ranking, in which faithfulness is promoted above both footing constraints, ALIGN-R and ALIGN-L.

(188) Serial Optimality



Each subgrammar has a different ranking of faithfulness constraints, and no subgrammar requires two markedness constraints to change their relative rank; ALIGN-R >> ALIGN-L is fixed across the language. The consequences of permuting the rank of two markedness constraints in subgrammars were discussed in §3.5 with respect to the Sundanese data, and similar arguments go through for the English case. For example, if ALIGN-L is promoted above ALIGN-R in an English subgrammar, classes of words would differ in whether they obey rightward or leftward alignment of stress. This result is not as outrageous as some of the patterns discussed earlier, but the general point holds: to the extent that subgrammar theory is predicated on differences between levels of derivation, it is committed to explaining the similarities them. In particular, it should explain why relative markedness rankings do not differ.

The serial OT English grammar sketched in (188) resembles the Tiberian Hebrew grammar in §4.7, in that both grammars have at least two non-initial levels of derivation. Some outputs of the first subgrammar are input into level 2A, and others are sent off to level 2B. In Tiberian Hebrew, words produced at level 2A (jussive/2fs stems) and words produced at level 2B (imperatives) are non-overlapping portions of the lexicon. English, on the other hand, permits a mutual feeding relation between its non-initial subgrammars. Outputs of level 2A, such as *dangerous*, can be concatenated with a class 2 affix and evaluated by level 2B ranking, yielding related words like *dangerousness*. And outputs of level 2B can be input into level 2A. An AOG-violation like *condèmnabílity* is derived as follows: first *condém<n>*, with peninitial stress and its final cluster simplified, is output from level 1. This output is put together with the suffix *-able* and input to level 2B, which produces the faithful form *condém<n>able*, because faithfulness outranks ALIGN-R and ALIGN-L at level 2B. In turn, this output is concatenated with *-ity* and put through the level 2A subgrammar. Here, main stress is not preserved because ALIGN-R is dominant, but secondary stress appears on the peninitial syllable of *condèm<n>abílity*, because faithfulness outranks ALIGN-L. Thus, forms can be passed back and forth among levels as needed. Of course, level 2B only needs to feed level 2A in the AOG-violating cases, which are notably less common than AOG-satisfying words, so that for the most part level 2B is fed by level 1 and level 2A, and 2B does not feed its outputs into any other level. This rather simplistic serial OT model resembles Mohanan's (1986) Lexical Phonology, in which a loop device allows forms to cycle back to an earlier level of derivation.

However, a closer look at cluster simplification and other closure effects turns up a significant problem with the serial OT grammar in (188). It cannot be the case that class 1 affixed words are derived at a non-initial level of derivation, because class 1 affixed words can be more faithful to their underlying forms than to their unaffixed bases. The [n] in *damnation* is not present in the base *dam<n>*, but as set out earlier, it is available to the affixed output through an IO-correspondence relation with the underlying form of the root. In serial OT, where there is only input-output mapping, it is not clear how class 1 affixed words are sometimes faithful to the output base and sometimes faithful to the underlying root. On the simple serial model, class 1 affixed words lose their link to the underlying representation; in effect, derivation at level 1 erases the UR.

One possible refinement of the serial OT model allows URs to be input to the grammar at either level 1 or level 2A. But the choice would be made on an ad hoc basis. When stress is relevant, level 1 derivation feeds level 2A: for example, *arístocrat* goes through level 1 derivation to derive its predictable penintial stress, and the promoted faithfulness constraint at level 2B preserves this stress in the related class 1 word *arìstocrácy*. When cluster simplification is at stake, the UR is input directly to level 2A. Thus *damnation* has access to the underlying [n] in the root /damn/.

The problem with this hypothesis is that some words need to have it both ways. Consider *pàradìgmátic* and *còndèmnátion*, which (at least potentially) condition both stress preservation and cluster simplification. The secondary stress on the pre-tonic syllable in these words is the residue of primary stress on *paradígm* and *condémn*. These unaffixed words are derived first, at level 1, before the class 1 suffixes are attached. But if this is correct, why do the affixed words have [gm] and [mn] consonant clusters? These clusters should be simplified by the level 1 ranking, when they are word-final in *condemn* and *paradigm*. Cases like these are problematic for serial OT, but not for TCT: affixed words like *paradigmatic* and *condemnation* are related simultaneously to an output base and an underlying form, and may be faithful to either string. They are faithful to their bases in stress (because OO_1-ANCHOR >> ALIGN-L) and faithful to their underlying forms in segmentism (because IO-MAX >> OO_1-DEP).

A possible fix-up for the serial theory is to recognize both IO-Faith and OO-Identity constraints. The idea is that, at any given non-initial level, the input consists of both the output of the previous level and the UR of the morphemes involved. But this is, in essence, the transderivational theory: words are required to be faithful to other words by OO-Identity constraints and faithful to their inputs by IO-Faith constraints. In effect, this transderivational-serial theory retains serialism only to enforce the PRIORITY OF THE BASE generalization; by assuming that derivations cannot look ahead to later levels, back-copying from a more-complex word to its less-complex base is impossible. TCT, as discussed, enforces the PRIORITY OF THE BASE through recursive evaluation of paradigm units. The two theories therefore make the same predictions about underapplication (it occurs only when overapplication would occur in the base). The theories differ, however, in their typological predictions. The serial theory posits multiple levels of derivation, and it must somehow prevent re-ranking of constraints between levels. In the transderivational-serial model, not even faithfulness constraints change their rank; the levels of derivation all have the same constraint ranking. This seems odd in the serial framework, but follows naturally in the parallel theory. I return to the transderivational-serial OT model in §6.4, in a discussion of cases alleged to volate the PRIORITY OF THE BASE generalization.

It is not obvious that a (non-transderivational) serial OT analysis of English is workable; it certainly cannot succeed with a considerable amount of stipulation. Stated generally, the objection to serial OT (and Lexical Phonology) is that the grammar's predictive power needs to be constrained by defining the relationships between levels or subgrammars. How (or if) various levels feed forms to each other is one part of the question. Another is how the contents of the subgrammars (their rules or rankings) are allowed to differ. As noted, levels of derivation appear to differ only in the rank of faithfulness constraints. Moreover, it appears that faithfulness is always *higher-ranked* at later levels than at earlier ones, although logically, faithfulness could be demoted in non-initial subgrammars. This same observation was made, in different terms, in rule-based Lexical Phonology, and modelled formally as the turning off of rules (or constraints) over the course of the derivation, as set out below.

5.7.2 The Strong Domain Hypothesis and Structure Preservation

Two principles developed in Lexical Phonology that limit variation among levels of derivation are the Strong Domain Hypothesis (SDH) and Structure Preservation. Citing unpublished work by Kiparsky, Borowsky (1986) formulates the SDH as follows.

(189) The Strong Domain Hypothesis (Borowsky, 1986:12 citing Kiparsky 1983/4)

1. All rules are available at the earliest level of the phonology.
2. Rules may cease to apply, but may not begin to apply at a later level by stipulation [sic].

Phonological rules can turn off over the course of the derivation, but they cannot turn on after the derivation has begun. Later rules are a subset of earlier rules. Consequently, affixed words, which are derived at later stages, undergo fewer phonological rules than simplex words derived earlier do.

Obviously, turning off rules has the same effect as promoting faithfulness constraints. As long as nothing changes, things remain the same; this is the "do-nothing" theory of faithfulness implicit in rule-based phonological theory. As discussed, turning rules off is crucial in rule-based analyses of underapplication. Morphology comes along too late to trigger an underapplying rule, and reapplication is prevented by turning the rule off. In Northern Irish English, the dentalization rule is turned off before class 2 affixation, producing an unexpected pre-rhotic alveolar in words like *loader*. While the SDH correctly reflects the facts, it does not follow from anything. Why aren't phonological rules turned on over the course of the derivation? By ignoring the role of faithfulness in phonology, in particular the role of paradigmatic faithfulness, the SDH amounts to a simple stipulation.

Myers (1991b) relates the SDH to Structure Preservation, explaining that to the extent that it holds true, Structure Preservation (SP) is a subcase of the SDH. Myers paraphrases the statement of SP in Kiparsky (1982a, 1985) as (190).

(190) Structure Preservation
A restriction on underlying representation holds throughout
the lexical phonology.

SP is part of a theory of phonological inventories, and it also restricts the ways that rules apply in phonological derivations. The basic premise is that underlying representations do not contain predictable or nondistinctive information. URs consist of phonemes, or units of contrast, and phonological processes can be sensitive to this phonemic inventory (for example, vowel harmony can be blocked if it would produce a segment type that is not part of the inventory). In a stratal-ordered derivation, SP restricts the ways that rules apply by forbidding early rules to introduce non-distinctive features. Kiparsky (1985) asserts that the SP holds through the word-level phonology, but allows that this may be too strong. Borowsky (1986) argues that SP does not hold over the word-level phonology. Misapplying allophonic rules like Philadelphia æ-tensing or Northern Irish dentalization violate SP by introducing allophones, but they nevertheless apply in the word-level phonology, before class 2 affixation takes place.

Myers points out that the empirical consequences of the SDH and SP are similar: both work toward a "gradual loosening of the restrictions on phonological representation" (1991b:382). The SDH allows words derived at a late stage to undergo fewer phonological processes than words derived at earlier levels, and SP holds that the inventory increases over the course of the derivation, so that words derived later admit a larger inventory of features or structures than words derived earlier. Phonological repairs of marked structures fail to take place at later levels (because rules get turned off), and this has the effect of increasing the inventory of admissible structures.

Recall the epenthesis patterns in Tiberian Hebrew. Coda clusters are resolved by epenthesis in the language at large. A repair applies, and complex codas are excluded from the Tiberian Hebrew inventory of syllable margins. Truncated words show identity-driven underapplication of epenthesis, so they can have complex codas. Because the epenthesis rule is turned off before truncation takes place, the inventory of syllable margins is greater in truncated than in non-truncated words. Similarly in Northern Irish English, pre-rhotic alveolars are generally disallowed, but the dentalization rule is turned off before class 2 affixation takes place, so pre-rhotic alveolars are tolerated in class 2 affixed words. Turning off rules in later derivation is consistent with increasing the inventory of permissible structures.

The SDH and SP describe but do not explain the facts. There is no obvious reason why later derivation should not undergo more rules or generate a smaller inventory than earlier stages. TCT, on the other hand, predicts the effects of the SDH and SP (fewer rules, larger inventory in later stages). Moreover, the opposite pattern (more rules, smaller inventory in later stages) cannot be generated.

A phonological process is produced by a ranking of M >> Faith; structures marked by M are avoided by being unfaithful to the input. Phonology is "turned off" if Faith >> M. In the cases at hand, a phonological process produced by M >> IO-Faith is turned off in

morphologically-complex words by OO-Identity >> M. The inventory increases: complex words admit M-violating structures, even though simplex words do not.

No ranking of constraints can force a decrease in inventory size, so that complex words admit fewer structures than simplex ones, because all words enter into an IO-correspondence relation with an input or underlying form. Any structure admitted in simplex words (by IO-Faith >> M) will also occur in complex words, because complex words are also subject to the IO-Faith >> M ranking. Thus, input material that violates M is allowed to surface in both classes of words.

Morphologically-complex words avoid a structure that simplex words allow only if OO-Identity ranks above the IO-Faith >> M hierarchy. This bans the M-violating structure from complex words, but only if avoiding M-violation increases paradigmatic identity. For example, in English cluster simplification an inventory shrinks in response to an OO-Identity >> IO-Faith ranking. Simplex words prohibit certain clusters ([mn] [mb], [gn]) tautosyllabically, but allow these clusters to be heterosyllabic. Words with class 2 affixes avoid these clusters even when they could be heterosyllabic (*dam<n>ing*, *bom<b>ing*), because OO$_2$-DEP >> IO-MAX. This is not an inventory effect, however, because class 2 affixed words do not avoid these clusters across-the-board; the deletion repair overapplies only if it increases identity with the base. That is, class 2 affixed words do not impose a general ban on heterosyllabic [mn] or [ng] clusters; they prohibit them only if the corresponding cluster cannot surface in the base (consider *damnifying* or *signatoryhood*, where the clusters are realized faithfully). Apart from this kind of misapplication identity effect, there is no way to force complex words to avoid a structure that is licit in simplex words. The inventory never "decreases" over the course of the derivation.

The serial elaboration of OT can produce a system that violates the SDH/SP predictions, in which phonological restrictions tighten, and the permissible inventory decreases, in complex words. Very simply, faithfulness constraints are demoted at later levels of derivation. Suppose that the level 1 subgrammar consists of a ranking of Faith >>

M, so that M-violation is allowed to surface in simplex words, but the M-violating structure is eliminated from complex words by the level 2 ranking M >> Faith. With re-ranking at the core of the serial OT analysis, it has to be explained why the SDH and SP hold true, and phonological restrictions on complex words are not greater than those governing simplex words. Thus, alongside the stipulation that faithfulness constraints can re-rank between subgrammars (but markedness constraints cannot), serial OT has to ensure that faithfulness is always promoted, and never demoted, at later stages of derivation.

Monostratal TCT makes the correct predictions without extra statements. Through differential ranking of IO-Faith and OO-Identity constraints, complex words derived "later" may be subject to less phonological restriction than simplex words, but it cannot be the case that complex words show more phonological restrictions. Every word is related to an input string, and no grammar can make an inventory smaller in complex words than it is in simplex words.

To summarize, I have argued that the serial OT model of English word formation has problems that the transderivational theory does not have. First, it has difficulty relating complex words to their underlying forms as well as to their output bases, because each level of derivation has just one input (the UR or the output of the previous level, if any). But words like *paradìgmátic* and *condèmnátion* are faithful to their inputs in some respects and to their bases in others, so both relations must be available simultaneously, as they naturally are in TCT. This section also presented further development of the argument begun in earlier chapters: that a theory of multiple derivational levels is challenged to explain the similarities between them. Why is it always the case that markedness relations do not change, but faithfulness is promoted as the derivation proceeds? I showed that the effects of a logical alternative, the demotion of faithfulness, cannot be achieved in TCT.

5.8 Summary

In this chapter I proposed that the distinction between class 1 and class 2 affixation in English follows from the rank of faithfulness constraints on two distinct OO-correspondence relations. The diagnostics of an affix's class membership are the misapplication identity effects produced by OO-correspondence constraints, ranked above markedness or IO-Faith constraints. Both classes of affixed words exhibit identity-driven misapplication patterns: class 1 paradigms show underapplication of leftward stress alignment, while class 2 paradigms show misapplication of rightward main stress and a variety of segmental processes. Both classes of paradigms are subject to OO-correspondence constraints, but different ones.

I also argued that there is no phonological "closure" before class 2 affixes, in either a prosodic or a derivational sense. Closure effects are produced by OO_2-Identity constraints, which force a high degree of faithfulness between a class 2 affixed word and its base. Closure is not absolute, so a class 2 affixed word can be identical to its base along some dimensions and differ in others. The Adelaide English case made this point clearly: words in the paradigm *goal* *goalie* [gɔuɫ gɔu.liy] differ in l-coloring but are identical in vowel quality (*[gʌʊ.liy]), even though rounding of this vowel usually requires a tautosyllabic dark [ɫ]. A theory that posits closure, based on either representational assumptions or rule orderings, has to say something extra about cases in which only partial identity is achieved. In TCT, every dimension of the representation is regulated by a separate ranked and violable OO-Identity constraint, and partial identity in paradigms is predicted.

Abandoning the notion of closure also makes it easy to see that there is no formal difference between "level-ordering" and "true cyclicity" effects. The misapplication of secondary stress in English class 1 paradigms and the misapplication of main stress and segmental alternations in class 2 paradigms are the same thing: identity effects produced by ranked constraints on an OO-correspondence relation.

Phonological classhood was a central theme of this chapter. I proposed that class 1 and class 2 affixes are distinguished solely in terms of the faithfulness relation on each kind of affixation paradigm. English affixes are arbitrarily divided into two groups by subcategorization: class 1 affixes select an OO_1-correspondence relation, and class 2 affixes are subcategorized by a distinct OO_2-correspondence relation. The rank of faithfulness constraints on each relation determines the phonological behavior of each class of affixed words.

One of the results of this case study is that constraints on each OO-correspondence relation tend to cluster together in the English constraint hierarchy. In general, the OO_2-Identity constraints are ranked higher than the OO_1-Identity constraints. There appears to be a meta-ranking of OO_2-Identity >> OO_1-Identity in force, so that each OO_2-Identity constraint ranks equally to or higher than the analogous OO_1-Identity constraint. Given free ranking, it is unclear why some OO_1-Identity constraints cannot be shown to dominate their OO_2-Identity counterparts, to force class 1 words to be more faithful to their bases in some respect than class 2 affixed words are. Also, the fact that several OO_2-Identity constraints are highly-ranked, producing misapplication of a wide variety of phonological alternations, is left unexplained. In recent work, Burzio (p.c.) proposes that if one phonotactic generalization can be violated, others can be violated at lesser cost. I leave questions about the apparent clustering of the faithfulness constraints for future research. More speculative discussion and pointers to future work are presented in §6.

CHAPTER 6
CONCLUDING AND SPECULATIVE REMARKS

6.1 Transderivational Relations

The case studies have shown how the deviant phonology of morphologically-complex words is derived without intermediate stages of derivation. Deviations from canonical patterns are identity effects, produced by constraints on paradigmatically-related forms. Subparadigms, or pairs of related words, are evaluated simultaneously against recursions of a fixed constraint ranking. Paradigmatic identity can rank above phonological constraints, so that processes over- or underapply to make related words alike in featural, segmental or prosodic structure. Paradigmatic identity can also be sacrificed to the canonical phonotactics, so that related words are not identical in surface forms.

Paradigmatic OO-Identity constraints are distinct from input-output IO-Faithfulness requirements, and both types of faithfulness constraints coexist in the same grammar. There are two kinds of evidence in support of this claim. One comes from the cases in which an allophonic alternation misapplies; these include Sundanese nasalization, Tiberian Hebrew spirantization and Northern Irish English dentalization. In allophonic cases, IO-Faith have to rank lower than markedness, because inputs are rich in noncontrastive features, while the analogous OO-Identity constraints rank higher than markedness, to force the alternations to misapply. Moreover, because allophony entails an interaction between two markedness constraints, some of these cases show that IO-Faith and OO-Identity interact with the same markedness hierarchy. In Sundanese, both IO-Faith and OO-Identity interact with a *NVORAL >> *VNAS ranking (OO-Identity ranks between them, and IO-Faith ranks below them). This suggests that IO-Faith and OO-Identity are part of the same grammar. Other evidence comes from direct conflict between OO-Identity and IO-Faith. In the English cluster simplification case, OO_2-DEP dominates IO-MAX, and underlying clusters are not realized in class 2 words. If OO-Identity constraints and IO-Faith constraints can be ranked with respect to one another, they are part of the same grammar.

Affixes (and other morphological derivation) can invoke distinct OO-correspondence relations. I have proposed that classes are delineated by subcategorization. Words formed with one kind of affix (or truncation, etc.) can subscribe to one set of OO-Identity constraints, while words with another type of affixation behave differently. In English and Tiberian Hebrew, two classes of morphemes participate in distinct misapplication effects, produced by OO-Identity constraints on each class of paradigm.

The strong claim of this theory is that all morpheme-specific behavior follows from the rank of the relevant set of faithfulness constraints (OO-Identity, IO-Faith or BR-Identity). This is not a very restrictive system, in that it allows a language to produce as many distinct surface patterns as it has morphemes. The only phonological limitation on the variety of patterns produced in the same language is that they all obey the same relative markedness relations, because there is only one ranking of constraints. It appears, however, that most grammars do not exploit OO-correspondence relations to the fullest possible extent, but instead group affixes into classes. Something disprefers morpheme-specific behavior. If my proposals are correct, this something is not part of the phonology. Learnability principles clearly play a role, since each association between a morpheme and an OO-correspondence relation is learned. Learnability may impose some sort of overall evaluation metric on the grammar, such that a grammar that has fewer faithfulness relations, or has faithfulness relations correlated with some independently motivated property (such as part-of-speech or etymology) is preferred. These remarks are obviously highly speculative. Investigation of what is involved in learning an articulated faithfulness system like TCT, together with investigation of the learnability of the serial alternative, is likely to shed light on the advantages of each approach.

In the rest of this chapter I address some consequences of the transderivational theory and refute a few counterexamples to my proposals. In §6.2 I argue that

misapplication of phonology does not occur in affixes. This follows from the basic premise that phonological identity relations hold only between a derived word and its base, and not between words derived by the same affix. In §6.3 I show that the base of an OO-correspondence relation need not be a proper substring of the derived word. Cases are presented to show that an inflected form can function as the base of an OO-correspondence relation with another inflected form. In §6.4 I return the PRIORITY OF THE BASE generalization and to the comparison of recursion in TCT to serial alternatives. To conclude, §6.5 briefly speculates about the implications of the transderivational theory for the interface between the phonological and morphological components of grammar.

6.2 Affixal Phonology

One of the entailments of TCT is that there are no identity effects in affixes. Transderivational relations hold between affixed words and their unaffixed bases (*sane* *sanity*) and not between words that bear the same affix (**sanity* *brevity* *obesity*). Because affixal material is typically not in an OO-correspondence relation, there can be no misapplication identity effects in affixes.[120]

Kenstowicz (1996) proposes that paradigmatic identity effects in affixes are possible. The case is Spanish *s*-aspiration. In many Spanish dialects, *s* becomes *h* in coda. However, in a certain negative prefix, which Kentowicz assumes is underlyingly /des-/, *h* appears both in codas and in onsets.

(191) Spanish

a.	/des + calzar/	deh.calzar	'unshoe'
b.	/des + echo/	de.he.cho	'refuse'

Kenstowicz argues that the prefix-final segment in (191b) is realized as *h* in an onset because the prefix-final segment is realized as *h* in coda in words like (191a). This identity effect is produced by a Uniform Exponence constraint.

120 Affixal material is in an OO-correspondence relation in multiply-affixed words (e.g., *original* *originality*). Identity effects in affixal material are possible in such cases.

(192) Uniform Exponence (Kenstowicz, 1996)

Minimize the differences in the realization of a lexical item
(morpheme, stem, affix, word).

One complication is that *s*-aspiration overapplies only in the negative prefix. Roots show normal application of aspiration, realizing underlying *s* as *h* only in codas, as in the paradigm *meh*   *meseh* 'month(s)' (from underlying /mes (+ es)/). Thus, the Uniform Exponence constraint is specific to the negative prefix.

Kenstowicz's argument that the appearance of the prefix-final *h* in (191b) is an overapplication identity effect is suspect, because there is no evidence that the underlying form of the prefix contains an *s*. Every surface realization of the prefix has *h* (Kenstowicz 1996: fn. 3). In support of the underlying form /des-/, Kenstowicz relies on Harris' (1993) proposal that the only source for surface *h* in these dialects is underlying *s*. But logically this claim has to be based on morphologically-conditioned alternations, like the *meh*   *meseh* 'month(s)' example, to show the presence of the underlying *s* in the prefix. But there is no alternation in the negative prefix – it always surfaces as *deh*-. It seems clear, then, that the underlying form of the prefix is actually /deh-/, and there is no misapplication at all in (191b).

The claim that every *h* derives from *s* is motivated, in part, by the fact that the *s/h* alternation is generally determined by syllable structure. Leaving aside the *deh*- prefix, the *s/h* alternation is phonologically predictable: *s* appears in onsets, and *h* appears in codas. Defining a phonemic inventory in the traditional way, one would say that surface *h* derives from the underlying phoneme /s/. However, the *s/h* alternation is not fully predictable from syllabification. In (191b) *de.he.cho*, an *h* appears in an onset. The same general description applies to some of the misapplication patterns discussed earlier. Sundanese nasal harmony is almost entirely allophonic; the only exceptions are overapplicational plurals like [ɳ-ãl-ĩãr] 'seek (pl)'. In Sundanese, the exceptions to allophonic nasal harmony are explained by paradigmatic identity: nasalization overapplies in the plural to mimic the singular base

[ɳĩãr]. The Spanish case is formally different, because overapplication of the *s* --> *h* alternation in *de.he.cho* does not improve identity with its morphological base *echo*.

But consider a transderivational analysis of the alleged overapplication in (191b). An OO-Identity constraint that imposes uniform exponence on the prefix would be satisfied by realizing either the *des*- or the *deh*- alternant in all prefixed words. Thus, both {*deh.cal.zar*, *de.he.cho*} and {*des.cal.zar*, *de.se.cho*) satisfy OO-Identity. The former wins, so *h* must be preferred to *s*. The CODACOND against *s* (or whatever is responsible for the *s/h* alternation) is irrelevant to the overapplication context *de.he.cho*, so it must be context-free markedness *s >> *h that prefers the *deh*- prefix. This is the crux of the transderivational analysis of misapplication in affixes. Since both allomorphs *deh*- and *des*- are properly conditioned in some prefixed words but not in others, the allomorph that imposes its phonology on all other realizations of the affix should be the one that violates the lowest-ranked constraints in the grammar.

But this is not always true. One case involves the German diminutive affix -*chen*. German has an allophonic alternation between front and back fricatives: the [+back] velar fricative [x] appears after [+back] vowels, and the [-back] palatal fricative [ç] appears in the elsewhere case; after [-back] vowels, post-consonantally and in word-initial position. The diminutive suffix, however, is uniformly realized as [çən] with a palatal, even when it follows a [+back] vowel. The diminutive is an umlauting suffix, so there are very few examples in which it follows a [+back] vowel, but these few examples have received a good deal of attention in the literature (Bloomfield, 1930; Hall, 1989; Macfarland & Pierrehumbert, 1991; Iverson & Slamons, 1992; Borowsky, 1993; Merchant, 1997, among others).

(193) German

	Frau-chen	[fraʊçən]	'little woman; animal's mistress'
	Tau-chen	[taʊçən]	'little rope'
	Kuh-chen	[kuːçən]	'little cow'
cf.	rauch-en	[raʊxən]	'to smoke'

The anomalous diminutives have been analyzed as the product of cyclic or level-ordered derivation: the alternation in fricatives precedes affixation, so by the time the suffix becomes adjacent to a [+back] vowel it is too late for the assimilation rule to apply (Hall, 1989; Borowsky, 1993). If cyclic effects are better understood as transderivational identity effects, it might be proposed that the [-back] palatal fricative preserves identity among the various realizations of the suffix in diminutive words.

Suppose that this is true, and a high-ranking OO-Identity constraint requires all realizations of the diminutive morpheme *-chen* to be identical. Since the suffix sometimes follows front vowels or consonants, and sometimes follow back vowels, two possibilities have to be considered. In one case all realizations of the diminutive suffix have a front fricative: {…a-çən, …ɪ-çən, …t-çən}. The other possibility is that all realizations of the suffix have a back fricative: {…a-xən, …ɪ-çən, …t-xən}. OO-Identity is indifferent, so the choice must be made by markedness or IO-Faith constraints.

In this German case, the ranking does not select the optimal form. Independently-motivated rankings predict that the diminutive is uniformly *[-xən], not [-çən]. As discussed, the ç/x alternation is allophonic; the back alternant appears under assimilation to a preceding back vowel, and the front alternant appears elsewhere. The ranking in (194) dictates the canonical distribution of the allophones.

(194) German's Allophonic ç/x Alternation

*aç >> *x >> *ç, IO-FAITH

A context-sensitive constraint bans the less-marked elsewhere allophone [ç] from a specific context (after back vowels) by dominating *x, and this context-free markedness limits the marked allophone [x] to the specific context by dominating IO-Faith. This derives the allophonic pattern from inputs rich in noncontrastive [±back] fricatives, as in (195).

(195) German's Allophonic ç/x Alternation

*aç >> *x >> *ç, IO-FAITH

a.

/…aç…/	*aç	*x	ç	IO-FAITH
a. ☞ …ax…		*		*
b. …aç…	*!		*	

/…ax…/	*aç	*x	ç	IO-FAITH
a. ☞ …ax…		*		
b. …aç…	*!		*	*

b.

/…ɪç…/	*aç	*x	ç	IO-FAITH
a. …ɪx…		*!		*
b. ☞ …ɪç…			*	

/…ɪx…/	*aç	*x	ç	IO-FAITH
a. …ɪx…		*!		
b. ☞ …ɪç…			*	*

c.

/xə…/	*aç	*x	ç	IO-FAITH
a. xə…		*!		*
b. ☞ çə…			*	

/çə…/	*aç	*x	ç	IO-FAITH
a. xə…		*!		*
b. ☞ çə…			*	

The back fricative x appears after back vowels (195a), and ç appears after front vowels (195b) and elsewhere (195c).

Now consider the alleged misapplication in *-chen*. An OO-Identity constraint on all realizations of the suffix is satisfied if either [-çən] or [-xən] occurs in all diminutive words, as schematically represented in candidates (196a) and (196b), respectively. Given the ranking in (195), the latter should be optimal, but this is the wrong result.

(196) "Misapplication" in Diminutives

	OO-IDENT	*aç	*x	ç
a. {…ɪ-çən, …a-çən}		*!		*
b. 💣 {…ɪ-xən, …a-xən}			*	

The front fricative is less-marked in the general case (because *x >> *ç), but it is more marked when it follows a back vowel (because *aç >> *x). The incorrect prediction is that all realizations of the suffix are [-xən] because this best satisfies high-ranking *aç. If the suffix sometimes follows a back vowel, it should always have a back fricative in it.

Thus, the idea that the realizations of an affix in separate words are subject to OO-Identity constraints is unworkable, because it cannot be determined which instantiation of the affix will influence all the others. Independently-established markedness rankings will not reliably pick the correct result. I conclude that misapplication in affixes is not possible, and in fact does not occur.

I have proposed that the Spanish case involves mistaken analysis of the UR of the morpheme. The negative prefix is always realized as *deh-*, and never as *des-*, so speakers have no reason to posit an *s* in the prefix's underlying form. The German case has to have a different solution, because IO-Faith is demonstrably low-ranking: even if the UR were fixed as /-çən/, the grammar cannot be relied on to output [çən]. Fortunately, other analyses of German diminutives are available. Merchant (1997) presents an account that employs the morphological labels Root and Stem along the lines Selkirk (1982) and ALIGN constraints, as in McCarthy & Prince (1993b) and Cohn & McCarthy (1995). Merchant proposes that fricatives assimilate to preceding vowels only when they are ambisyllabic or in coda position. Fricatives that are parsed exclusively into an onset are always [-back]. In anomalous diminutives like *Frauchen,* the fricative cannot be ambisyllabic, and therefore it cannot assimilate to the preceding vowel, because an ALIGN constraint demands right alignment of stems and syllables, as in $[[\text{fraʊ}]_{\text{Stem}}\ \text{çən}]_{\text{Word}}$. A perhaps simpler analysis is that *-chen* is word-like, in that it must be coextensive with a prosodic word constituent.

Since the [-back] fricative always appears word-initially, the [-back] fricative in *-chen* is expected.

I conclude that neither Spanish nor German provides convincing evidence that phonology can misapply to achieve identity between various surface realizations of an affix. OO-correspondence relations hold only between derived words and their underived bases, and not between words that bear the same affix, so misapplication in affixes is not possible.

6.3 Inflected Bases

In TCT, misapplication is possible only in words that are related to an output base. Words built from bound roots, such as English *electric* or *receive*, cannot show over- or underapplication of phonology because they have no output base to mimic (**electr*, **ceive*). In cyclic theory, misapplication in words derived from bound roots is ruled out by the stipulation that the output of every cycle of phonological rules (or stratum of derivation) is itself a complete word (Brame, 1974; Inkelas, 1989).

According to Kiparsky (1982a), the claim that "cycled substrings must occur as independent words … taken literally is too strong because stems ... which do constitute cyclic domains are not necessarily capable of occurring as independent words in inflectional languages, where they may require an obligatory case ending" (1982a:33). Kiparsky therefore proposes that the output of every level of derivation is a *lexeme*, a category that includes both full words and the bound roots that require inflectional augmentation.

In the cases that Kiparsky alludes to, an inflected word serves as the base of an OO-correspondence relation with another inflected form. The base's inflection is prevented from surfacing on the derived word by morphological constraints that ban non-peripheral inflection or incompatible inflectional markings. One example, discussed in §4 above, comes from Polish (Kraska-Szlenk, 1995:108ff.). The genitive plural form in (197) overapplies a process that raises *o* to *u* in closed syllables. As a result of the overapplication, the genitive plural is more like the nominative singular base, where closed-syllable-raising is properly conditioned.

(197) Polish Feminine Diminutives

'cow'	Singular	Plural
Nom.	kr[u]w.ka	kr[u]w.ki
Gen.	kr[u]w.ki	kr[u].wek
Dat.	kr[u]w.ce	kr[u]w.kom
Acc.	kr[u]w.ke	kr[u]w.ki
Inst.	kr[u]w.ka	kr[u]w.kami
Loc.	kr[u]w.ce	kr[u]w.kach

The base of the responsible OO-Identity relation must be an inflected form, since inflection is obligatory in the language. Kraska-Szlenk proposes that the relevant base of gen.pl. [kru.wek] is the nom.sg. [kruw.ka]. But the nominative base's /-ka/ suffix is not present in the genitive plural word; the genitive plural is required to be faithful to the base's vowel quality, but not to its inflectional morphology. Morphological constraints ensure that this is always true. It is reasonable to assume that the grammar rejects words that are marked for both nominative singular and genitive plural (or any other conflicting inflections). The base's inflection cannot be realized in the derived word, although OO-Identity constraints would like it to be, because morphological constraints against double or inconsistent inflectional marking are dominant.

In some cases the base's inflection influences the phonology of the stem, and that influence is also felt in the related derived word. An example comes from Portugese (Ranier, 1995). The data in (198) show singular and plural nouns, together with singular and plural diminutives marked with the suffix *-zinha/o*.

(198) Portugese

Singular	Sg.Diminutive	Plural	Pl.Diminutive	
cão	cãozinho	cães	cãezinhos	'dog'
flor	florzinha	flores	florezinhas	'flower'

In the 'dog' forms, suffixation of the plural *-(e)s* eliminates, or forces assimilation of, the root-final vowel: /cão + es/ --> [cães]. This change is also visible in the plural diminutive,

even though the plural morpheme is not adjacent to the stem in the diminutive: [cãezinhos] < /cão + zinho + es/, *[cãozinhos]. Similarly in the diminutive of 'flowers' [florezinhas] a vowel appears between the root and the diminutive suffix, even though no vowel is necessary in this environment (cf. [florzinha]). These are OO-Identity effects, forced by constraints on the relation between the plural and the diminutive plural.

(199) Portugese

OO-correspondence

cães → cãezinhos

↑ ↑

/ cão + es / / cão + zinho+ es /

The base of this subparadigm is an inflected word, but its inflection does not get faithfully reproduced in the derived word. The diminutive is [cãe-zinho-s], and not *[cãe-s-zinho], with word-internal plural marking. Morphological well-formedness requires plural marking to be edgmost, so word-internal plural marking or double plural marking (e.g., *[cãe-s-zinho-s]) are prohibited. But even though the plural morpheme cannot be realized adjacent to the root in the diminutive, its influence on the root-final vowel is transferred to from the non-diminutive base by OO-Identity constraints.

Another relevant case comes from the Bantu language Cibemba (Hyman, 1994). The causative morpheme, which consists of the super high or super close vowel [i̥], triggers mutation in preceding consonants, as in the causatives in (200). In causative-applicatives, consonant mutation similarly affects root-final consonants, even though the applicative morpheme intervenes between the causative trigger and the root. This is an overapplication effect: mutation affects both the applicative (which is underlyingly /-il/) as well as the root-final consonant.

(200) Cibemba

Root	Causative	Causative-Applicative	
leep	leef-i̥	leef-es-i̥	be long/lengthen/lengthen for
lob	lof-i̥	lof-es-i̥	be extinct/exterminate/exterminate for
fiit	fiis-i̥	fiis-is-i̥	be dark/darken/darken for
lil	lis-i̥	lis-is-i̥	cry/make cry/make cry for

Hyman analyzes the double mutations as a cyclic effect. The causative marker attaches to the root on the first cycle, triggering mutation in the root-final consonant, and then the applicative marker is infixed on cycle 2, and mutation re-applies. In nonprocedural TCT, the causative stem serves as the base of an OO-correspondence relation with the causative-applicative. The double mutation is overapplication forced by high-ranking OO-Identity.

The strings in (200) are not independent words. Bantu languages have obligatory inflection: all words have a classifying prefix and a final vowel. Hyman does not provide examples of fully-inflected words, so for present purposes I use the final vowel *-e* and represent the classifying prefix with a schematic CV-. In (201), the base of the OO-correspondence relation is a causative, and the related word is a causative-applicative.

(201) Cibemba

	OO-correspondence	
CV-leef-i̥-e	→	CV-leef-es-i̥-e
↑		↑
/ CV + leep + i̥ + e /		/ CV + leep + i̥ + il + e /

The overapplication of consonant mutation in the causative-applicative is a paradigmatic identity effect; the root-final consonant must mutate in the causative-applicative because the root-final consonant mutates in the causative base. This identity effect is not impeded by the obligatory final vowel; that is, the base's final vowel is not faithfully reproduced in the derived word. The final vowel appears word-finally, where morphology requires it.

I conclude that an inflected form can serve as the output base of an OO-correspondence relation. In Portugese, the base's plural inflection does not appear inside the diminutive marker, because inflection is required to be peripheral in the word. But the base's inflection still influences the diminutive in an overapplication identity effect. Similarly in Cibemba, the obligatory final vowel on the causative base does not occur word-internally in the related causative-applicative, because final vowels are always absolutely final in the word.

There is no need to stipulate that the minimal domain of phonology is the *lexeme*. Phonological derivation optimizes *words* (or pairs of words), and not any other unit. Cyclic or misapplication effects can occur in words related to an obligatorily-inflected stem because an inflected stem can function as the base of an OO-correspondence relation. Morphological constraints prevent the base's inflection from surfacing in the related word. Of course, cyclic effects in other kinds of bound roots are still impossible. The bound root must be made into a full word by inflectional marking only, because only inflection is prohibited by morphological constraints from surfacing in a related inflected word. It follows that only full words and a subset of bound roots, those that can be made into full words by inflection (i.e., Kiparsky's *lexemes*), are the minimal domains of phonological derivation.

6.4 Base Priority

Transderivational identity relations are asymmetrical, in that the derived word can mimic the base, but the base cannot mimic the phonology of the derived word. The "back-copying" phenomenon in reduplication is not possible in paradigms. I proposed that this PRIORITY OF THE BASE asymmetry is enforced universally as RANKING PRIORITY in a recursive evaluation of subparadigm units. The base never deviates from canonical patterns in order to mimic its derived counterpart because the base is evaluated against a dominant recursion of the constraint hierarchy.

As discussed, traditional accounts of paradigmatic identity effects prevent back-copying with a "no look-ahead" serial derivation. Early derivation is blind to later stages, so a less-complex word never violates constraints to be like a more-complex word. Because the "no look-ahead" provision is considered to be implicit in the serial derivation itself, Lexical Phonology and serial OT prohibit back-copying universally, just like TCT.[121] It is worth considering, therefore, whether the PRIORITY OF THE BASE is always true.

To my knowledge, two purported violations of base-priority have been presented in recent literature. Burzio (1994) has a case involving English stress. Final stress on a proper name like *Evangelíne* is a product of an identity relation with *Evangelína*, where stress is regularly penultimate. I will not review his arguments here, because Burzio has since withdrawn from this claim, and in current work accepts base-priority as an inviolable generalization.

Another alleged counterexample is discussed by Kenstowicz (1996). This is rhotacization in Latin. In rule-based terms, *s* becomes *r* intervocalically. Kenstowicz argues that the forms in (202) require the unaffixed nominative to copy the intervocalic rhotic in the affixed genitive, in violation of base-priority.

(202) Latin

nom. sg.	gen.sg.			
honor	hono:r-is	'honor'	cf. hones-tus	'honest'
arbor	arbo:r-is	'tree'	cf. arbus-tus	'wooded'
angor	ango:r-is	'constriction'	cf. angus-tus	'tight'

The claim that the nominative copies the genitive rests on the assumption that the underlying roots of the nouns in (202) end in *s*: /honos/, /arbos/, /angos/. This is based on the adjectival forms shown at the right of the display, in which a root-final *s* surfaces pre-consonantally. This claim is dubious, however, in light of the differences in the vowels of the nominal and adjectival forms. These unpredictable contrasts suggest that adjectives and nouns are not derived from the same underlying root. If this is correct, there is no evidence that the underlying form of *honor* is /honos/. Rather, the data suggest that the underlying root of the nouns is /honor/.

[121] In rule-based theory, the derivation cannot look ahead to later stages or look back to earlier ones. Rules apply strictly locally, irrespective of what goes on before or after they apply. Below I argue that the "no look-ahead" provision is not logically entailed by serialism, and has to be enforced by an extra statement.

Kiparsky (1997) analyzes this case in a serial OT framework. Like Kenstowicz, he assumes that nominal forms are derived from an *s*-final underlying root. To derive the nominative singular [honor] serially, genitive marking is added first and then stripped away by rules of s-deletion and i-deletion (/honos + is/ --> *honoris* --> *honori* --> *honor*). Kiparsky proposes that this is phonological deletion, rather than morphological truncation or back-formation. The morphological relation between the nominative and genitive forms is unimportant; the nominative just happens to be derived from the suffixed genitive form. This rather circuitous derivation is the only way that a serial model can derive the alleged violation of base-priority.[122]

It is my contention that base-priority is never violated. For the Latin case, this means that the underlying form of *honor* is /honor/, not /honos/. The s-final root may be correct for older forms of Latin, but in the stage represented in (202) a change in the underlying form has already occurred. Based on the surface evidence provided, speakers would analyze the underlying form of *honor* as *r*-final /honor/, since this noun root never surfaces with a final *s*. Thus, Latin is not a convincing counterexample to base-priority.

TCT enforces base-priority by recursive evaluation of paradigms, and I have already devoted some space to comparison of this proposal with the serial alternative. I noted that the serial model has a conceptual disadvantage, in that identity of related words is essentially epiphenomenonal. Explanation is lost if the similarity between two related outputs is not formally recognized. The fact that derived features are sometimes faithfully preserved between cycles (*oríginal   orìginálity*, *dam<n>   dam<n>ing*) and sometimes not (*órigin   oríginal*, *dam<n>   damnation*) is not an accident. It follows from the rank of OO-Identity constraints relative to conflicting markedness and IO-Faith requirements.

[122] No familiar elaboration of Lexical Phonology can easily handle a case like this. Mohanan's (1982, 1986) loop device circumvents the "no look-ahead" serial derivation by allowing the output of a later level to re-enter an earlier one, but upon re-entry the form is expected to undergo further morphological or phonological derivation. This is how ordering and bracketing paradoxes are generated. In the Latin case, the intermediate stage *honoris* has to be stripped of its genitive morphology after the *s* --> *r* rule has applied. If there are no independently motivated *-is* deletion rules in Latin, and no further morphological derivation takes place, re-entering an earlier level of derivation does not help.

Another problem with the serial model is that it requires different stages of derivation to have different grammars, and this variability, without further restriction, makes unlikely typological predictions. In particular, it has to be explained by why the only difference between subgrammars that seems to be necessary is the promotion of faithfulness. Also, the serial model fails to recognize a relation between a derived word and the underlying root; a derived word is generated from an output base, and not from a lexical form. It not possible for an affixed word to be faithful to its base on some dimension, and faithful to its underlying form along another, although this must be true in certain cases, such as English *pàradìgmátic* and *condèmnátion*, which are faithful to the bases in stress and faithful to the underlying root's consonant cluster at the same time.

A serial version of OT could address these problems by introducing transderivational identity constraints. Complex words are subject to both IO-Faith and OO-Identity constraints; that is, words derived in a non-initial subgrammar are compared to both the underlying form and the output of the previous level. The only difference between this theory and TCT is how base-priority is enforced. The transderivational-serial theory retains the "no look-ahead" assumption of traditional serial models. The name *Larry* cannot surface with a back vowel in anticipation of the truncated form *Lar*, where a back vowel is conditioned by the tautosyllabic *r*, because the less-complex word is blind to later morphological derivation.

The "no look-ahead" assumption is familiar from rule-based serial theory. Rules cannot look ahead in the derivation, and they cannot look back either. Rule applications are blind to what goes on around them; they are "local". This characterization of local derivation is of course possible because rule-based theory does not explicitly recognize faithfulness. Non-application of rules makes underlying material surface (the "do-nothing" theory of faithfulness). In a sense, then, constraint-based theories that directly enforce faithfulness give up the "no looking back" provision of local rule application (although this loses some force in parallel OT, since there is only one stage (the UR) to look back on).

But if OT makes "looking back" possible by way of faithfulness constraints, it is not clear why "looking ahead" – specifically, violation of base-priority under the force of OO-Identity constraints – is not possible too. The "no look-ahead" policy in not logically implicit in serial derivation. In serial OT, it has to be explicitly enforced.

The transderivational-serial model reduces the serial derivation itself to this role: it is simply a prohibition on back-copying. Serialism's other job, turning derived outputs into inputs, is taken over by OO-Identity constraints, as it is in TCT. I have argued that serialism is unnecessary, because base-priority can be enforced by recursive evaluation of paradigms. I have also argued that serialism is undesirable, because it implicitly allows the grammar to be different at each stage of derivation. Observed similarities between levels, which in fact predominate over differences, have to be explained. In effect, there is a trade-off of advantages: parallel theory predicts that all words in a language obey the same generalizations but has to say something extra about base-priority, while serial theory predicts base-priority but has to explain why levels of derivation are so similar. I contend that the consistency of targets is the paramount consideration, and advocate the parallel approach.

To summarize, I take the PRIORITY OF THE BASE to be an inviolable generalization and build it in to the architecture of the grammar. Cases alleged to show base-priority violation must succumb to other analyses, as I have argued the Latin case does. I have also shown that serial theories are just as committed to base-priority as TCT is – both theories prohibit back-copying effects across-the-board. If convincing cases of back-copying are discovered, both serial theory and TCT will have to be significantly revised. In TCT, paradigms will have to be evaluated non-recursively, and an alternative analysis of underapplication, which I have shown to be possible only with recursive evaluation, will have to be devised.

6.5 The Morphology-Phonology Interface

Phonology is sensitive to morphology because phonological identity relations hold over morphologically-related words. Phonological relations mirror morphological relations, and, through constraint ranking, the phonological grammar values surface identity of related words. Word pairings are not always transparent from a phonological point of view. Related words are often in a morphological subset relation, reflecting a straightward morphological derivation. But in some cases, involving obligatorily-inflected words, it is not clear why one particular word serves as the phonological base of another. I have assumed that independent morphological or lexical principles determine that the imperfective is the base of jussive truncation in Tiberian Hebrew, or that the nominative singular is the base of the genitive plural feminine diminutive in Polish, but this is an issue that needs further investigation.

I have also assumed that morphology can impact directly on phonology by way of markedness constraints. In §5 I gave a brute-force formulation BOUNDROOT to prevent morphologically-bound material from surfacing on its own, and in §6.3 I proposed that morphological constraints ban non-peripheral inflectional affixation. Thus, morphology places some tight controls on phonology. But in a general sense, the interface between the morphology and phonology is fairly loose in TCT, and the components are free to act relatively autonomously. As far as the phonology is concerned, there is no necessary synchronicity with the morphological derivation, contra stratal theories like Lexical Phonology and serial OT. There is no reason to expect that morphological and phonological classes are coextensive, because there is no assumption that material that gets introduced at one level, because it is part of a morphological class, undergoes the same phonology. Phonological classes are of course free to reflect morpho-lexical generalizations; for example, Japanese sub-lexicons, which are differentiated only by the rank of IO-Faith constraints (Fukazawa, 1996), correlate with etymological classes. There is obviously a learnability advantage, in that learning is facilitated when a phonological

pattern correlates with some other feature. However, morphemes can also be arbitrarily grouped into phonological classes, including singleton classes. In English, for example, affix classhood does not correlate with any independent factors at all; the distinction is morpholo-syntactically, etymologically, and prosodically arbitrary. Class membership may, therefore, be simply a phonological fact.

I have proposed that morpheme-specific or class-specific behavior results from differential ranking of constraints on correspondence relations. It seems possible that the *only* morpheme-specific constraints in grammar are faithfulness constraints keyed to a specific OO-, IO- or BR-correspondence relations. The strong claim of TCT is that in the domain of paradigms, the selection of an OO-correspondence relation, played out in the rank of the faithfulness constraints proper to that relation, is sufficient to model phonology's sensitivity to morphological information.

BIBLIOGRAPHY

Alderete, John. 1995. Faithfulness to prosodic heads. Ms., University of Massachusetts, Amherst.

Alderete, John. 1996a. Prosodic faithfulness in Cupeño. Ms., University of Massachusetts, Amherst.

Alderete, John. 1996b. Head dependence in stress-epenthesis interactions. To appear in B. Hermans & M. van Oostendorp (eds.). *The Derivational Residue in Phonology*. Amsterdam: Benjamins.

Alderete, John. 1997. Multiple correspondence and base optimization. Poster presented at Maryland Mayfest/Hopkins Optimality Workshop.

Allen, Margaret. 1978. *Morphological Investigations*. Doctoral dissertation, University of Connecticut.

Allen, Margaret. 1975. Vowel mutation and word stress in Welsh. *Linguistic Inquiry* 6: 181-201.

Anderson, Stephen. 1972. On nasalization in Sundanese. *Linguistic Inquiry* 3: 253-268.

Anderson, Stephen. 1975a. On the interaction of phonological rules of various types. *Journal of Linguistics* 11: 39-62.

Anderson, Stephen. 1975b. On the typology of phonological rules. In A. Bruck, R. Fox & M. LaGaly (eds.). *Papers from the Parasession on Natural Phonology*, 1-12. Chicago: Chicago Linguistic Society.

Anderson, Stephen. 1992. *A-morphous Morphology*. Cambridge: Cambridge University Press.

Archangeli, Diana. 1984 [1988]. *Underspecification in Yawelmani Phonology and Morphology*. Doctoral dissertation, MIT. [New York: Garland].

Archangeli, Diana. 1996. Output identity and Javanese vowels. Handout of talk presented at AFLA 3, UCLA.

Archangeli, Diana & Douglas Pulleyblank. 1994. *Grounded Phonology*. Cambridge, MA: MIT Press.

Aronoff, Mark. 1976. *Word Formation in Generative Grammar*. Cambridge, MA: MIT Press.

Aronoff, Mark. 1994. *Morphology by Itself*. Cambridge, MA: MIT Press.

Aronoff, Mark & S.N. Sridhar. 1983. Morphological levels in English and Kannada; or, Atarizing Reagan. In *Proceedings of CLS 19: Parasession on the Interplay of Morphology, Phonology and Syntax*, 16-35. Chicago: Chicago Linguistic Society.

Aronoff, Mark & Frank Anshen. 1979. Morphological productivity and phonological transparency. Ms., SUNY Stony Brook. [Presented at the LSA annual meeting].

Bakovic, Eric. 1995. Strong onsets and Spanish fortition. In *Proceedings of SCIL 6*. Cambridge, MA: MITWPL.

Bakovic, Eric. 1997. Spanish codas and overapplication. Ms., Rutgers University. [To appear in the proceedings of LSRL-27]

Bat-El, Outi. 1992. Stem modification and cluster transfer in modern Hebrew. *Natural Language and Linguistic Theory* 12: 571-596.

Beckman, Jill. In prep. *Positional Faithfulness.* Doctoral dissertation, University of Massachusetts, Amherst.

Benua, Laura. 1995. Identity effects in morphological truncation. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 77–136. Amherst: GLSA.

Benua, Laura. 1997a. How morphology breaks phonotactic patterns: The case of Javanese vowels. Talk presented at HILP 3, University of Amsterdam.

Benua, Laura. 1997b. Affix classes are defined by faithfulness. Talk presented at Maryland Mayfest/Hopkins Optimality Workshop. [To appear in the University of Maryland Working Papers.]

Black, Andrew. 1993. *Constraint-Ranked Derivation: A Serial Approach to Optimization*. Doctoral dissertation, University of California, Santa Cruz.

Blevins, Juliette. 1994. The bimoraic foot in Rotuman morphology and phonology. *Oceanic Linguistics* 33.

Bloomfield, Leonard. 1930. German ç and x. *Le maître phonétique* 3, 20: 27-28.

Booij, Geert. 1985. The interaction of phonology and morphology in prosodic phonology. In E. Gussmann (ed.). *Phono-Morphology: Studies in the Interaction of Phonology and Morphology*, 23-34. Lublin: Redakcja Wydawnictw.

Booij, Geert & Jerzy Rubach. 1984. Morphological and prosodic domains in lexical phonology. *Linguistic Inquiry* 18: 1-44.

Borowsky, Toni. 1986. *Topics in the Lexical Phonology of English*. Doctoral dissertation, University of Massachusetts, Amherst.

Borowsky, Toni. 1993. On the word level. In S. Hargus & E. Kaisse (eds.). *Phonetics and Phonology 4: Studies in Lexical Phonology*, 199-234. New York: Academic Press.

Brame, Michael. 1974. The cycle in phonology: Stress in Palestinian, Maltese and Spanish. *Linguistic Inquiry* 5: 39-60.

Buckley, Eugene. 1995. Cyclicity and correspondence. Talk presented at the Tilburg Conference on the Derivational Residue in Phonology, Tilburg University.

Burzio, Luigi. 1994a. *Principles of English Stress*. Cambridge: Cambridge University Press.

Burzio, Luigi. 1994b. Anti-Allomorphy. Handout of talk presented at the Going Romance conference, University of Utrecht.

Burzio, Luigi. 1996a. Surface constraints versus underlying representations. In J. Durand & B. Laks (eds.) *Current trends in phonology: Models and methods*. CNRS, Paris X and University of Salford.

Burzio, Luigi. 1996b. Multiple correspondence. Ms., The Johns Hopkins University.

Burzio, Luigi. 1997a. Class lectures, The Johns Hopkins University and University of Maryland, College Park.

Burzio, Luigi. 1997b. Strength in Numbers. Talk presented at Maryland Mayfest/Hopkins Optimality Workshop. [To appear in the University of Maryland Working Papers.]

Burzio, Luigi. 1997c. Cycles, non-derived environment blocking and correspondence. Ms., The Johns Hopkins University.

Bybee, Joan. 1985. *Morphology: A Study of the Relations between Meaning and Form*. Amsterdam: Benjamins.

Bybee, Joan. 1988. Morphology as lexical organization. In M. Hammond & J. Noonan (eds.). *Theoretical morphology: Approaches in modern linguistics*, 119-141. New York: Academic Press.

Bybee, Joan & Carol Moder. 1983. Morphological classes as natural categories. *Language* 59: 251-270.

Bye, Patrick. 1996. *Correspondence in the Prosodic Hierarchy and the Grid*. Master's thesis, University of Tromsø.

Cairns, Charles. 1996. The two words can and prosodic structure in general American and New York City English. Ms., Queens College and CUNY Graduate Center.

Carrier, Jill. 1979. *The Interaction of Phonological and Morphological Rules in Tagalog: A Study of the Relationship between Rule Components in Grammar*. Doctoral dissertation, MIT.

Carrier-Duncan, Jill. 1984. Some problems with prosodic accounts of reduplication. In M. Aronoff & R. Oehrle (eds.). *Language Sound Structure; Studies in Phonology Presented to Morris Halle by his Teacher and Students*. Cambridge, MA: MIT Press.

Cartmill, Matt. 1976. Welsh vowel mutation: Surface phonology and underlying forms. *Linguistic Inquiry* 7: 675-677.

Causley, Trisha. 1997a. Featural correspondence and correspondence constraints. Talk presented at the workshop on prosodic morphology, HILP 3. University of Amsterdam.

Causley, Trisha. 1997b. Max-Dep asymmetries and *Structure constraints. Poster presented at Maryland Mayfest/Hopkins Optimality Workshop.

Chambers, Jack. 1973. Canadian raising. *Canadian Journal of Linguistics* 18: 113-135.

Chomsky, Noam & Morris Halle. 1968. *The Sound Pattern of English*. New York: Harper and Row.

Chung, Sandra. 1983. Transderivational relationships in Chamorro phonology. *Language* 59: 35–66.

Churchward, C.M. 1940. *Rotuman Grammar and Dictionary*. Sydney: Australasia Medical Publishing Co. [Reprinted New York: AMS Press, 1978].

Clements, G.N. 1988. Toward a substantive theory of feature specification. In J. Blevins & J. Carter (eds.). *Proceedings of NELS 18*, 79-93. Amherst: GLSA.

Clements, G.N. 1990. The role of the sonority cycle in core syllabification. In J. Kingston & M. Beckman (eds.). *Papers in Laboratory Phonology 1: Between the Grammar and the Physics of Speech*, 293-333. New York: Cambridge University Press.

Cohn, Abigail. 1990. *Phonetic and Phonological Rules of Nasalization*. Doctoral dissertation, University of California, Los Angeles. [UCLA Working Papers in Phonetics 76].

Cohn, Abigail. 1992. The consequences of dissimilation in Sundanese. *Phonology* 9: 199-220.

Cohn, Abigail & John McCarthy. 1994. Alignment and parallelism in Indonesian phonology. Ms., Cornell University and University of Massachusetts, Amherst.

Cole, Jennifer. 1990. Arguing for the phonological cycle: A critical view. *Proceedings of FLSM 1*, 51-67.

Cole, Jennifer. 1995. The cycle in phonology. In J. Goldsmith (ed.). *The Handbook of Phonological Theory*, 70-113. Cambridge, MA: Blackwell.

Coleman, John. 1993. English word-stress in unification-based grammar. *Edinburgh Working Papers in Cognitive Science* 8.

Duanmu, San. 1995. Alignment and the cycle are different. Talk presented at the Tilburg Conference on the Derivational Residue in Phonology, Tilburg University.

Dudas, Karen. 1976. *The Phonology and Morphology of Modern Javanese*. Doctoral dissertation, University of Illinois at Urbana-Champaign.

Dunlap, Elaine. 1987. English [æ] tensing in lexical phonology. Ms., University of Massachusetts, Amherst.

Fabb, Nigel. 1988. English suffixation is constrained only by selectional restrictions. *Natural Language and Linguistic Theory* 6: 527-539.

Ferguson, Charles. 1972. 'Short a' in Philadelphia English. In M. E. Smith (ed.). *Studies in Linguistics in Honor of George L. Trager*, 250-274. The Hague: Mouton.

Flemming, Edward. 1995. *Auditory Representations in Phonology*. Doctoral dissertation, UCLA.

Fukazawa, Haruka. 1996. Japanese vocabulary strata. Ms., University of Maryland, College Park.

Fukazawa, Haruka and Viola Miglio. 1996. Local conjunction of constraint families. Talk presented at ESCOL, University of California, Santa Cruz.

Gnandesikan, Amalia. 1997. *Phonology with Ternary Scales*. Doctoral dissertation, University of Massachusetts, Amherst.

Goldsmith, John. 1976 [1979]. *Autosegmental Phonology*. Doctoral dissertation, MIT. [New York: Garland].

Guerssel, Mohand. 1983. A lexical approach to word formation in English. *Linguistic Analysis* 12: 183-243.

Hall, Tracy. 1989. Lexical phonology and the distribution of German [ç] and [x]. *Phonology* 6: 1-18.

Halle, Morris. 1963. Phonology in generative grammar. *Word* 18: 54-72.

Halle, Morris. 1973. Prolegomena to a theory of word formation. *Linguistic Inquiry* 4: 3-16.

Halle, Morris. 1979. Formal vs. functional considerations in phonology. In B. Brogyanyi (ed.). *Studies in Diachronic, Synchronic and Typological Linguistics: Festschrift for Oswald Szemerenyi*, vol. 1, 325-341. Amsterdam: Benjamins.

Halle, Morris. 1990a. Respecting metrical structure. *Natural Language and Linguistic Theory* 8: 149-176.

Halle, Morris. 1990b. An approach to morphology. In *Proceedings of NELS 21*, 150-185.

Halle, Morris & Jean-Roger Vergnaud. 1987a. *An Essay on Stress*. Cambridge, MA: MIT Press.

Halle, Morris & Jean-Roger Vergnaud 1987b. Stress and the cycle. *Linguistic Inquiry* 18: 45-84.

Halle, Morris, James Harris and Jean-Roger Vergnaud. 1991. A reexamination of the stress erasure convention and Spanish stress. *Linguistic Inquiry* 23: 141-159.

Halle, Morris & K.P. Mohanan. 1985. Segmental phonology of modern English. *Linguistic Inquiry* 16: 57-116.

Halle, Morris & Michael Kenstowicz. 1991. The Free Element Condition and cyclic versus noncyclic stress. *Linguistic Inquiry* 22: 457-501.

Hammond, Michael. 1991. Morphemic circumscription. In G. Booij & J. van Marle (eds.). *Yearbook of Morphology*, 195-210. Dordrecht: Kluwer.

Hargus, Sharon. 1985. *The Lexical Phonology of Sekani*. Doctoral dissertation, UCLA.

Hargus, Sharon. 1993. Modeling the phonology-morphology interface. In S. Hargus & E. Kaisse (eds.). *Phonetics and Phonology 4:Studies in Lexical Phonology*, 45-74. New York: Academic Press.

Harris, James. 1973. On the order of certain phonological rules in Spanish. In S. Anderson & P. Kiparsky (eds.). *A Festschrift for Morris Halle*. New York: Holt, Reinhart and Winston.

Harris, James. 1985. Spanish diphthongization and stress: A paradox resolved. *Phonology* 2: 31-45.

Harris, James. 1989. The stress erasure convention and cliticization in Spanish. *Linguistic Inquiry* 20: 339-363.

Harris, John. 1990. Derived phonological contrasts. In S. Ramsaran (ed.). *Studies in the pronunciation of English; A commemorative volume in honour of A.C. Gimson*, 87-105. London: Routledge.

Hart, George. 1981. Nasality and the organization of autosegmental phonology. Bloomington: Indiana University Linguistics Club.

Hayes, Bruce. 1980 [1985]. *A Metrical Theory of Stress Rules*. Doctoral dissertation, MIT. [New York: Garland].

Hayes, Bruce. 1984. The phonology of rhythm in English. *Linguistic Inquiry* 13: 227-276.

Hironymous, Patricia. 1996. Sonority as alignment. Ms., University of Maryland, College Park.

Hock, Hans H. 1973. Exceptions and synchronic analogy in Sanskrit. *Studies in the Linguistic Sciences* 3: 81-101.

Hockett, Charles. 1954. Problems of morphemic analysis. *Language* 23: 321-343.

Holton, David. 1995. Assimilation and dissimilation of Sundanese liquids. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 167–180. Amherst: GLSA.

Hooper, Joan. 1976. *An Introduction to Natural Generative Phonology*. New York: Academic Press.

Hulst, Harry van der & Norval Smith. 1984. Prosodic domains and opaque segments in autosegmental theory. In H. van der Hulst & N. Smith (eds.). *The Structure of Phonological Representations, vol 2.*, 311-336. Dordrecht: Foris.

Hung, Henrietta. 1994. *The Rhythmic and Prosodic Organization of Edge Constituents*. Doctoral dissertation, Brandeis University.

Hyman, Larry. 1985. *A Theory of Phonological Weight*. Dordrecht: Foris.

Hyman, Larry. 1994. Cyclic phonology and morphology in Cibemba. In J. Cole & C. Kisseberth (eds.). *Perspectives in Phonology*, 81-112. Stanford: CSLI Publications.

Inkelas, Sharon. 1989. *Prosodic Constituency in the Lexicon*. Doctoral dissertation, Stanford University.

Inkelas, Sharon. 1993. Deriving cyclicity. In S. Hargus & E. Kaisse (eds.). *Phonetics and Phonology 4: Studies in Lexical Phonology*, 75-110. New York: Academic Press.

Inkelas, Sharon. 1994. Exceptional stress-attracting suffixes in Turkish: Representations versus the grammar. Ms., University of California, Berkeley.

Inkelas, Sharon, Orhan Orgun & Cheryl Zoll. 1996. Exceptions and static phonologial patterns: Cophonologies vs. prespecification. Ms., University of California, Berkeley and University of Iowa.

Itô, Junko. 1986. *Syllable Theory in Prosodic Phonology*. Doctoral dissertation, University of Massachusetts, Amherst.

Itô, Junko & R. Armin Mester. 1992. Weak layering and word binarity. Ms., University of California, Santa Cruz.

Itô, Junko & R. Armin Mester. 1993. Licensed segments and safe paths. *Canadian Journal of Linguistics* 38: 197-213.

Itô, Junko & R. Armin Mester. 1994a. Reflections on CodaCond and alignment. In J. Merchant, J. Padgett & R. Walker (eds.). *Phonology at Santa Cruz* 3, 22-46.

Itô, Junko & R. Armin Mester. 1994b. Headedness and Alignment. Lecture notes, University of Massachusetts, Amherst.

Itô, Junko & R. Armin Mester. 1995. The core-periphery structure of the lexicon and constraints on reranking. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 181-209. Amherst: GLSA.

Itô, Junko & R. Armin Mester. 1996. Correspondence and compositionality: The Ga-gyo variation in Japanese phonology. Ms., University of California, Santa Cruz.

Itô, Junko & R. Armin Mester. 1997. Prosodic interludes and Sympathy effects: Examples from Germanic phonology. Talk presented at Maryland Mayfest/Hopkins Optimality Workshop. [To appear in the University of Maryland Working Papers.]

Itô, Junko, R. Armin Mester & Jaye Padgett. 1995. NC: Licensing and underspecification in Optimality Theory. *Linguistic Inquiry* 26:271-313.

Itô, Junko, Yoshihisa Kitagawa & R. Armin Mester. 1995. Prosodic faithfulness and correspondence: Evidence from a Japanese argot. Ms., University of California, Santa Cruz and Indiana University.

Iverson, Gregory & Joe Salmons. 1992. The place of Structure Preservation in German diminutive formation. *Phonology* 9: 137-143.

Kager, Rene. 1989. *A Metrical Theory of Stress and De-Stressing in English and Dutch*. Dordrecht: Foris.

Kager, Rene. 1995. Surface opacity of metrical structure in Optimality Theory. Talk presented at the Tilburg Conference on the Derivational Residue in Phonology, Tilburg University.

Kahn, Daniel. 1976 [1980]. *Syllable-Based Generalizations in English Phonology*. Doctoral dissertation, MIT. [New York: Garland].

Kean, Mary-Louise. 1974. The strict cycle in phonology. *Linguistic Inquiry* 5: 179-203.

Kenstowicz, Michael & Charles Kisseberth. 1977. *Topics in Phonological Theory*. New York: Academic Press.

Kenstowicz, Michael & Charles Kisseberth. 1979. *Generative Phonology*. San Diego: Academic Press.

Kenstowicz, Michael. 1981. Functional Explanations in Generative Phonology. In D.L. Goyvaerts (ed.). *Phonology in the 1980's*. Story-Scientia, Ghent.

Kenstowicz, Michael. 1986. Multiple Linking in Javanese. In *Proceedings of NELS 16*, 230-248. Amherst: GLSA.

Kenstowicz, Michael. 1995. Cyclic vs. Non-Cyclic Constraint Evaluation. *Phonology* 12.

Kenstowicz, Michael. 1996. Base Identity and Uniform Exponence: Alternatives to Cyclicity. In J. Durand & B. Laks (eds.) *Current trends in phonology: Models and methods*. CNRS, Paris X and University of Salford.

Kenstowicz, Michael. 1997. Uniform exponence: Exemplification and extension. Talk presented at Maryland Mayfest/Hopkins Optimality Workshop.

Kenyon, John & Thomas Knott. *A Pronouncing Dictionary of American English*. Springfield, MA: Miriam-Webster.

Kiparsky, Paul. 1968. How Abstract is Phonology? In O. Fujimura (ed.), *Three Dimensions of Linguistic Theory*, 1-136. Tokyo: Taikusha.

Kiparsky, Paul. 1973a. "Elsewhere" in phonology. In S. Anderson & P. Kiparsky (eds.). *A Festschrift for Morris Halle*, 93-106. New York: Holt, Rinehart and Winston.

Kiparsky, Paul. 1973b. Abstractness, opacity and global rules. In In O. Fujimura (ed.), *Three Dimensions of Linguistic Theory*, 57-86. Tokyo: Taikusha

Kiparsky, Paul. 1979. Metrical structure assignment is cyclic. *Linguistic Inquiry* 10: 421-441.

Kiparsky, Paul. 1982a. Lexical Morphology and Phonology. In I.-S. Yang (ed.). *Linguistics in the Morning Calm, vol. 2*, 3-91. Soeul: Hanshin.

Kiparksy, Paul. 1982b. From Cyclic Phonology to Lexical Phonology. In H. van der Hulst & N. Smith (eds.). *The Structure of Phonological Representations, vol. 1*, 131-175. Dordrecht: Foris.

Kiparsky, Paul. 1982c. *Explanation in Phonology*. Dordrecht: Foris.

Kiparsky, Paul. 1985a. On the Lexical Phonology of Icelandic. In C.-C. Elert, I. Johansson & E. Strangert (eds.). *Nordic Prosody* III, 135-164. University of Umea.

Kiparsky, Paul. 1985b. Some consequences of Lexical Phonology. *Phonology* 2: 85–138.

Kiparsky, Paul. 1986. The phonology of reduplication. Ms., Stanford University.

Kiparsky, Paul. 1993. Blocking in Nonderived Environments. In S. Hargus & E. Kaisse (eds.). *Phonetics and Phonology 4: Studies in Lexical Phonology*, 277-313. New York: Academic Press.

Kiparsky, Paul. 1997. Output-output constraints vs. cyclicity. Handout from LSA Summer Institute, Cornell University.

Kisseberth, Charles. 1971. Cyclic rules in Klamath phonology. *Linguistic Inquiry* 3: 3-33.

Kraska-Szlenk, Iwona. 1995. *The Phonology of Stress in Polish*. Doctoral dissertation, University of Illinois at Urbana-Champaign.

Labov, William. 1981. Resolving the Neogrammarian controversy. *Language* 57: 267-308.

Lamontagne, Greg. 1996. Relativized contiguity. Ms., University of British Columbia.

Lamontagne, Greg & Tim Sherer. 1993. Optimality, Alignment and English Level-Ordering Effects. Talk presented at Rutgers Optimality Workshop (ROW-1), Rutgers University.

Lamontagne, Greg & Keren Rice. 1995. A Correspondence Account of Coalescence. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 211-223. Amherst: GLSA.

Leben, William & Orrin Robinson. 1977. 'Upside down' phonology. *Language* 53: 1-20.

Levin, Julliette. 1988. Bidirectional foot construction as a window on level ordering. In M. Hammond & J. Noonan (eds.). *Theoretical Morphology: Approaches in Modern Linguistics*, 371-388. New York: Academic Press.

Levy, Erika. 1997a. Word-word correspondence in German. Ms., New York University.

Levy, Erika. 1997b. Identity-driven syllabification in German surface forms. Ms., New York University.

Liberman, Mark & Alan Prince. 1977. On stress and linguistic rhythm. *Linguistic Inquiry* 8: 249-336.

Lieber, Rochelle. 1980. *On the Organization of the Lexicon*. Doctoral dissertation, MIT. Bloomington: Indiana University Linguistcis Club.

Lombardi, Linda. 1995a. Positional faithfulness and the phonology of voicing in Optimality Theory. Ms., University of Maryland, College Park.

Lombardi, Linda. 1995b. Why place and voice are different: Constraint interactions and featural faithfulness in Optimality Theory. Ms., University of Maryland, College Park.

Lorentz, Ove. 1996. Length and correspondence in Scandinavian. In E. Jahr, et.al. (eds.). *Papers from the 2nd Workshop on Comparative Germanic Phonology*, 111-128. Tromsø: School of Languages and Literature, University of Tromsø.

Macfarland, Talke & Janet Pierrehumbert. 1992. On ich-laut, ach-laut and Structure Preservation. Phonology 9: 171-180.

Marantz, Alec. 1982. Re Reduplication. *Linguistic Inquiry* 13: 435-482.

Marchand, H. 1960. *The Categories and Types of Present-Day English Word-Formation*. Weisbaden: Otto Harrassowitz.

Mascaró, Joan. 1976. *Catalan Phonology and the Phonological Cycle*. Doctoral dissertation, MIT.

Matthews, P.H. 1974. *Morphology*. Cambridge: Cambridge University Press.

McCarthy, John. 1979 [1985]. *Formal Problems in Semitic Phonology and Morphology*. Doctoral dissertation, MIT. [New York: Garland].

McCarthy, John. 1993. A case of surface constraint violation. *Canadian Journal of Linguistics* 38: 169-195

McCarthy, John 1995. Extensions of faithfulness: Rotuman revisited. Ms., University of Massachusetts, Amherst.

McCarthy, John. 1997a. Process-specific constraints in Optimality Theory. *Linguistic Inquiry* 28: 231-251.

McCarthy, John. 1997b. Faithfulness and prosodic circumscription. Ms., University of Massachusetts, Amherst.

McCarthy, John. 1997c. Sympathy & phonological opacity. Talk presented at Maryland Mayfest/Hopkins Optimality Workshop.

McCarthy, John & Alan Prince. 1986. Prosodic morphology. Ms., University of Massachusetts, Amherst and Brandeis University. Rutgers Center for Cognitive Science (RuCCs) technical report 32.

McCarthy, John & Alan Prince. 1990. Foot and word in prosodic morphology: The Arabic broken plural. *Natural Language and Linguistic Theory* 8: 209-283.

McCarthy, John & Alan Prince. 1993a. Prosodic Morphology I: Constraint Interaction and Satisfaction. Ms., University of Massachusetts, Amherst and Rutgers University. Rutgers Center for Cognitive Science (RuCCs) technical report 3. [To appear, Cambridge, MA: MIT Press].

McCarthy, John & Alan Prince. 1993b. Generalized alignment. In G. Booij & J. van Marle (eds.). *Yearbook of Morphology*, 79-153. Dordrecht: Kluwer.

McCarthy, John & Alan Prince. 1994a. The emergence of the unmarked: Optimality in prosodic morphology. In *Proceedings of the NELS 24*, 333–379. Amherst: GLSA.

McCarthy, John & Alan Prince. 1994b. An overview of prosodic morphology. Lectures presented at the OTS/HIL Workshop on Prosodic Morphology, University of Utrecht.

McCarthy, John & Alan Prince. 1995. Faithfulness and Reduplicative Identity. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 249–384. Amherst: GLSA.

Merchant, Jason. 1994. German fricative assimilation, ambisyllabicity, and noncrisp alignment. *Phonology at Santa Cruz* 3: 65-77.

Merchant, Jason. 1997. Alignment and fricative assimilation in German. *Linguistic Inquiry* 27: 709-719.

Mester, R. Armin. 1986. *Studies in Tier Structure*. Doctoral dissertation, University of Massachusetts, Amherst.

Mester, R. Armin. 1990. Patterns of Truncation. *Linguistic Inquiry* 20: 478-485.

Mester, Armin. 1994. The Quantitative Trochee in Latin. *Natural Language and Linguistic Theory* 12: 1-61.

Mester, R. Armin & Junko Itô. 1988. Feature predictability and underspecification: Palatal prosody in Japanese mimetics. *Language* 65: 258-293.

Mohanan, K.P. 1982. *Lexical Phonology*. Doctoral dissertation, MIT.

Mohanan, K.P. 1986. *The Theory of Lexical Phonology*. Dordrecht: Reidel.

Moltmann, Frederike. 1990. Syllabification and lexical phonology in German. Ms., MIT.

Morén, Bruce. 1996. Markedness constraints and faithfulness constraints on the association of moras: The dependency between vowel length and consonant weight. Ms., University of Maryland, College Park.

Myers, Scott. 1991a. Persistent rules. *Linguistic Inquiry* 22:315-344.

Myers, Scott. 1991b. Structure preservation and the strong domain hypothesis. *Linguistic Inquiry* 22: 379–85.

Newman, Paul. 1986. Tone and affixation in Hausa. *Studies in African Linguistics* 17: 249-267.

Newman, Stanley. 1946. On the stress system of English. *Word* 2: 171-187.

Odden, David & Mary Odden. 1985. Ordered reduplication in Kihehe. *Linguistic Inquiry* 16: 497-503.

Odden, David. 1993. Interaction between Modules in Lexical Phonology. In S. Hargus & E. Kaisse (eds.). *Phonetics and Phonology 4: Studies in Lexical Phonology*, 111-144. New York: Academic Press.

Orgun, Orhan. 1996. Sign-Based morphology: A declarative theory of phonology-morphology interleaving. Ms., University of California, Berkeley.

Orgun, Orhan. 1997. *Sign-Based Morphology and Phonology with Special Attention to Optimality Theory*. Doctoral dissertation, University of California, Berkeley.

Pater, Joe. 1995. Syllable Weight and Secondary Stress in English. Ms., McGill University.

Payne, Arvilla. 1980. Factors controlling the acquisition of the Philadelphia dialect by out-of-state children. In Labov (ed.). *Locating Language in Time and Space*. New York: Academic Press.

Pesetsky, David. 1979. Russian morphology and lexical theory. Ms., MIT.

Potter, Brian. 1994. Serial optimality in Mohawk prosody. In *Proceedings of the Thirtieth Regional Meeting of the Chicago Linguistic Society*. Chicago: Chicago Linguistic Society.

Prince, Alan. 1975. *The Phonology and Morphology of Tiberian Hebrew*. Doctoral dissertation, MIT.

Prince, Alan. 1983. Relating to the grid. *Linguistic Inquiry* 14: 19-100.

Prince, Alan. 1990. Quantitative consequences of rhythmic organization. In M. Ziolkowski, M. Noske & K. Deaton (eds.). *Parasession on the Syllable in Phonetics and Phonology*, 355-398. Chicago: Chicago Linguistic Society.

Prince, Alan & Paul Smolensky. 1991. Notes on Connectionism and Harmony Theory in linguistics. Technical report CU-CS-533-91, Department of Computer Science, University of Colorado, Boulder.

Prince, Alan & Paul Smolensky. 1993. Optimality Theory: Constraint interaction in generative grammar. Ms., Rutgers University and University of Colorado, Boulder. Rutgers Center for Cognitive Science (RuCCs) technical report 2. [To appear, Cambridge, MA: MIT Press].

Raffelsiefen, Renate. 1992. A nonconfigurational approach to morphology. In M. Aronoff (ed.). *Morphology Now*, 133-162. Albany: State University of New York Press.

Raffelsiefen, Renate. 1993. Relating Words: A model of base recognition. *Linguistic Analysis* 23: 3-159.

Rainer, Franz. 1995. Inflection inside derivation: Evidence from Spanish and Portugese. In G. Booij & J. van Marle (eds.). *Yearbook of Morphology*, 83-91. Dordrecht: Kluwer.

Rice, Keren. 1988. Continuant voicing in Slave (Northern Athapaskan): The cyclic application of default rules. In M. Hammond & J. Noonan (eds.). *Theoretical Morphology: Approaches in Modern Linguistics*, 371-388. New York: Academic Press.

Robins, R.H. 1957. Vowel nasality in Sundanese. *Studies in Linguistic Analysis; Special Volume of the Philological Society*, 87-103. Reprinted in *Diversions of Bloomsbury, Selected Writings in Linguistics*, Amsterdam: North-Holland, 1970.

Rubach, Jerzy. 1984. *Cyclic and Lexical Phonology: The Structure of Polish*. Dordrecht: Foris.

Rubach, Jerzy. 1985. On the interaction of word formation and phonological rules. In E. Gussmann (ed.). *Phono-Morphology: Studies in the Interaction of Phonology and Morphology*, 131-155. Lublin: Redakcja Wydawnictw.

Sainz, Susana. 1988. A noncyclic analysis of English word stress. *Working Papers of the Cornell Phonetics Laboratory* 3: 1-82.

Samek-Lodovici, Vieri. 1993. Morphological gemination. Talk presented at ROW I, Rutgers University.

Schlindwein, Deborah. 1991. Reduplication in lexical phonology: Javanese plural reduplication. *The Linguistic Review* 8: 97-106.

Selkirk, Elisabeth. 1982. *The Syntax of Words*. Cambridge, MA: MIT Press.

Selkirk, Elisabeth. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.

Selkirk, Elisabeth. 1995. The prosodic structure of function words. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 439-469. Amherst: GLSA.

Shaw, Patricia. 1976 [1980]. *Dakota Phonology and Morphology*. Doctoral dissertation, University of Toronto. [New York: Garland].

Siegel, Dorothy. 1974. *Topics in English Morphology*. Doctoral dissertation, MIT.

Simpson, Jane. 1980. Cyclic syllabification and a first cycle rule of vowel-rounding in some dialects of Australian English. Ms., MIT

Sledd, James H. 1966. Breaking, Umlaut, and the Southern Drawl. *Language* 42: 18-41.

Smolensky, Paul. 1993. Harmony, markedness, and phonological activity. Talk presented at ROW I, Rutgers University.

Smolensky, Paul. 1995. On the internal structure of the constraint component Con of UG. Handout of talk presented at UCLA.

Sproat, Richard. 1985. *On Deriving the Lexicon*. Doctoral dissertation, MIT.

Steriade, Donca. 1987. Redundant values. In A. Bosch, B. Need & E. Schiller (eds.). *CLS 23: Parasession on Autosegmental and Metrical Phonology*, 339-362. Chicago: Chicago Linguistic Society.

Steriade, Donca. 1988a. Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology* 5: 73-155.

Steriade, Donca. 1988b. Greek accent: A case for preserving structure. *Linguistic Inquiry* 19: 271-314.

Steriade, Donca. 1995. Underspecification and markedness. In J. Goldsmith (ed.). *The Handbook of Phonological Theory*, 114-174. Cambridge, MA: Blackwell.

Steriade, Donca. 1996. Paradigm uniformity and the phonetics-phonology boundary. Paper presented at the 5th Conference in Laboratory Phonology, Evanston, IL. Ms., UCLA.

Stevens, Alan M. 1968. *Madurese Phonology and Morphology*, American Oriental Series no. 52. New Haven.

Stevens, Alan M. 1977. On local ordering in Sundanese. *Linguistic Inquiry* 8: 155-162.

Strauss, Steven. 1982a. *Lexicalist phonology of English and German*. Dordrecht: Foris.

Strauss, Steven. 1982b. On the theory of word-formation and its role in phonological analysis. *Linguistic Analysis* 9: 253-276.

Struijke, Caro. (to appear). Reduplication and TETU in Kwakwala. Ms. University of Maryland, College Park.

Szpyra, Jolanta. 1989. *The Phonology-Morphology Interface*. London: Routledge.

Tesar, Bruce & Paul Smolensky. 1993. The learnability of Optimality Theory: An algorithm and some basic complexity results. Talk presented at ROW I, Rutgers University.

Tesar, Bruce & Paul Smolensky. 1996. Learnability in Optimality Theory. Technical report JHU-CogSci-96-3. Department of Cognitive Science, The John Hopkins University.

Urbanczyk, Suzanne. 1995. Double reduplications in parallel. In J. Beckman, L. Walsh-Dickey & S. Urbanczyk (eds.). *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory*, 499-531. Amherst: GLSA.

Urbanczyk, Suzanne. 1996. *Patterns of Reduplication in Lushootseed*. Doctoral dissertation, University of Massachusetts, Amherst.

Verhijde, Mark. In prep. *Cycles, Scars and Other Relics*. Doctoral dissertation, University of Utrecht.

Weeda, Donald. 1992. *Word Truncation in Prosodic Morphology*. Doctoral dissertation, University of Texas, Austin.

Wilbur, Ronnie. 1973. *The Phonology of Reduplication*. Doctoral dissertation, University of Illinois at Urbana-Champaign.

Williams, Edwin. 1981. On the notions "lexically related" and "head of a word". *Linguistic Inquiry* 12:245-274.

Wilson, Colin. 1996. Output-output faithfulness in Tiberian Hebrew phonology. Ms., The Johns Hopkins University.

Zoll, Cheryl. 1995. A unified treatment of latent segments and floating features. Ms., University of California, Berkeley.

Zoll, Cheryl. 1996. *Parsing Below the Segment in a Constraint Based Framework*. Doctoral dissertation, University of California, Berkeley.