Universität Potsdam

Antony D. Green

Phonology Limited

Linguistics in Potsdam | 27

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Series Editors:

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in memoriam Douglass M. Green
July 22, 1926 – September 1, 1999

The more constraints one imposes, the more one frees one's self.

— Igor Stravinsky

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Preface

Phonological theory was revolutionized by the 1993 appearance of Prince and Smolensky's manuscript "Optimality theory: Constraint interaction in generative grammar," finally published eleven years later. The idea that all phonological processes in all languages could be reduced to a language-specific hierarchical ranking of universal constraints proved highly attractive to theoretical linguists around the world, but it remains of course very controversial as well, with many preeminent linguists either unconvinced of its accuracy or convinced of its inaccuracy. In *Phonology Limited* I intend to address some of the concerns that opponents of optimality theory (OT) have brought up, and to argue that many problems encountered in OT are solved by allowing not only universal constraints on phonological well-formedness (markedness constraints) into the theory, but language-specific constraints on morphemes as well. Previous approaches that have assumed only universal markedness constraints have run into problems with phonological opacity, allomorphy, static irregularities, and lexical exceptions, and have often required very powerful mechanisms to deal with those problems. In this book, on the other hand, I argue that any process commonly held to be "morphophonological" is actually part of the morphology and is to be analyzed in terms of language-specific morphological constraints. As a result, phonology is based on the interaction of faithfulness constraints with truly universal markedness constraints; everything language-specific is allocated to the lexicon.

This division of labor is not new: natural phonology (Stampe 1973) contrasts *rules* (which can make reference to morphological information) from processes (which cannot); lexical phonology (Kiparsky 1982a, 1985, Booij and Rubach 1984, Mohanan 1986, Pulleyblank 1986, and many others) similarly contrasts *lexical rules* from *postlexical rules*; and generative phonotactics (Ford and Singh 1983, 1985, 1996; cf. also Ford, Singh, and Martohardjono 1997) similarly contrasts *nonauto-*

matic alternations from *automatic alternations*. This is not to say the difference between those three theories is purely terminological—far from it!—but all three share the basic insight that some phenomena that involve alternations of phonemes and/or allophones must make reference to morphological information, while others are apparently blind to morphological information. The point of this book is to allow OT to make the same contrast: morphological constraints can be language-specific and must make reference to a morpheme, while markedness constraints are universal and must not make reference to morphemes. This last point bears emphasizing: one of the most attractive tenets of OT to most linguists is the universality of constraints, and although I am arguing that morphological constraints can be language-specific, I nevertheless maintain the OT orthodoxy that all phonological markedness constraints are universal.

In this book the discussion of morphological constraints will focus on those that are language-specific, but this should not be interpreted as a rejection of the possibility of universal morphological constraints. The theory of natural morphology (Mayerthaler 1980, 1981; Wurzel 1980, 1984; Dressler 1985, 1986, 2000; Dressler et al. 1987) holds that there are also morphological universals; while it would certainly be interesting to explore the possibility of framing these in terms of optimality-theoretic constraints, it would go beyond the scope of this book to do so.

Many people have helped me while I was writing this book by providing helpful comments and criticisms, by asking insightful questions, sometimes just by giving moral support. Among those I would particularly like to thank are Luigi Burzio, Caroline Féry, and Tracy Hall for their detailed reviews of the manuscript, as well as Matthew Anstey, Philippe Besnard, Patrik Bye, Laura Downing, Heiner Drenhaus, Dafna Graf, Silke Hamann, Eric Holt, René Kager, Robert Kirchner, John McCarthy, James Myers, Ciarán Ó Duibhín, Renate Raffelsiefen, Doug Saddy, Raj Singh, Tom Stewart, Siri Tuttle, Adam Ussishkin, Ruben van de Vijver, Ralf Vogel, Heide Wegener, and participants at several conferences: the 2001 Conference on the Lexicon in Linguistic Theory in Düsseldorf, the 2002 Conference on English phonology in Toulouse, the Fourth Celtic Linguistics Conference in Cambridge in 2003, the Eleventh International Morphology Meeting in Vienna in 2004, the 2004 Workshop on Word Domains in Leipzig, and the Second Old World Conference on Phonology in Tromsø in 2005. Much of the work in this book was presented at those conferences and has been improved by the questions and comments of the other participants. Finally, my heartfelt thanks go to Simon for loving me, for encouraging me, and for being the *Mann meines Lebens*.

Chapter 1
Introduction

1.1 Optimality theory

Optimality theory (Prince and Smolensky 2004; cf. also McCarthy and Prince 1993b, Kager 1999, McCarthy 2002, and the articles collected in Beckman, Walsh Dickey, and Urbanczyk 1995, Archangeli and Langendoen 1997, Dekkers, van der Leeuw, and van de Weijer 2000, and McCarthy 2004) is a constraint-based approach to the relationship between native speakers' implicit knowledge of the grammar of their language and the actual utterances used by those speakers. Optimality theory, or OT, rapidly gained popularity in the field of phonology throughout the 1990s, and its influence in syntax (see, for example, Barbosa et al. 1998 and Legendre, Grimshaw, and Vikner 2001) has been steadily increasing as well. This book, however, will be restricted to OT phonology and the interaction of phonology with the lexicon. In this introductory chapter we will get an overview of OT and see what ramifications it has on phonological and morphological theory. In particular, we will see how the OT principles of richness of the base and lexicon optimization force a rethinking of traditional views of lexical organization, away from the traditional concept of abstract underlying representation and towards a model in which the input itself is a concrete pronounceable form. Over the course of the book it will be shown that an effective approach to phonological analysis requires interplay between universal constraints on phonological markedness and language-specific constraints on morphological form. Under this approach, the role of phonology is limited to the interaction of markedness and faithfulness. Phonemic or allophonic alternations that cannot be described in terms of markedness and faithfulness, on the other hand, are caused by constraints on morphological structure.

OT rests firmly on the principle of universal grammar (UG), a cornerstone of generative linguistic theory at least since Chomsky (1965), ultimately traceable to the view of the 13th-century Modists that all languages had the same grammatical categories, known as "modes" (Seuren 1998, 29–33). UG is the set of principles defining the limitations to and possibilities of human language, and is assumed by linguists in the Chomskyan tradition to be innate in all humans. According to OT, UG consists of a set CON of universal, violable constraints, a function GEN generating the set of possible output forms for any input form, and a function EVAL that determines the most harmonic, or optimal, output candidate for any input. The grammar of a language consists of a ranked hierarchy of the constraints in CON: constraints may be violated in the optimal surface form if violation of one constraint spares a violation of a higher ranking constraint in the hierarchy. Before OT, constraints in generative phonology were held to be inviolable, such as the well-formedness condition (Goldsmith 1976, Pulleyblank 1986), the clash filter (Prince 1983, Nespor and Vogel 1989), and the obligatory contour principle (Leben 1973, Odden 1986), as they are in other constraint-based theories like declarative phonology (Bird 1990, Coleman 1991, Scobbie 1991, 1993). Like constraints in other theories, OT constraints have generally been held to be universal, i.e. present in the grammar of every human language, but uniquely in OT, they have a hierarchical ranking that is different in every language.[1]

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1 Some groups of constraints, for example those relating to sonority (cf. Prince and Smolensky 2004, chapter 8), are however held to form a fixed subhierarchy, i.e. to be universally ranked with respect to each other. In this case, language-specific effects are derived not from different rankings within the fixed subhierarchy but rather from the ranking of constraints (e.g. faithfulness constraints) that do not belong to the fixed subhierarchy. See McCarthy (2002, 20–22, 117–19) for more discussion of fixed subhierarchies.

The result is that many (low-ranking) constraints are violated by surface forms. But one of the goals of this book is to restrict the claim of universality to phonological constraints; I contend that every language has its own specific morphological constraints in addition to the universal phonological ones.

Some criteria must be applied to proposed phonological constraints to determine whether they can plausibly be considered universal. Kager (1999, 11–12) has outlined two such criteria, which seem to have wide acceptance among linguists: typology and phonetic grounding. Ideally every universal constraint should meet both criteria. According to the typological criterion, a constraint may be considered universal if it is found to be active in a number of unrelated languages. According to the criterion of phonetic grounding, a constraint may be considered universal if there can be shown to be physical reasons relating to the mechanism of articulation or auditory perception why it should hold. Neither of these criteria is particularly clear-cut, unfortunately; it is easy to imagine cases of a proposed constraint found in only a handful of languages, or perhaps in genetically unrelated languages that are in close geographic proximity to each other, making it unclear whether the typological criterion has been met. Similarly, a constraint may be proposed for which the phonetic motivation is unclear but not patently absent, so that there may be uncertainty as to whether the phonetic grounding criterion has been met. Additionally, a constraint may meet one criterion but not the other, which can also raise questions as to that constraint's universality. As difficult as universality may be to determine in some cases, it does appear that most phonological constraints that have met with broad consensus in the OT community can be reasonably said to have met both criteria. Having determined what constitutes a plausible constraint, we can now turn our attention to how constraints interact with the lexicon.

The lexicon of a language is held to consist of a list of inputs which the speaker compiled as a learner; each input corresponds to a set of candidate outputs generated by GEN. These candidates compete with each other to determine the optimal output, which is the actual surface form pronounced by the speaker. EVAL judges competing candidates to determine which candidate best meets the constraint hierarchy. This evaluation is represented graphically by means of a tableau like that in (1) for the English word *hymn*.

(1) SONSEQ ≫ DEP-IO ≫ MAX-IO, from *hymn*

/hɪmn/	SONSEQ	DEP-IO	MAX-IO
[.hɪmn.]	* !		
[.hɪ.mən.]		* !	
☞ [.hɪm.]			*

In this tableau, /hɪmn/ is the input. SONORITY SEQUENCING (SONSEQ), DEP-IO, and MAX-IO are constraints; they are ranked from left to right, showing that SONSEQ outranks DEP-IO, and DEP-IO outranks MAX-IO (in shorthand, SONSEQ ≫ DEP-IO ≫ MAX-IO). The candidates are [.hɪmn.], [.hɪ.mən.], and [.hɪm.]; their violations of each constraint are marked *. SONSEQ requires, among other things, that a coda cluster have falling sonority; it is violated by the [mn] cluster of [.hɪmn.]. DEP-IO requires that the output contain no material not present in the input; it is violated by [.hɪ.mən.] because [ə] is present in the output but not the input. MAX-IO requires that all material present in the input be present in the output; it is violated by [.hɪm.] because the [n] of the input is not present in the output. Because SONSEQ is the highest ranking constraint, its violation by [.hɪmn.] is fatal (marked with the exclamation point), since the other two candidates do not violate it. The candidate [.hɪ.mən.] violates DEP-IO but [.hɪm.] does not; this eliminates [.hɪ.mən.] from consideration, and [.hɪm.] is selected as the optimal candidate, i.e. the one that is the actual surface form. The symbol ☞ points to the optimal candidate. The fact that [.hɪm.] violates MAX-IO is irrelevant, because MAX-IO is lower ranking in English than the constraints violated by the other two candidates. Shaded cells are those where violation or fulfillment of a constraint is irrelevant to the evaluation process. The input /hɪmn/ and the output [.hɪm.] are said to stand in a correspondence relationship, which is represented as /hɪmn/ ℜ [.hɪm.]. In this correspondence relationship, the elements (distinctive features, segments, prosodic categories, etc.) of the input and the elements of the output are mapped to each other, with mismatches resulting in faithfulness violations. In the case of /hɪmn/ ℜ [.hɪm.], it is the fact that nothing in the output corresponds to the /n/ of the input that engenders a DEP-IO violation.

OT conventionally uses three major kinds of constraints: faithfulness constraints, markedness constraints, and alignment constraints. Faithfulness constraints govern the relationship between the input and the output by requiring identity between the two. DEP-IO and MAX-IO are examples of faithfulness constraints. Markedness constraints make general statements about well-formedness in the output; any structure that violates a markedness constraint is considered to marked with respect to that constraint. As McCarthy (2002, 15) makes clear, the term markedness is used differently in OT from its usage elsewhere in linguistics, dating back to the Prague school of the 1930s. Praguian markedness statements are of the form "If a language has property A, then it is has property B," meaning that A is marked with respect to B (B can be present without A, but A cannot be present without B). In OT, on the other hand, markedness constraints may contradict each other, so that only their ranking with respect to each other and to faithfulness constraints determines which marked structures will be allowed in a language: a marked structure is allowed if either a relevant faithfulness constraint or a contradictory markedness constraint outranks the markedness constraint prohibiting the structure.

The third type of constraint encountered in OT is alignment constraints, which require certain prosodic or morphological entities to share an edge with certain other prosodic or morphological entities. Alignment constraints generally have the form "Align(κ, E; λ, E′)" where κ and λ are prosodic or morphological categories and E and E′ are edges (left or right). κ is quantified universally while λ is quantified existentially: a prose statement of the constraint is "for every κ there is some λ such that the E edge of κ is aligned with the E′ edge of λ." E and E′ need not be the same (for example, the left edge of a suffix may be aligned with the right edge of a root), but in practice they very often are the same. In that case, the shorthand notations Align-L(κ, λ) ("the left edge of every κ is aligned with the left edge of some λ) and Align-R(κ, λ) ("the right edge of every κ is aligned with the right edge of some λ) are often used. A well known example of a minimally violable alignment constraint comes from Tagalog (McCarthy and Prince 1993b). In this language, the affix *um* (which indicates that the focus of the sentence is on the agent) is inserted before the first vowel of a root, as shown in (2).

(2) *um*-affixation in Tagalog

a.	aral	**um**aral	'teach'
b.	sulat	s**um**ulat	'write'
c.	gradwet	gr**um**adwet	'graduate'

McCarthy and Prince's analysis is that two constraints are in conflict: NoCoda, a markedness constraint requiring syllables to be open, and Align-L(*um*, Stem) (in shorthand, Align-um), an alignment constraint requiring the left edge of affix *um* to coincide with the left edge of a stem. Align-um is not violated by [**um**aral], but it is violated by [s**um**ulat] and [gr**um**adwet]. These violations are tolerated, however, because nonviolation (*[**um**sulat], *[**um**gradwet]) would result in excessive violations of NoCoda. This is shown in the tableaux in (3). In these tableaux, the two morphemes of each input are not ordered with respect to each other, i.e. the input does not specify that *um* is a prefix; this is indicated by separating the two morphemes with a comma. Violations of Align-um are indicated by showing the individual segments that separate *um* from the left edge the stem.

(3) NoCoda ≫ Align-um

a. *um* with V-initial stem

/um, aral/	NoCoda	Align-um
☞ .**u.m**a.ral.	*	
a.**um**.ral.	**!	a
a.r**u.m**al.	*	a!r

b. *um* with C-initial stem

/um, sulat/	NoCoda	Align-um
.**um**.su.lat.	**!	
☞ .s**u.m**u.lat.	*	s
.su.l**u.m**at.	*	su!l

c. *um* with CC-initial stem

/um, gradwet/	NoCoda	Align-um
.**um**.grad.wet.	***!	
.g**um**.rad.wet.	***!	g
☞ .gr**u.m**ad.wet.	**	gr
.grad.w**u.m**et.	**	gra!dw

Note that although NoCoda is high ranking, it can be violated by optimal forms. Nevertheless, the placement of *um* is such that it ensures a minimal violation of NoCoda.

Alignment constraints can be used also in metrical phonology to determine stress placement. For example, in a language with penultimate stress, an alignment constraint ensures that a syllabic trochee (σ́ σ) is right-aligned with the prosodic word.

The constraints used in OT, and the way they are ranked in each language, make up the core of the theory. Every introduction to OT (McCarthy and Prince 1993b, Archangeli and Langendoen 1997, Kager 1999, McCarthy 2002, Prince and Smolensky 2004, etc.) asserts that one of the tenets of the theory is that constraints are universal: they are supplied by UG and are therefore present in every language, although in any given language many constraints will be ranked too low to be active in that language.[2] But we have just seen an apparent exception: ALIGN-um makes reference to a specific morpheme *um* in one language, Tagalog; this constraint hardly seems likely to be present universally in all languages. Thus in the next section we will see that there is another class of constraints, one that must be language-specific: the morphological constraint. A clear distinction must be made between universal phonological markedness constraints and language-specific morphological constraints.

1.2 Phonological and morphological constraints

Despite the prominence of the claim of constraint universality, one does not have to look far to find the proposal of a constraint that looks anything but universal: consider FREE-V (Prince and Smolensky 2004, 123), stated in (4), proposed in a discussion of the Australian language Lardil.

(4) FREE-V
Word final vowels must not be parsed (in the nominative).

The proviso "in the nominative" makes this constraint language-specific, since not all languages even have a nominative for this constraint to apply to. Nevertheless, as Prince and Smolensky (2004, 123) point out, this constraint does have a universal component, being phonologically grounded in

> the prosodic weakness of final open syllables, which are liable to de-stressing, de-voicing, shortening, truncation, and so on, under purely phonological conditions. (Estonian morphology has virtually the same constraint, including limitation to the nominative, the null-affixed case.) It may also have connection with

2 Ellison (2000) argues that it is preferable to regard the universality of constraints as a convenient but arbitrary convention rather than a literal truth. Boersma (2000) presents a model of learning an OT grammar that does not require the assumption of innate constraints.

> the commonly encountered constraint to the effect that stems or words must end in a consonant.

Similarly, ALIGN-um, while being specific to Tagalog, makes reference to the universal tendency for affixes to occur at morphological edges (i.e. infixes are cross-linguistically disfavored). Thus it is perhaps not uncommon for a language-specific constraint to arise by making a universal constraint more specific, applying it to certain morphological circumstances unique to the language in question.

As we will see in the course of this book, apparently language-specific constraints like FREE-V always make reference to morphological information (in this instance, the nominative case): I will argue that all *language-specific* constraints are morphological constraints, and all *phonological* constraints are universal. This hypothesis is found outside of OT as well, e.g. in the Phonological Alternation Principle of Ford, Singh, and Martohardjono (1997): "for an alternation to be truly phonological it must be motivated by a well-formedness condition" (cf. also Singh 1987, 1996a). Thus FREE-V is not a constraint on Lardil phonology, but a constraint on Lardil morphology, a property of the Lardil lexicon.[3]

Other cases of constraints that appear to be language-specific turn out to be universal when interpreted correctly. Often linguists will simplify the interaction of several general constraints into a single constraint, which may then look quite language-specific. Some of these have then been pounced on by detractors of OT to argue that the universality of constraints

3 It is important here to point out that Lardil does not generally prohibit vowels from surfacing in word-final position. Rather, vowels that are *final in the input* (a reference to morphology since the input is the morphological word) may not appear in the output. Thus the input /majaɾa/ 'rainbow' corresponds to the output [majaɾ]. However, if the input ends in a consonant, and that consonant is blocked from appearing on the surface (because of Lardil's strict coda condition limiting coda consonants to nonvelarized coronals), then the surface form will end in a vowel: /wuŋkunuŋ/ ℜ [wuŋkunu], not *[wuŋkun] (Prince and Smolensky 2004, 122–23, based on data from Klokeid 1976).

is untenable. McMahon (2000, 23), for example, calls the constraints ROUNDING and UNROUNDING, proposed by McCarthy (2003, 27) in a discussion of Nootka, "rather Nootka-specific." The constraints are stated in (5) and (6); K stands for any dorsal consonant.

(5) ROUNDING
*oK

(6) UNROUNDING
$*K^w]_\sigma$

McCarthy (2003, 27) says about these constraints, "The constraints themselves are universal; their interaction through ranking is language particular and learned. Here I will focus on just the interaction, glossing over details of constraint formulation that are not relevant in this context." It is the details of constraint formulation that McCarthy glosses over that reveal the universal nature of these constraints. The ROUNDING constraint reflects the universal property that adjacent segments tend to share features, in this case [round]. A complete analysis of Nootka would have to include constraint interactions showing why only dorsals become rounded after rounded vowels: rounded labials and coronals are less frequent cross-linguistically than rounded dorsals and thus may be considered more marked. In Nootka perhaps constraints prohibiting rounded labials and coronals outrank ROUNDING while the constraint prohibiting rounded dorsals is lower ranked. The UNROUNDING constraint also reflects a universal tendency, namely that marked segments (such as those with secondary articulation) tend to be disfavored in coda position. Thus ROUNDING and UNROUNDING are indeed both reflections of universal constraints and are not Nootka-specific at all.

Nevertheless many (maybe even most) languages do have some idiosyncratic alternations that appear to call for language-specific constraints. We will see many examples in forthcoming chapters, where it will be shown that the alternations always depend to some extent on the morphology. It is often the case that a language-specific morphological property contains the residue of a historical sound change, which was itself a regular phonological process reflecting universal phonological well-formedness. As a result, many of the processes to be discussed in this book (e.g. initial consonant mutation in Celtic languages) look tantalizingly phonological, because historically they were phonological. Nevertheless, over time these processes have been morphologized and can no longer be considered phonological properties of the languages in which they occur.

1.3 Conclusions

OT has proved to be a highly insightful and successful theory of linguistics in general and phonology in particular, focusing as it does on surface forms and treating the relationship between inputs and outputs as a form of conflict resolution. Yet there have also been a number of serious problems with the approach that have led some detractors to argue that OT has failed as a theory of generative grammar. The most serious of these problems is opacity, discussed in detail in chapter 2. I will argue that these problems disappear once we allow language-specific morphological constraints to play a significant role in analysis. The next two chapters of the book provide evidence for the role of language-specific morphological constraints in allomorphy (chapter 3) and in static irregularities and lexical exceptions (chapter 4). The book ends with a chapter of conclusions and directions for future research.

Chapter 2
Opacity

2.1 Introduction to opacity

In the previous chapter we saw how optimality theory works and were introduced to the idea that in addition to universal markedness constraints, the grammars of languages include language-specific morphological constraints. In this chapter we turn to opacity, a problem widely recognized as constituting a serious threat to the viability of OT, and see how using language-specific morphological constraints may enable a solution of the problem.

Phonological opacity is the phenomenon of a process applying even though its environment is not present on the surface (overapplication), or of a process failing to apply even though its environment is present on the surface (underapplication).[1] In rule-based frameworks, opacity is frequently accounted for by allowing rules to apply in counterbleeding order (for overapplication) or counterfeeding order (for underapplication) (Kiparsky 1968, Iverson 1995), although not all instances of counterbleeding and counterfeeding result in opacity.[2]

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1 Portions of this chapter were presented at the second Old World Conference on Phonology (OCP2) in Tromsø in January 2005. Many thanks to the participants at that conference, in particular Patrik Bye, John McCarthy, and Adam Ussishkin, for helpful comments and discussion. An early version of this chapter appeared as Green (2004b).

2 Two rules are said to apply in counterbleeding order if the second rule destroys the environment of the first rule (after the first has already applied), and in counterfeeding order if the second rule creates the environment of the first rule (after the first has already failed to apply).

Spencer (1996, 169) gives an example of counterbleeding with resultant opacity from Bulgarian. In this language, the rules of velar palatalization (1) and yer deletion (2) apply in counterbleeding order (i.e. the second destroys the environment of the first after the first has already applied), resulting in apparent overapplication of velar palatalization: the velar /k/ has palatalized to [tʃ] without the motivation for the change (a front vowel) present on the surface, as shown in the derivation of [mratʃna] 'dark (fem.)' (cf. [mrak] 'darkness') in (3).

(1) Velar palatalization
/k/ → [tʃ] / _ [−cons, −back]
/k/ goes to [tʃ] before a front vowel.

(2) Yer deletion
/ĭ/ → ∅ / _ C_0 V_{full}
The front vowel /ĭ/ (a so-called "yer vowel") is deleted before a syllable containing a full vowel.

(3) Derivation of [mratʃna] 'dark (fem.)

Underlying representation	/mrakĭna/
Velar palatalization	tʃ
Yer deletion	∅
Surface representation	[mratʃna]

An example of opacity due to counterfeeding is taken from German (Hall 2000, 142). Here, the rules of dorsal assimilation (4) and r-vocalization (5) apply in counterfeeding order, with apparent underapplication of dorsal assimilation: the front dorsal [ç] appears on the surface after the back vocoid [ɐ̯], as shown in the derivation of *durch* [dʊɐ̯ç] 'through' in (6).

(4) Dorsal assimilation
/ç/ → [+back] / [−cons, +back] _
/ç/ goes to [x] after a back vocoid.

(5) R-vocalization
/r/ → [ɐ̯] / [−cons] _ $C_0]_\sigma$
Coda /r/ is vocalized to [ɐ̯].

(6) Derivation of *durch* [dʊɐ̯ç] 'through'

UR	/dʊrç/
Dorsal assimilation	—
R-vocalization	ɐ̯
SR	[dʊɐ̯ç]

The normal application of dorsal assimilation is seen in forms like *Buch* /bu:ç/ → [bu:x] 'book' and *Bach* /baç/ → [bax] 'creek'.

Although derivational phonology thus allowed opaque interactions to be expressed, it was acknowledged that they are less natural than transparent interactions, and it was often argued that rule orderings tend to switch from opaque to transparent over time (Kenstowicz and Kisseberth 1971, 1977, Kiparsky 1971, 1973).

But in a surface-based theory like OT, it is very difficult to explain why faithfulness should be violated excessively when it does not result in improved markedness, which is usually the problem in cases of opacity. Both supporters and opponents of optimality theory point to opacity as a serious flaw in the theory. René Kager, a prominent OT phonologist, says in his textbook on OT (1999, 377):

> Opacity appears to be a direct empirical refutation of the *surface-based* evaluation of well-formedness constraints in OT. Since opacity is OT's Achilles heel, researchers have attempted to find solutions for it which maximally preserve the theory's advantages.

But in his subsequent discussion he finds that each attempted solution has certain advantages and disadvantages and none of them seems to truly solve the opacity problem.

Perhaps the best known proposal for solving the opacity problem in OT is sympathy theory (McCarthy 1999, 2003), which extends the domain of faithfulness constraints beyond input/output and output/output relations to include relations between competing candidates. As we shall see below, sympathy theory enables opaque candidates to be selected as optimal by proposing constraints enforcing some degree of faithfulness between one candidate and another, so-called "sympathetic," candidate, which would have been optimal if a specific constraint had been ranked high rather than low.

Another approach to opacity is provided by stratal OT (McCarthy and Prince 1993b (appendix); Kenstowicz 1995; Booij 1996, 1997; Noyer 1997; Paradis 1997; Rubach 1997; Koontz-Garboden 2001; Kiparsky 2003; Bermúdez-Otero in prep.), which allows evaluation to proceed in more than one stage, with the possibility of constraint reranking between stages; the input for each stage after the first is the output of the previous stage, rather than the "underlying" input. This approach also enables the selection of opaque candidates, because faithfulness constraints consider only the relationship of the surface form to an intermediate input rather than the underlying input. I will argue against both sympathy theory and stratal OT below, and show that both approaches are not only too powerful but also unnecessary for an analysis of apparent opacity.

Itô and Mester (2003) argue that opacity has many sources and that at least some opaque relationships can be analyzed by treating word and phrase phonology as separate modules. They also argue, contrary to the assertions made here, that opacity is not restricted to processes involving the phonology-morphology interface, but includes fully productive and otherwise surface-true interactions. One example they look at is the interaction of spirantization and devoicing in Colloquial Northern German (CNG), where syllable-final input /g/ surfaces as [x] or [ç][3], while syllable-final input /k/ surfaces faithfully as [k].

3 Depending on the nature of the preceding sound: [ç] appears after consonants and front vowels, [x] after back vowels.

(7) Word-final velars in CNG

a.	/kø:nɪg/	[kø:nɪç]	'king'	(cf. [kø:nɪgə] 'kings')
b.	/re:gnən/	[re:çnən]	'to rain'	(cf. [re:gən] 'rain')
c.	/tru:g/	[tru:x]	'carried' (sg.)	(cf. [tru:gən] 'carried' (pl.))
d.	/tsvɛrg/	[tsvɛrç]	'dwarf'	(cf. [tsvɛrgə] 'dwarfs')
e.	/dɪk/	[dɪk]	'fat' (pred.)	(cf. [dɪkə] 'fat' (attr.))

They attribute the spirantization of /g/ in syllable-final position to a complex constraint conjunction called *CD&IDENT(voi), which assigns a violation mark to any dorsal stop in coda position that is unfaithful to its input correspondent for the feature [voice]. Thus, given the input /ho:nɪg/ 'honey', the output candidate [ho:nɪç] is more harmonic than *[ho:nɪk], because the final [k] of *[ho:nɪk] is *both* a dorsal stop in coda position *and* an IDENT(voi) violation, since its input correspondent /g/ is voiced. The other candidates *[ho:nɪg] and *[ho:nɪɣ] are ruled out by a high-ranking constraint against voiced obstruents in coda position.

(8) Constraints used in Itô and Mester's (2003) analysis of CNG

a. *VC	No voiced obstruents in coda position
b. *CD	No dorsal stops in coda position[4]
c. IDENT(voi)	An input segment and its output correspondent agree in [voice].
d. *CD&IDENT(voi)	*CD and IDENT(voi) are not both violated by the same segment.
e. IDENT(cont)	An input segment and its output correspondent agree in [continuant].

4 For Itô and Mester, *VC and *CD are themselves actually constraint conjunctions: *VC is a conjunction of a constraint against syllable codas with a constraint against voiced obstruents and *CD a conjunction of a constraint against syllable codas with a constraint against dorsal stops.

(9) Itô and Mester's (2003) analysis of [ho:nıç] 'honey' (simplified)

/ho:nıg/	*VC	*CD& IDENT(voi)	IDENT(cont)	*CD	*IDENT(voi)
[ho:nıg]	* !			*	
[ho:nıɣ]	* !		*		
[ho:nık]		* !		*	*
☞ [ho:nıç]			*		*

Where the input ends in /k/, however, as in /plastık/ 'plastic', *CD&IDENT(voi) is not violated by the faithful candidate [plastık], which is then optimal.

(10) Itô and Mester's (2003) analysis of [plastık] 'plastic' (simplified)

/plastık/	*VC	*CD& IDENT(voi)	IDENT(cont)	*CD	*IDENT(voi)
[plastıg]	* !	*		*	*
[plastıɣ]	* !		*		*
☞ [plastık]				*	
[plastıç]			* !		

The most immediate objection that can be raised against this analysis is that like so many other approaches to phonological opacity, it increases the predictive power of phonological theory to the point of unfalsifiability. If German phonology can only be explained by means of a thoroughly arbitrary constraint like "velar stops may appear in coda position only if their input and their output share the same value for the feature [voice]," it is difficult to imagine a hypothetical phonological process that could not be explained with a similar constraint.

Sanders (2003, 196) has also suggested that while final devoicing is a productive phonological process in German, g-spirantization is not, as the former but not the latter applies to foreign loanwords in German like *Monolog* [monolo:k] (*[monolo:x]) ‘monologue’ and *Airbag* [ɛ:rbɛk] (*[ɛ:rbɛç]) ‘airbag’.

Idsardi (1997, 1998, 2000), an opponent of OT, argues that traditional OT cannot handle the opacity found in the alternations between stops and fricatives in Tiberian and Modern Hebrew at all, and that even sympathy theory, which may be able to handle opacity, predicts that historical language change should decrease opacity (a hypothesis made also by derivational phonologists, as mentioned above), contrary to the facts, since Modern Hebrew has more opaque interactions than Tiberian Hebrew had. He considers opacity to be “*the* single most important issue in current phonological theory” (Idsardi 2000, 337). Other opponents of OT (e.g. Chomsky 1995, McMahon 2000, and Frampton 2002) concur, arguing that opacity proves that OT is false and that phonology *must* be derivational.

In this chapter I will argue that the apparent opaque relationships of Tiberian Hebrew (henceforth TH) can be analyzed in a fully parallel, monostratal version of OT without recourse to mechanisms like sympathy theory and stratal OT. In particular, I contend that there is no phonologically productive opacity in TH; rather, opaque interactions are always limited to certain morphological classes or environments.[5] In TH at least, and perhaps more generally, problems of opacity are never purely phonological in character but are always dependent on morphological/lexical information in some way. If this assertion turns out to be true cross-linguistically, then opacity is a red herring in OT phonology, because truly phonological

5 The case of German *durch* ‘through’ mentioned above might be thought to be a counterexample, as it really is purely phonological. However, Robinson (2001), drawing on phonetic evidence of Ulbrich (1972), points out that the quality of the nonsyllabic vocoid corresponding to underlying /r/ is actually rather more front before [ç] than the transcription [ɐ̯] would indicate. In this case, the output corresponding to /dʊrç/ is [dʊɛ̯ç] or [dʊɪ̯ç], both transparent candidates, and therefore there is no opacity here after all. Hall (2002), on the other hand, suggests the effect may be “purely phonetic [and] should not be captured in phonological representations or rules.”

processes are always transparent. Opacity becomes a question of the interaction of morphology and phonology, rather than a question of the interaction between markedness and faithfulness, which previous accounts have made it out to be.

The chapter is organized as follows: in §2.2 we are introduced to the phonology of TH, and in the following sections we examine in turn two cases of opacity found in TH: the interaction between epenthesis and ʔ-deletion in §2.3, and that between spirantization and syncope in §2.4. In §2.5 we see how opacity has been handled up to now in OT, namely by discarding parallelism either covertly (as in sympathy theory) or overtly (as in stratal OT). In §2.6 we reexamine the TH data and find that an analysis taking morphological constraints into consideration allows for a fully parallel interpretation of OT: no additional machinery is necessary to account for opacity. §2.7 sums up with conclusions.

2.2 The basics of Tiberian Hebrew phonology

Tiberian Hebrew (Brown, Driver, and Briggs 1906, Gesenius 1910, Prince 1975, Rappaport 1984, Hetzron 1987, Malone 1993, Khan 1997, Steiner 1997, Churchyard 1999, Coetzee 1999) is the language in which almost the entire Old Testament is written.[6] The term "Tiberian" refers not to the region in which the language was spoken, but to the region where the scholars (called Masoretes) lived who devised the pointing system that eventually became standard. It is important to be aware that all information about vowels, stress, and spirantization is indicated by this Tiberian pointing system and that Hebrew had died out as a language of everyday communication several centuries before the pointing system was invented. Thus virtually everything that modern linguists assume about the structure of TH depends on information provided by people who were native speakers of Aramaic, not Hebrew.

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6 A few passages, namely Ezra 4:8–6:18, 7:12–26, Jeremiah 10:11, and Daniel 2:4–7:28, are written in Aramaic.

2.2.1 Consonants

The surface consonant phone inventory of TH is as shown in (11). The sounds enclosed by boxes are allophones of a single phoneme.

(11) Surface consonant phones of TH

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Laryngeal
Voiceless stops	p	t			k			
Voiceless fricatives	f	θ	s, ś	ʃ	x			
"Emphatic" obstruents		ṭ	ṣ			q		
Voiced stops	b	d			g			
Voiced fricatives	v	ð	z		ɣ			
Nasals	m	n						
Liquids			l, r					
Voiceless glides							ħ	h, ʔ
Voiced glides	w			j			ʕ	

The so-called "emphatic" coronals [ṭ ṣ] were probably originally ejective and later uvularized or pharyngealized (Churchyard 1999, 126); the uvular stop [q] also belongs to the class of "emphatic" obstruents. The sound symbolized [ś] descends from Proto-Semitic [ɬ] but had already merged with [s] five hundred years before the Masoretic period (Churchyard 1999, 126). If [ś] was ever a nonlateral sibilant fricative distinct from [s], it is unknown what the distinction was: McCarthy (1979/85, 13) suggests [ś] may have been palatalized; Malone (1993, 28) assumes [ś] is [−distributed] (i.e. apical) while [s] is [+distributed] (i.e. laminal). Note that the pharyngeals [ħ ʕ] and laryngeals [h ʔ] are considered glides.

2.2.2 Vowels

The nature of the vowel system in TH is somewhat controversial. Some phonologists working on TH, including Prince (1975), McCarthy (1979, 1999), Rappaport (1984), Idsardi (1997, 1998, 2000), Benua (1998), Churchyard (1999), and Coetzee (1999), have assumed five different vowel qualities that can contrast phonemically for length, thus: /i e a o u, iː eː aː oː uː/. Others, including Hetzron (1987), Khan (1990, 1997), Malone (1993), Rendsburg (1997), Steiner (1997), and Bye (2003) assume TH had seven different full vowel qualities /i e ɛ a ɔ o u/ and that vowel length was not phonemic. The latter group of authors do not agree in all points as to what the distribution of vowel length was, however. All authors from both traditions agree that the four reduced vowels [ə ɛ̆ ɔ̆ ă][7] were not phonemic, but rather surface allophones of (short) vowels in certain unstressed syllables. In this chapter I will be following the seven-quality tradition and will not mark any vowels as long, since the question of when the full vowels surfaced as long is tangential to the issues discussed here.

(12) Vowels of TH (seven-quality tradition; allophonic length of full vowels not indicated)

Full		Reduced		
i	u			
e	o			
ɛ	ɔ	ɛ̆	ə	ɔ̆
a			ă	

There are two interesting phenomena conventionally described as opaque interactions that we will discuss in turn in the following sections: an epenthesis process that interacts opaquely with ʔ-deletion and a spirantization process that interacts opaquely with syncope.

2.2.3 Spirantization

As indicated in (11), the stops [p t k b d g] are in an allophonic relationship with the fricatives [f θ x v ð ɣ]. The stop allophones may conveniently be considered to be the ones present in the

7 Authors in the five-quality tradition transcribe [ɛ̆ ɔ̆] as [ĕ ŏ].

input, with the fricative derived a process of spirantization.[8] The facts of the distribution within the prosodic word[9] (abstracting away from the opaque interactions to be discussed below in §2.4) are quite simple: the fricatives occur as singletons after vowels, the stops occur elsewhere (word-initially, after consonants, and as geminates).

(13) Distribution of stops and fricatives in TH

	Form	Gloss	Citation
a.	**p**ɔʕal	'he did'	Deut. 32:27
	ji-**f**ʕal	'he will do'	Job 22:17
b.	ħɛr**p**ɔ	'a reproach'	Gen. 34:14
	ħărɔ**f**oθ	'reproaches'	Daniel 12:2
c.	ti-s**p**or	'you (m. sg.) count'	Job 39:2
	sɔ**f**ar	'he counted'	2 Sam. 24:10
	si**pp**ar-ti	'I recounted'	Ps. 119:26
d.	**t**ɔvor	'Tabor' (name of a mountain)	1 Sam. 10:3
	bə-**θ**ɔvor	'against Tabor'	Josh. 19:22
e.	ba**θ**	'daughter'	Exod. 1:16
	bi**tt**-i	'my daughter'	Deut. 22:16
f.	mal**k**-i	'my king'	2 Sam. 19:44
	mɛlɛ**x**	'king'	Gen. 14:7
g.	ni-m**k**ar	'he was sold'	Lev. 25:48
	mɔ**x**ar	'he sold'	Lev. 27:20
	hiθ-ma**kk**er	'he sold himself'	1 Kings 21:25
h.	wə-ʔɛ-q**b**ər-ɔ	'and I bury'	Gen. 23:4
	qɔ**v**ar	'he buried'	Gen. 23:19
	lə-qa**bb**er	'to bury'	1 Kings 11:15

8 Strictly, by richness of the base the constraint hierarchy should be organized in such a way that the correct distribution of allophones is predicted regardless of which allophone is assumed in the input.

9 Spirantization across prosodic word boundaries also occurs in TH, but a discussion of it in that environment would be beyond the scope of this chapter.

i.	**d**ibbɛr	'he spoke'	Gen. 12:4
	jə-**ð**abber	'he speaks'	Gen. 44:7
j.	ner**d**	'spikenard'	Song of Sol. 4:14
k.	g**ɔð**ol	'great'	Gen. 4:13
	wə-hiθ-**g**a**dd**il-ti	'and I will show my greatness'	Ezek. 38:23
	hi-**ɣd**il	'he made great'	Ps. 41:10

In an OT analysis, spirantization can be attributed to the constraint interaction *V⁀STOP ≫ IDENT-IO(cont). The constraint *V⁀STOP prohibits postvocalic stops, and IDENT-IO(cont) prohibits a mismatch in the feature [continuant] between the input and the output.[10] The constraint interaction responsible for the distribution of stops and fricatives is illustrated in (14) by [gɔðol] 'great'. (The relationship between input /a/ and output [ɔ] in the first syllable is not analyzed here.)

(14) *V⁀STOP ≫ IDENT-IO(cont), from [gɔðól]

/gadol/	*V⁀STOP	IDENT-IO(cont)
gɔdol	* !	
☞ gɔðol		*
ɣɔðol		**!

As the failure of geminates to undergo spirantization is not relevant to the discussion of opacity, I will not develop an analysis of it here. The interested reader is directed to Guerssel (1977), Kenstowicz (1982), Hayes (1986), Schein and Steriade (1986), Inkelas and Cho (1993), Elmedlaoui (1993), Keer (1999), and Kirchner (2000) for discussions of geminate inalterability.

10 The nonspirantization of /ṭ q/ may be attributed to undominated context-free markedness constraints against the "emphatic" nonsibilant fricatives [θ̣] and [χ].

2.3 Epenthesis and ʔ-deletion

Among the declension classes of TH is one comprising the forms known as *segolate* nouns.[11] Segolate nouns are characterized by their penultimate stress and by the vowel [ɛ] (but [a] adjacent to pharyngeals and [i] after [j]) in the final syllable. In Proto-Semitic, the ancestors of the TH segolate nouns had the root form CVCC, and most phonologists working on TH assume this shape in the underlying forms of the segolate nouns for synchronic analyses as well. Some examples of segolate nouns are shown in (15); forms a–d have the default epenthetic vowel [ɛ], forms e–g have epenthetic [a] adjacent to a pharyngeal, and form h has epenthetic [i] after [j]. Forms a, d, and h also show that the epenthetic vowel triggers spirantization of a following nonemphatic stop.

(15) Segolate nouns (Gesenius 1910, 264–65)

	UR	Surface form	Gloss	Citation
a.	/malk/	mɛ́lɛx	'king'	Gen. 14:7
b.	/sepr/	séfɛr	'book'	2 Sam. 11:14
c.	/qodʃ/	qóðɛʃ	'sacredness'	Exod. 3:5
d.	/mawt/	mɔ́wɛθ	'death'	Deut. 19:6
e.	/naʕr/	náʕar	'a youth'	Gen. 37:2
f.	/neṣħ/	néṣaħ	'perpetuity'	1 Sam. 15:29
g.	/poʕl/	póʕal	'deed'	Hab. 1:1
h.	/zajt/	zájiθ	'olive'	Gen. 8:11

Suffixed forms like those in (16) have no epenthetic vowel, indicating that the locus of epenthesis is a syllable- or word-final consonant cluster.

(16) Suffixed forms of segolate nouns

a.	/malk-i/	malkí	'my king'	2 Sam. 19:44
b.	/sepr-i/	sifrí	'my book'	Exod. 32:33
c.	/qodʃ-i/	qɔðʃí	'my sacredness'	Lev. 20:3
d.	/neṣħ-i/	niṣħí	'my perpetuity'	Lam. 3:18

11 From *segol* [səɣol], the Hebrew name of the vowel point representing [ɛ].

Malone (1993, 93–94) proposes the rule of segolate epenthesis shown in (17), which inserts the vowel [ɛ] into a word-final consonant cluster.[12]

(17) Segolate epenthesis (Malone 1993, 93–94)
$\varnothing \rightarrow \varepsilon$ / C _ C #
[ɛ] is inserted into a word-final consonant cluster.

Segolate nouns are not the only words with epenthesis. Another class of words that typically shows penultimate stress is the jussive and imperfect consecutive forms of *lamed-he* verbs (see Benua 1998, ch. 4, and Churchyard 1999, ch. 1 for discussion).[13] Some examples are shown in (18); related suffixed forms with no epenthesis are shown beneath the forms with epenthesis. Glosses translate the roots, not the specific inflected forms cited.

(18) Jussive and imperfect consecutive forms of *lamed-he* verbs (*italicized* forms are the orthographic roots, shown for ease of reference)

a.	/ji-bz/ (*bzh*)	‘despise’
	jí-vɛz	Gen. 25:34
	ji-vz-éhu	1 Sam. 17:42
b.	/ji-bn/ (*bnh*)	‘build’
	jí-vɛn	Gen. 2:22
	ji-vn-éhu	Job 20:19

12 Malone’s formulation is more complex, taking into account the fact that the vowel surfaces as [a] adjacent to pharyngeals and as [i] after [j]. Malone states his rules using an *SPE*-style formalism, though most phonologists working in 1993 would probably have stated the rule of segolate epenthesis in terms of syllable structure.

13 The vast majority of Hebrew verb roots are considered to consist of three consonants. The *lamed-he* verbs are those whose third consonant (etymologically [j] or [w]) is orthographically *h* and phonologically never present on the surface.

c.	/ji-gl/ (*glh*)	‘remove’
	jí-ɣɛl	Job 20:28
	ji-ɣl-ú	Amos 6:7
d.	/ja-gl/ (*glh*)	‘exile’
	jɛ́-ɣɛl	2 Kings 17:6
	ja-ɣl-ɛ́hɔ	2 Kings 16:9
e.	/ji-kl/ (*klh*)	‘be consumed’
	jí-xɛl	Job 33:21
	ji-xl-ú	Isa. 1:28
f.	/ta-mr/ (*mrh*)	‘rebel’
	tɛ́-mɛr	Ezek. 5:6
	ta-mr-ú	1 Sam. 12:14
g.	/ja-ʕl/ (*ʕlh*)	‘bring up’
	já-ʕal	Gen. 8:20
	ja-ʕl-ém	Deut. 28:61
h.	/ji-pn/ (*pnh*)	‘turn’
	jí-fɛn	Exod. 2:12
	ji-fn-ɛ́	1 Sam. 13:17
i.	/ja-pr/ (*prh*)	‘make fruitful’
	jɛ́-fɛr	Ps. 105:24
	ja-fr-əxɔ́	Gen. 28:3
j.	/ji-ʃʕ/ (*ʃʕh*)	‘look’
	jí-ʃaʕ	Gen. 4:4
	ji-ʃʕ-ɛ́	Isa. 17:7
k.	/ja-tʕ/ (*tʕh*)	‘cause to stray’
	jɛ́-θaʕ	2 Chron. 33:9
	ja-θʕ-ém	Job 12:24
l.	/ji-rb/ (*rbh*)	‘multiply’
	jí-rɛv	Gen. 1:22
	ji-rb-əjún	Deut. 8:13

As we will see shortly, epenthesis interacts with another phonological process, called ʔ-deletion, that involves ʔ/∅ alternations of the kind shown in (19).

(19) ʔ/∅ alternations (the vowel alternations here are not relevant to the discussion)

a.	/śaneʔ/	śɔné	Deut. 12:31	'hate'
		śəneʔ-ɔ́h	2 Sam. 13:15	
b.	/ħeṭʔ/	ħeṭ	Lev. 19:17	'sin'
		ħɛṭʔ-ó	Lev. 24:15	
c.	/gajʔ/	gaj	Num. 21:20	'valley'
		geʔ-óθ	Ezek. 31:12	
d.	/ja-rʔ/ (*rʔh*)	já-r	Gen. 18:2	'see'
		ji-rʔ-ɛ́	Gen. 22:8	

Alternations like those in (19) lead to the conclusion that [ʔ] is deleted in syllable-final position. Idsardi's (1998) rule of laryngeal deletion is stated in (20).

(20) Laryngeal deletion

$$\begin{array}{c} X\,]_{\sigma} \\ \nplus \\ \text{ʔ} \end{array}$$

But there is some inconsistency regarding word-final /Cʔ/ clusters. Sometimes the /ʔ/ is simply deleted and the preceding consonant surfaces as the word-final sound, as in (19)b–d. But in other cases, an epenthetic [ɛ] appears word-finally after the consonant, as in (21).

(21) Word-final [ɛ] where input ends in /Cʔ/ (the vowel alternations here are not relevant to the discussion)

a.	/gabʔ/	‘pool’
	gɛ́vɛ	Isa. 30:14
	gəvɔʔ-ɔw	Ezek. 47:11
b.	/daʃʔ/	‘grass’
	dɛ́ʃɛ	Gen. 1:11
	daʃʔ-ó	(unattested)
c.	/ṭanʔ/	‘basket’
	ṭɛ́nɛ	Deut. 26:4
	ṭanʔ-ăxɔ́	Deut. 28:5
d.	/kɛlʔ/	‘imprisonment’
	kɛ́lɛ	1 Kings 22:27
	kilʔ-ó	2 Kings 25:29
e.	/pɛlʔ/	‘wonder’
	pɛ́lɛ	Exod. 15:11
	pilʔ-ăxɔ́	Ps. 89:6
f.	/parʔ/	‘wild ass’
	pɛ́rɛ	Hosea 8:9
	pərɔʔ-ím	Jer. 14:6
g.	/je-dʔ/ (*dʔh*)	‘fly swiftly’
	jé-ðɛ	Ps. 18:11
	ji-ðʔ-ɛ́	Deut. 28:49
h.	/te-lʔ/ (*lʔh*)	‘be weary’
	té-lɛ	Job 4:5
	ti-lʔ-ɛ́	Job 4:2
i.	/je-rʔ/ (*rʔh*)	‘see’
	jé-rɛ	Exod. 5:21
	ji-rʔ-ɛ́	Gen. 22:8

In these forms, there is an opaque interaction of ʔ-deletion with segolate epenthesis. ʔ-deletion counterbleeds segolate epenthesis in these forms by destroying part of the latter’s structural description after it has already applied. On the surface, segolate epenthesis appears to have overapplied, since the epenthetic vowel is not followed by a consonant. The derivation of [pɛ́lɛ] is shown in (22).

(22) Derivation of [pɛ́lɛ]

UR	/pɛlʔ/
Stress placement	pɛ́lʔ
Segolate epenthesis	pɛ́lɛʔ
ʔ-deletion	pɛ́lɛ
SR	[pɛ́lɛ]

Ordering epenthesis before ʔ-deletion provides a derivational explanation for the opacity in this form, as does the sympathy theory analysis of McCarthy (1999), which brought TH opacity to the attention of phonologists. Bye (2003) proposes an analysis in Declarative Phonology, according to which the epenthetic [ɛ] appears before the position of a ʔ/∅ alternation, but is not regulated by syllable structure.

But none of these analyses is satisfying, since none of them accounts for the fact that not all instances of word-final /Cʔ/ surface opaquely as [Cɛ]: recall (19)b–d in which /Cʔ/ surfaces transparently as [C]. Malone (1993, 60) simply calls the rule of ʔ-deletion "uneven," while Coetzee (1999, 76) denies that [ħeṭ] 'sin' ((19)b) genuinely has /ʔ/ in its underlying representation, claiming that "no phonetic form of this word attests in any way to the underlying /ʔ/." This claim is in my opinion not tenable in view of forms like [ħɛṭʔ-ó] 'his sin' (Lev. 24:15), [ħɛṭʔ-ɔ́m] 'their sin' (Lev. 20:20), and [ħăṭɔʔ-ím] 'sins' (Eccles. 10:4), all of which attest clearly to a root-final /ʔ/ in this word. McCarthy (1999) and Bye (2003) fail to mention the transparent forms at all in their analyses. But the issue is addressed by Bruening (1999), who proposes that the transparent and opaque forms belong to different morphological classes with different prosodic requirements, a suggestion I pick up on and elaborate in §2.6.2.

2.4 Spirantization and syncope

The second opaque interaction found in TH is between spirantization, discussed above in §2.2.3, and a process of pretonic syncope, by which a vowel is deleted in an open syllable before a stressed syllable, if another open syllable precedes (i.e. $CVCVC\acute{V}C_0 \rightarrow CVCC\acute{V}C_0$). Pretonic syncope is restricted to certain morphological categories, including the construct plural of masculine nouns[14] and the imperative form of certain verb conjugations.

Some examples of pretonic syncope in the construct plural of masculine nouns are shown in (23). The construct is part of the same stress unit (Bruening 1999 suggests the prosodic word) as the noun that follows it, which is why the stress indicated on construct forms is secondary. (Some forms additionally show vowel alternations, which will not concern us here.)

(23) Construct plural forms showing pretonic syncope

a.	/qodaʃ-e/	qɔðʃè	'holy things (construct)'	Lev. 22:15
b.	/dabar-e/	divrè	'words (construct)'	Gen. 24:30
c.	/ħakam-e/	ħaxmè	'wise men (construct)'	Exod. 28:3
d.	/zaqen-e/	ziqnè	'old men (construct)'	Gen. 50:7
e.	/ħaṣer-e/	ħaṣrè	'villages (construct)'	1 Chron. 9:16

Some examples of pretonic syncope in imperatives with a vowel-initial ending or suffix are shown in (24).[15]

14 The construct state is semantically a sort of "reversed-polarity genitive": rather than indicating the possessor in a possessor/possessed relationship, like a genitive, the construct indicates the possessed. Thus in [dəvar ʔĕlohim] 'a word of God' (Judg. 3:20), [dəvar] 'word' is in the construct state, whereas in languages with a genitive case, the word for 'God' would be in the genitive in this construction.

15 The second person singular feminine imperative ending is [-i] and the second person plural masculine imperative ending is [-u]. In addition, the second person singular masculine imperative is sometimes augmented by an emphatic suffix [-ɔ].

(24) Imperative forms showing pretonic syncope

a. /ʃamoʕ-i/	ʃimʕí	'listen' (2 f.sg. impv.)	Ps. 45:11
b. /ħagor-i/	ħiɣrí	'gird on' (2 f.sg. impv.)	Jer. 6:26
c. /ħazoq-u/	ħizqú	'be strong' (2 m.pl. impv.)	Deut. 31:6
d. /maṣoʔ-u/	miṣʔú	'find' (2 m.pl. impv.)	Jer. 6:16
e. /ʃomor-ɔ/	ʃɔmrɔ́	'keep' (2 m.sg. impv.)	1 Chron. 29:18
f. /mokor-ɔ/	mixrɔ́	'sell' (2 m.sg. impv.)	Gen. 25:31

By deleting a vowel, syncope can remove the environment for spirantization. But according to derivational accounts like Malone (1993) and Idsardi (1998), spirantization applies before syncope does, so syncope counterbleeds spirantization. This results in an opaque interaction where spirantization appears on the surface to have overapplied, since normally stops rather than fricatives appear after consonants (e.g. [malkí] 'my king' (16)a). An example of this opaque interaction is by the derivation of [malxè] 'kings (construct)' in (25).

(25) Derivation of [malxè]

UR	/malak-e/
Stress placement	malakè
Spirantization	malaxè
Pretonic syncope	malxè
SR	[malxè]

Other forms also show the opaque interaction between spirantization and reduction, such as [kiθvú] 'write (imperative plural)' < /kotobu/, where the fricative [v] "unexpectedly" appears on the surface after a consonant.[16] In §2.6.3 I will argue that overapplication of spirantization in TH is attributable to paradigm uniformity considerations, but first we turn our attention to how the problem of opacity has been approached by previous OT researchers.

16 OT analyses of opaque spirantization in TH include Benua (1995, 1998), Coetzee (2002), and McCarthy (2003).

2.5 Opacity in OT

In derivational phonology rule ordering is sufficient to account for the presence of opaque relationships like the ones described above. In OT phonology, however, over- and underapplication of phonological processes are very difficult to explain. Consider the interaction of epenthesis and ʔ-deletion discussed above in §2.3. In an OT analysis, both of these processes involve violation of faithfulness constraints: epenthesis violates DEP-IO(V) and ʔ-deletion violates MAX-IO(C). But the markedness constraints against complex codas and syllable-final [ʔ] outrank the faithfulness constraints, as is seen in (26) and (27). (Other processes, such as the raising of /a/ to [ɛ] and the spirantization of /k/ to [x] in (26) and the rounding of /a/ to [ɔ] in (27), are not discussed as they are tangential to the issue at hand.)

(26) $*CC]_\sigma \gg$ DEP-IO(V), from [mɛ́lɛx] 'king'

/malk/	$*CC]_\sigma$	DEP-IO(V)
malk	* !	
☞ mɛ́lɛx		*

(27) $*ʔ]_\sigma \gg$ MAX-IO(C), from [śɔné] 'he hated'

/śaneʔ/	$*ʔ]_\sigma$	MAX-IO(C)
śɔnéʔ	* !	
☞ śɔné		*

In the correspondence relationship /daʃʔ/ ℜ [dɛ́ʃɛ], both markedness constraints are obeyed and *both* faithfulness constraints are violated; but the violation of DEP-IO(V) appears gratuitous. The competing candidate *[daʃ] also obeys both markedness constraints while violating only one of the faithfulness constraints, and is therefore predicted to win the evaluation.[17] (The symbol ☹ indicates the selection of an ungrammatical candidate.)

17 Note that closed syllables are freely allowed in Hebrew, e.g. [sus] 'horse'; thus it is not the fact that *[daʃ] is a closed syllable that renders it ungrammatical.

(28) Constraint ranking fails on [dɛ́ʃɛ] 'grass'

/daʃʔ/	*CC]$_\sigma$	*ʔ]$_\sigma$	DEP-IO(V)	MAX-IO(C)
daʃʔ	* !	*		
dɛ́ʃɛʔ		* !	*	
dɛ́ʃɛ			* !	*
☹ daʃ				*

McCarthy's (1999) solution to this paradox is sympathy theory. According to sympathy theory, the optimal candidate in an evaluation must not only maximize unmarkedness and faithfulness to the input in the conventional manner, but also maximize faithfulness to the so-called "sympathetic candidate" (marked with ❁ in tableaux) chosen by a special constraint called the selector constraint (marked with ✯ in tableaux). The selector constraint may be ranked anywhere in the hierarchy but behaves as if it were top-ranked for purposes of selecting a sympathetic candidate. In the case of /daʃʔ/ ℜ [dɛ́ʃɛ], the selector constraint is MAX-IO(C) and the sympathetic candidate is [dɛ́ʃɛʔ]. The optimal candidate must obey a faithfulness constraint to the sympathetic candidate, in this case MAX-❁O(V). This constraint compares each candidate not against the input /daʃʔ/ but against the sympathetic candidate [dɛ́ʃɛʔ] and gives a violation mark to any candidate lacking a vowel present in the sympathetic candidate. The optimal candidate [dɛ́ʃɛ] obeys MAX-❁O(V) while the transparent candidate [daʃ] fatally violates it. The tableau for the entire sympathy interaction is shown in (29).

(29) Sympathy analysis of [dɛ́ʃɛ] 'grass'

/daʃʔ/	*CC]$_\sigma$	*ʔ]$_\sigma$	MAX-❁O(V)	DEP-IO(V)	✯MAX-IO(C)
daʃʔ	* !	*	*		
❁ dɛ́ʃɛʔ		* !		*	
☞ dɛ́ʃɛ				*	*
daʃ			* !		*

The selection of the sympathetic candidate is achieved by imagining that the selector constraint, in this case MAX-IO(C), is top-ranked. If it were, [dɛ́ʃɛʔ] would win, because [dɛ́ʃɛ] and [daʃ] would fatally violate MAX-IO(C), and [daʃʔ] would fatally violate *CC]$_\sigma$.

A very similar result is obtained in a different OT approach to opacity, namely stratal OT, which follows lexical phonology in assuming different levels of phonological activity. Under stratal OT, the output of one level becomes the input to the next level. In the TH example, a stratal OT analysis would argue that level 1 has the crucial ranking MAX-IO(C) $\gg$ *ʔ]$_\sigma$, picking [dɛ́ʃɛʔ] as the optimal output to the input /daʃʔ/. At the next level, the input is /dɛ́ʃɛʔ/ and MAX-IO(C) is demoted below *ʔ]$_\sigma$; the crucial ranking is now *ʔ]$_\sigma$ $\gg$ MAX-IO(C), MAX-IO(V). The output of the level 2 constraint interaction is [dɛ́ʃɛ].

(30) /daʃʔ/ ℜ [dɛ́ʃɛ] in stratal OT

a. Level 1

/daʃʔ/	MAX-IO(C)	*CC]$_\sigma$	*ʔ]$_\sigma$	MAX-IO(V)	DEP-IO(V)
daʃʔ		* !	*		
☞ dɛ́ʃɛʔ			*		*
dɛ́ʃɛ	* !				*
daʃ	* !				

b. Level 2

/dɛ́ʃɛʔ/	*CC]$_\sigma$	*ʔ]$_\sigma$	MAX-IO(C)	MAX-IO(V)	DEP-IO(V)
dɛʃʔ	* !	*		*	
dɛ́ʃɛʔ		* !			
☞ dɛ́ʃɛ			*		
dɛʃ			*	* !	

The problem with stratal OT is that it eliminates the parallelism of traditional OT. One of the main characteristics that distinguish OT from derivational phonology is that OT establishes a correspondence between an input and an output that does not assume any serial derivation or change over time from the input to the output. Parallelist OT does not assume any intermediate stages "between" the input and the output; the input does not come "before" the output in any way. Stratal OT, on the other hand, is derivational: first there is an evaluation at one level, then there is a second evaluation with a new input and a new constraint ranking. Moreover, in this case and many others like it, there is no independent evidence, such as the addition of a morpheme, for two separate levels. In both conventional lexical phonology and the most strictly defined versions of stratal OT (e.g. Bermúdez-Otero in prep.), each level corresponded to some level of morphological affixation. That is not always the case in opacity cases, meaning that stratal OT analyses of opacity will not reliably yield positive results.

Sympathy theory is an attempt to sidestep this problem by ostensibly allowing a fully parallel selection of both the sympathetic candidate and the optimal candidate, but it is unclear to what extent this is conceptually really possible. If the selection of the optimal candidate depends on faithfulness to the sympathetic candidate, then the selection of sympathetic candidate must happen in some sense "before" the selection of the optimal candidate. If this is the case, then there is no substantial difference between sympathy theory and stratal OT, and the tableau in (29) is just a shorthand for the two tableaux in (30).

A further conceptual problem with both sympathy theory and stratal OT is their reliance on faithfulness to a nonexistent form. The output [dɛ́ʃɛ] clearly exists, as this is the form the speaker articulates and the listener perceives; the input exists as well, as this is the form that the speaker (and the listener as well) has listed in the lexicon. But the form [dɛ́ʃɛʔ] cannot be said to exist in the same way: it is a *hypothetical* form that is neither the lexical representation nor the surface form, and yet the grammar is somehow supposed to compare the candidates for faithfulness against both the lexical input /daʃʔ/ and the hypothetical form [dɛ́ʃɛʔ]. Serious questions about learnability are raised here: the learner acquires the output [dɛ́ʃɛ] by hearing it, and the lexical input /daʃʔ/ by induction, comparing it to related forms like [daʃʔó] ‘his/its grass’[18], but how does the learner acquire the “sympathetic candidate” or “intermediate input” [dέʃɛʔ]? For that matter, how does the learner learn to use the relatively low ranked selector constraint (in sympathy theory) or to rerank constraints between levels (in stratal OT)? The most successful models of learning OT grammars, such as the gradual learning algorithm (Boersma 1998, 2000) make no provision for treating a low ranking constraint as if it were high ranking or for reranking constraints in the course of a single instance of harmonic evaluation.

The [dέʃɛ] paradox relies crucially for its existence on the assumption that the /daʃʔ/ ℜ [dέʃɛ] correspondence is purely phonological in character. If morphological constraints play a role, then the output [dέʃɛ] could be superior to its competitor *[daʃ] for nonphonological reasons. In the next section I will argue that this is indeed the case.

2.6 A reexamination of the TH facts

In order to come up with a successful analysis of the TH facts, it will be necessary in this section to reexamine the data in the context of TH morphology.

2.6.1 Coda clusters in TH

The first fact to be considered is that it is not the case that coda clusters are completely forbidden in TH, as both the derivational epenthesis rule (17) and the constraint ranking $*CC]_\sigma \gg$ DEP-IO(V) would imply. There are an (admittedly very small) number of nouns which end in consonant clusters, such as [qoʃṭ] ‘truth’ (Prov. 22:21) and [nerd] ‘spikenard’ (Song of Sol. 4:14), which Coetzee (1999, 183) considers to be lexically marked as exceptional. In verbs, however, final clusters are regularly found in jussive/imperfect consecutive forms of *lamed-he* verbs (cf. (18)) when the cluster is of falling sonority.

18 The form [daʃʔó] ‘his/its grass’ is not attested in the Bible but was undoubtedly a form of spoken Hebrew.

(31) Final clusters in jussive/imperfect consecutive forms of *lamed-he* verbs

waj-jíʃb	Num. 21:1	'take captive'
waj-jíft	Job 31:27	'be simple'
waj-jéʃt	Gen. 9:21	'drink'
waj-jévk	Gen. 27:38	'weep'
jeśṭ	Prov. 7:25	'turn aside'
waj-jáʃq	Gen. 29:10	'give water to'

Final clusters are the norm in the second person singular feminine perfective form of verbs, where the ending [-t] is attached directly to the final consonant of the root.

(32) Second person singular feminine perfective verb forms

hɔláxt	Ezek. 16:47	'walk'
jɔláðt	Judg. 31:3	'bear'
liqqáṭt	Ruth 2:19	'glean'
jɔnáqt	Isa. 60:16	'suck'
niθpáśt	Jer. 50:24	'be taken'

Benua (1998, ch. 4) and Churchyard (1999, ch. 1) attribute the presence of final clusters in (31) and (32) to output-output faithfulness between a base and its truncated form. The forms in (31) are held to be truncated from full forms of the imperfective like those shown in (33).

(33) Full forms corresponding to (31)

jiʃbɛ́	(unattested)	'take captive'
jiftɛ́	Deut. 11:16	'be simple'
jiʃtɛ́	Gen. 44:5	'drink'
tivkɛ́	1 Sam. 1:7	'weep'
tiśṭɛ́	Num. 5:29	'turn aside'
jaʃqɛ́	Num. 5:26	'give water to'

As for the forms in (32), these are considered to be truncated from /-ti/ (on the basis of suffixed forms like [jəliðtí-ni] 'you (f. sg.) have borne me', Jer. 15:10). When not truncated, this ending is homophonous with that of the first person singular, shown in (34).

(34) First person singular equivalents of the forms in (32)

hɔláxti	Ruth 1:21	'walk'
jɔláðti	Gen. 21:7	'bear'
liqqáṭti	(unattested)	'glean'
jɔnáqti	(unattested)	'suck'
niθpáśti	(unattested)	'be taken'

However, the argument that the forms in (31)–(32) stand in a base-truncation correspondence relationship with the forms in (33)–(34) derives solely from the desire to explain the presence of consonant clusters in these forms. There is otherwise no independent evidence that these forms need to be in especially close correspondence with each other, nor that truncation is employed in TH inflectional morphology. Truncation usually has the nature of a hypocoristic (as the nickname *Lar* [lær] truncated from *Larry*, discussed by Benua in chapter 2); it is not clear that it is an advantage to morphological theory to propose that one verb form can be derived from another by truncation. A much simpler explanation would be that the ending of the second person singular feminine perfective is [-t], and its status is entirely parallel to that of other endings like [-ti] (first person singular perfective) and [-tɔ] (second person singular masculine perfective). Similarly, the input for a "truncated" jussive/imperfect consecutive form like [jiʃb] would be simply /ja-ʃb/, not /ja-ʃbɛ-TRUNC/ as Benua proposes.

If, then, it is the case that the inputs of, say, [liqqáṭt] and [jiʃb] are /liqqaṭ-t/ and /ja-ʃb/, then it is clear that DEP-IO(V) outranks $*CC]_\sigma$ in TH. Nouns like [qoʃṭ] and [nerd] are no longer a problem either. If this is the case, then correspondence relationships like /malk/ ℜ [mɛ́lɛx] and /ji-rb/ ℜ [jírɛv] need to be rethought and a new motivation for the vowel epenthesis found.

Bruening (1999) has argued that morphological classes in TH make reference to prosodic templates, but that these templates are not inputs (as was generally held in pre-OT templatic morphology theory) but are rather output conditions (consistent with the output-based orientation of OT generally). Under this analysis, the difference between segolate nouns and other nouns is that segolate nouns have to meet a trochaic template, while other nouns have to meet an iambic template. Bruening assumes that the trochee of the template is a moraic trochee and thus equally well achieved by (L L) or by (H). Both iambic and trochaic templates are to be aligned at the left edge of the prosodic word; this has the effect of allowing the suffixed forms of segolate nouns to conform to the template, e.g. [(mal)(kí)] 'my king' with a moraic trochee (mal) at the left edge. But Bruening does not address nouns like [gəvέrɛθ] 'mistress' (Isa. 47:5)[19] where there is no trochee at the left edge of the word.

If we modify Bruening's suggestion and assume that the trochaic template of TH is syllabic, not moraic, we can account for the difference between [mέlɛx] with epenthesis and [qoʃṭ] and [nerd] without epenthesis. [qoʃṭ] and [nerd] belong to the first declension, which ends in an iamb (H) or (L H). Iambs are always moraic, as has been shown by Prince (1990), Kager (1993), Hayes (1995), and Eisner (1997). [mέlɛx], on the other hand, belongs to the second declension, which is characterized by a syllabic-trochaic template, i.e. a foot of the shape ($\acute{\sigma}$ σ).

In fact, it is not necessary to assume a lexically marked iambic template. Rather, since the iambic pattern is the more widespread in TH, we may assume that it is the pattern called for by the purely phonological constraints of the language. Therefore we can say that segolate nouns and nouns like [gəvέrɛθ] are marked in the lexicon with a diacritic requiring them to end in a trochee, while other nouns have no lexical marking and take the iambic pattern by default. I will indicate the trochaic diacritic as "Tr."

19 This word is not a segolate noun, but rather belongs to a class of feminine nouns ending in /-t/ (surfacing as [ɛθ]) that consistently have penultimate stress.

(35) Nouns with and without the trochaic diacritic

	Input	Output	Gloss	Citation
a.	/malk/$_{Tr}$	mɛ́lɛx	'king'	Gen. 14:7
b.	/gabɛrt/$_{Tr}$	gəvɛ́rɛθ	'mistress'	Isa. 47:5
c.	/qoʃṭ/	qoʃṭ	'truth'	Prov. 22:21
d.	/dabar/	dɔvɔ́r	'word'	Gen. 18:14
e.	/raʕabon/	rəʕɔvón	'hunger'	Ps. 37:19

A constraint responsible for rightmost stress is STRESS-RIGHT (36).

(36) STRESSRIGHT
Align-R(PWord, σ́)
The right edge of a prosodic word is aligned with the right edge of a stressed syllable.

This constraint achieves the final stress seen in the forms in (35)c–e. But for words belonging to a morphological class marked as taking the trochaic template, the constraint TROCHEE takes precedence.

(37) TROCHEE
Align-R(PWord$_{Tr}$, Trochee)
The right edge of a prosodic word associated with the diacritic Tr is aligned with the right edge of a trochee.

TROCHEE outranks STRESSRIGHT (a case of Pāṇinian ordering since TROCHEE is more specific than STRESSRIGHT), as shown in the tableaux in (38). This results in epenthesis in [mɛ́lɛx] and [gəvɛ́rɛθ], both with the trochaic template, but not in [qoʃṭ] with no lexically marked template.[20]

20 Bruening himself actually assumes phonological epenthesis (i.e. $*CC]_\sigma \gg$ DEP-IO(V)), but then he does not address forms like [qoʃṭ].

(38) Nouns with and without lexically specified templates

a. Trochaic diacritic: [mɛ́lɛx] 'king'

/malk/$_{Tr}$	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_\sigma$
(malk)	* !			*
☞ (mɛ́lɛx)		*	*	

b. Trochaic diacritic: [gəvɛ́rɛθ] 'mistress'[21]

/gabɛrt/$_{Tr}$	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_\sigma$
ga(vɛ́rt)	* !			*
☞ gə(vɛ́rɛθ)		*	*	

c. No diacritic: [qoʃṭ] 'truth'

/qoʃṭ/	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_\sigma$
☞ (qoʃṭ)				*
(qóʃɛṭ)		* !	*	
(qəʃɛ́ṭ)			* !	

Epenthesis in segolate and [-ɛθ] nouns is thus driven not by the desire to avoid final clusters, but rather by the lexically imposed requirement to have a (σ́ σ) trochee at the end of the word.

Verbs almost always follow the iambic pattern (abstracting away from certain unstressed suffixes and endings), so that [liqqáṭt] and [jiʃb] surface without epenthesis.

(39) Verb forms not marked with Tr diacritic

a. [liqqáṭt] 'glean' (2 sg. fem. perf.)

/liqqaṭt/	STRESSRIGHT	DEP-IO(V)	*CC]$_\sigma$
☞ (liq)(qáṭt)			*
(liq)(qáṭɛθ)	* !		
(liq)(qəṭɛ́θ)		* !	

21 The candidate (gávɛrt) is excluded by the weight-to-stress principle (Prince 1990), according to which heavy syllables must be stressed. Although the trochee imposed by the Tr diacritic is syllabic, not moraic, in TH, TH is nevertheless a quantity-sensitive language since its predominant foot form is the iamb.

b. [jiʃb] ‘take captive’ (jussive)

/jiʃb/	StressRight	Dep-IO(V)	*CC]$_\sigma$
☞ (jiʃb)			*
(jíʃɛv)	* !		
(jəʃɛ́v)		* !	

Under this analysis, the motivation for epenthesis is not phonological (breaking up a consonant cluster) but morphological: epenthetic vowels are inserted only into words that are required to end in a syllabic trochee and thus in an unstressed syllable.

Faithfulness to the prosodic template may perhaps be overridden by phonotactic considerations. Consider the jussive/imperfect consecutive forms of various *lamed-he* verbs: the forms in (40)a–f are repeated from (31) and the forms in (40)g–q from (18).

(40) Jussive/imperfect consecutive forms of *lamed-he* verbs

a.	waj-jíʃb	Num. 21:1	‘take captive’
b.	waj-jíft	Job 31:27	‘be simple’
c.	waj-jéʃt	Gen. 9:21	‘drink’
d.	waj-jévk	Gen. 27:38	‘weep’
e.	jeśṭ	Prov. 7:25	‘turn aside’
f.	waj-jáʃq	Gen. 29:10	‘give water to’
g.	waj-jívɛz	Gen. 25:34	‘despise’
h.	waj-jívɛn	Gen. 2:22	‘build’
i.	jíɣɛl	Job 20:28	‘remove’
j.	waj-jɛ́ɣɛl	2 Kings 17:6	‘exile’
k.	jíxɛl	Job 33:21	‘be consumed’
l.	wat-tɛ́mɛr	Ezek. 5:6	‘rebel’
m.	waj-jífɛn	Exod. 2:12	‘turn’
n.	waj-jɛ́fɛr	Ps. 105:24	‘make fruitful’
o.	waj-jíʃaʕ	Gen. 4:4	‘look’
p.	waj-jɛ́θaʕ	2 Chron. 33:9	‘cause to stray’
q.	jírɛv	Gen. 1:22	‘multiply’

The forms in (40)a–f all end in a cluster with falling sonority; furthermore they all have final stress and thus conform to basic TH stress pattern. The forms in (40)g–p would all end in a cluster with level or rising sonority (assuming a fairly non-controversial view of the sonority scale, such as that given in Blevins 1995) if the epenthetic vowel were not present; they all have penultimate stress and thus conform to the trochaic template, but because level and rising sonority clusters are prohibited in word-final position in TH it is unclear whether these words are trochaic for phonotactic reasons or because they are conforming to a lexically specified trochaic template. But the form [jí-rɛv] in (40)q is clearly lexically marked for the trochaic template since the alternative without the epenthetic vowel, *[ji-rb], is phonotactically permitted as it ends in a cluster with falling sonority. Thus we may conclude that some jussive/imperfect consecutive forms of *lamed-he* verbs are marked for the iambic template and others for the trochaic template, but for many it is ambiguous to which they belong.

2.6.2 Epenthesis and ʔ-deletion

Turning next to the supposed opacity between epenthesis and ʔ-deletion in TH, we find that the derivational analysis, under which epenthesis precedes (and is counterbled by) ʔ-deletion, predicts that all cases of underlying word-final /Cʔ/ surface as [Cɛ], as we saw above in (21). However, this is not the case. There are nouns like [ħeṭ] 'sin' ((19)b) and [gaj] 'valley' ((19)c) and verb forms like [waj-jár] 'see (imperfect consecutive)' ((19)d) where [ʔ] is deleted without epenthesis before it. Recall from (28) that /Cʔ/ $\Re$ [C] is the predicted, transparent relation. In fact, the only place where the correspondence relationship /Cʔ/ $\Re$ [Cɛ] holds is in segolate nouns (e.g. [dɛ́ʃɛ] 'grass') and in the jussives and imperfect consecutives of *lamed-he* verbs whose second consonant is [ʔ], e.g. [jé-ðɛ] 'fly swiftly (imperfect consecutive)' (root *dʔh*). As we saw in the previous section, segolate nouns and "truncated" forms of some *lamed-he* verbs are lexically marked with the diacritic Tr, requiring them to have a syllabic trochee ($\acute{\sigma}$ σ) at their right edge. The forms without final [ɛ] do not have this diacritic. The purpose of the epenthesis is thus not to break up the /Cʔ/ cluster but to provide an unstressed final syllable so that the (σ́ σ) template can be met, as Bruening (1999) argued. The constraint hierarchy is shown in the tableaux in (41), on the basis of first declension (no diacritic) [ħeṭ] 'sin' and second declension (trochaic diacritic) [dέʃɛ] 'grass'.

(41) Treatment of final Cʔ clusters

a. First declension (no template) [ħeṭ] 'sin'

/ħeṭʔ/	*ʔ]$_\sigma$	Trochee	StressRight	Max-IO(C)	Dep-IO(V)	*CC]$_\sigma$
(ħeṭʔ)	* !					*
☞ (ħeṭ)				*		
(ħĕṭέ)				*	* !	
(ħéṭɛ)			* !	*	*	

b. Second declension (trochaic template) [dέʃɛ] 'grass'

/daʃʔ/$_{Tr}$	*ʔ]$_\sigma$	Trochee	StressRight	Max-IO(C)	Dep-IO(V)	*CC]$_\sigma$
(daʃʔ)	* !	*				*
(daʃ)		* !		*		
☞ (dέʃɛ)			*	*	*	

The same tableaux would hold for /waC-jarʔ/ ℜ [waj-jár] 'see (imperfect consecutive, no diacritic)' and /waC-jedʔ/$_{Tr}$ ℜ [waj-jéðɛ] 'fly swiftly (imperfect consecutive, trochaic diacritic)'.

2.6.3 Spirantization after consonants

Opacity between syncope and spirantization is illustrated by the relationship /malake/ ℜ [malxè] 'kings (construct)' (Gen. 17:16). Here, the fricative [x] surfaces even though a consonant precedes on the surface. This looks like a gratuitous violation of Ident-IO(cont); the transparent candidate would be *[malkè]. The constraint Lapse prohibits a sequence of two unstressed light syllables in a row.

(42) Transparent candidate *[malkè] wins instead of [malxè] 'kings (construct)'

/malake/	LAPSE	*V⌢STOP	IDENT-IO(cont)	MAX-IO(V)
mələkè	* !	*		
mələxè	* !		*	
☹ malkè				*
malxè			*	*

This overapplication of spirantization is found in only a few morphological contexts in TH.[22] First, it is found in imperative verb forms in the second person singular feminine, the second person plural masculine, and the second person singular masculine when this is augmented by the emphatic suffix [-ɔ]. Examples are shown in (43), where overapplication of spirantization is indicated by boldface.[23]

(43) Overapplication of spirantization in imperatives

a. Second person feminine singular

ʃix**v**í	'lie down!'	2 Sam. 13:11
ʃif**x**í	'pour out!'	Lam. 2:19
mɔl**x**í	'rule!'	Judg. 9:10

b. Second person masculine plural

kiθ**v**ú	'write!'	Deut. 31:19
wə-ʕiv**ð**ú	'and serve!'	Exod. 10:11
mɔʃ**x**ú	'draw!'	Ezek. 32:20
ħɔr**v**ú	'be wasted!'	Jer. 2:12

c. Second person masculine singular + emphatic suffix [-ɔ]

ʕɔz**v**-ɔ́	'leave!'	Jer. 49:11
ʃix**v**-ɔ́	'lie down!'	Gen. 39:7
ʕɛr**x**-ɔ́	'set in array!'	Job 33:5

22 It is also found in a few foreign (Persian) names, such as [ħar**v**onɔ], [biɣ**θ**ɔ], [ʔăvaɣ**θ**ɔ] in Esther 1:10.

23 There are occasional exceptions such as [ʔis**p**i] 'gather! (2 f. sg.)' (Jer. 10:17) beside expected [ʔisfu] 'gather! (2 m. pl.)' (Ps. 50:5).

In nouns, overapplication of spirantization is found in the plural construct, including forms with a possessive suffix. Examples are shown in (44).[24]

(44) Overapplication of spirantization in plural construct forms

a. Unsuffixed forms

biɣ**ð**è	'garments'	Gen. 27:15
zan**v**òθ	'tails'	Isa. 7:4
ħas**ð**è	'mercies'	Isa. 55:3
ħɔr**v**òθ	'ruins'	Isa. 5:17
jiq**v**è	'vats'	Zech. 14:10
jiθ**ð**òθ	'pins'	Exod. 27:19
kan**f**è	'wings'	Exod. 19:4
kan**f**òθ	'wings'	Deut. 22:12
kiθ**f**òθ	'shoulders'	Exod. 28:12
ʕiq**v**è	'heels'	Song of Sol. 1:8

b. Forms with possessive suffix

biɣ**ð**oθ-ɛ́xɔ	'your (m. sg.) garments'	Ps. 45:19
ħɔr**v**oθ-ájix	'your (f. sg.) ruins'	Isa. 49:19
kan**f**e-hɛ́m	'their (m.) wings'	1 Kings 6:27
kan**f**e-hɛ́n	'their (f.) wings'	Ezek. 17:3

The third context where overapplication of spirantization is consistently found is with the accusative/possessive suffixes [-xɔ́] 'you/your (m. sg.)', [-xɛ́m] 'you/your (m. pl.)' and [-xɛ́n] 'you/your (f. pl.)', which always begin with the fricative [x], regardless of whether a vowel or a consonant precedes.

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24 Here too there are occasional exceptions such as [ʔɔs**p**e] 'gatherings' (Mic. 7:1), [ħɛr**p**oθ] 'reproaches' (Ps. 69:10), [ṭar**p**e] 'preys' (Ezek. 17:9), [kas**p**e-hɛm] 'their (m.) silver coins' (Gen. 42:25), [nis**k**e-xɛm] 'your (m. pl.) drink offerings' (Num. 29:39), [ṣim**d**e] 'pairs' (Isa. 5:10), [riʃ**p**e] 'flames' (Song of Sol. 8:6, beside expected [riʃ**f**e] at Ps. 76:4). Since spirantization (or lack of it) is indicated by the vowel pointing, which was not devised until several centuries after Hebrew had stopped being used as a spoken language, it is impossible to know to what extent exceptions such as these were genuinely present in the living language.

Examples of these suffixes occurring after a consonant are shown in (45).

(45) Accusative/possessive suffixes beginning with [x] even after a consonant

a. 2nd person masculine singular

ʔăxɔl-**xɔ́**	‘your eating’	Gen. 2:17
bin-**xɔ́**	‘your son’	Gen. 22:2
u-verax-**xɔ́**	‘and he will bless you’	Deut. 7:13
goʔal-**xɔ́**	‘your Redeemer’	Isa. 48:17
ħibbəláθ-**xɔ**	‘she bore you’	Song of Sol. 8:5
wə-ʔɛʕɛɛ́-**xɔ́**	‘and I make you become’	Gen. 12:2
ʃim-**xɔ́**	‘your name’	Gen. 17:5

b. 2nd person masculine plural

ʔaðmaθ-**xɛ́m**	‘your ground’	Gen. 47:23
ʔăxɔl-**xɛ́m**	‘your eating’	Gen. 3:5
ʔɛθ-**xɛ́m**	‘you (acc.)’	Gen. 47:23
bi-vśar-**xɛ́m**	‘in your flesh’	Gen. 17:13
dim-**xɛ́m**	‘your blood’	Gen. 9:5
bə-jɛð-**xɛ́m**	‘into your hand’	Gen. 9:2
miʃmar-**xɛ́m**	‘your ward’	Gen. 42:19
ʕɔrlaθ-**xɛ́m**	‘your foreskin’	Gen. 17:11

c. 2nd person feminine plural

lə-qaðmaθ-**xɛ́n**	‘to your former state’	Ezek. 16:55

Finally, overapplication of spirantization is found when one of the proclitics [bə] ‘in’, [wə] ‘and’, [kə] ‘like, according to’, [lə] ‘to’ is attached to a word beginning [C_1əC_2-]. The result is [biC_1C_2-], [uC_1C_2-], [kiC_1C_2-], [liC_1C_2-] with spirantization of both C_1 (normal application) and C_2 (overapplication), assuming either belongs to the set of consonants exhibiting stop/fricative alternations (those enclosed in boxes in (11)).

(46) Overapplication of spirantization after proclitics

a. ʃəɣɔɣɔ́	‘error’	Num. 15:25
bi-ʃ**ɣ**ɔɣɔ́	‘in error’	Lev. 4:2

b.	gəvól u-ɣ**v**ól	‘a border’ ‘and a border’	Gen. 10:19 Num. 34:6
c.	ləvɔv-ó ki-l**v**ɔv-ó 13:14	‘his heart’ ‘according to his heart’	Deut. 2:30 1 Sam.
d.	bəθuláθ li-v**θ**uláθ	‘a virgin (construct)’ ‘to a virgin (construct)’	Deut. 22:19 Lam. 1:15

All of these cases of overapplication of spirantization can be attributed to paradigm uniformity effects (Kenstowicz 1996, 1997, Buckley 1999, Steriade 2000, Downing, Hall, and Raffelsiefen 2005).

Consider first the cases in (43). The imperative forms listed there are the only ones in the entire verbal paradigm where the third consonant of the verbal root follows a consonant. In all other forms, the third consonant follows a vowel and thus undergoes spirantization regularly. The spirantization in the imperative forms can thus be considered analogical, occurring in order to reduce variation within the paradigm. The first and second consonants of the root do alternate between stops and fricatives (provided they belong to the class of consonants allowing this alternation), but the third consonant is invariably spirantized. The paradigm of the qal binyan of the root *ktb* ‘write’ is given in (47); note that [k] and [θ] alternate with [x] and [t] in the imperfective, but [v] is invariant across all forms.[25]

25 Rappaport (1984) and Idsardi (1998, 41) posit an underlying stem /katob/ for the imperfective and argue that in a form like /ja-katob/ → [jixtov] the medial vowel is deleted before spirantization applies. This would then contradict Malone’s claim (1993, 64–66) that spirantization is a persistent rule applying whenever its structural description is met. But in fact there is no evidence to support the assumption of /katob/; the imperfective root is best assumed to be underlyingly /ktob/.

(47) Qal binyan of *ktb* 'write'

	Perfective	Imperative	Imperfective
1 sg.	kɔθávti		ʔɛxtóv
2 m. sg.	kɔθávtɔ	kəθóv/kiθ**v**ɔ́	tixtóv
2 f. sg.	kɔθavt	kiθ**v**í	tixtəví
3 m. sg.	kɔθáv		jixtóv
3 f. sg.	kɔθəvɔ́		tixtóv
1 pl.	kɔθávnu		nixtóv
2 m. pl.	kəθavtɛ́m	kiθ**v**ú	tixtəvú
2 f. pl.	kəθavtɛ́n	kəθóvnɔ	tixtóvnɔ
3 m. pl.	kɔθəvú		jixtəvú
3 f. pl.	〃		tixtóvnɔ
Infinitive construct	kəθóv		
Infinitive absolute	kɔθóv		
Active participle	koθév		
Passive participle	kɔθúv		

There are many proposals for analyzing paradigm uniformity effects in OT (see references mentioned above), and this is not the place to discuss the merits and liabilities of each. Suffice it to say the reason the boldfaced sounds in (47) are fricatives rather than stops is not because of an underlying vowel before them which causes spirantization before disappearing, but rather because of the desire to reduce intraparadigm variation and allow the third consonant of the root to surface in a uniform manner. The stop/fricative alternations of the first and second consonants are widespread and systematic within the paradigm and therefore tolerated.

The fact that nouns in the construct plural show spirantization of the final consonant after another consonant, as shown in (44), can also be attributed to paradigm uniformity. Consider the paradigms of an iambic noun such as [zɔnɔ́v] 'tail' and a trochaic (i.e. segolate) noun such as [mɛ́lɛx] 'king'. As shown in (48), the iambic noun has a vowel before the root-final consonant in all forms of the singular as well as in the plural absolute, so that a fricative is phonologically predicted here. It is only in the construct plural that the root-final consonant follows another consonant; phonologically a stop would be expected, but in fact a fricative occurs.

(48) Paradigm of [zɔnɔ́v] 'tail' (first declension)

	Singular	Plural
Absolute	zɔnɔ́v	zənɔvóθ
Construct	zənàv	zan**v**òθ
Construct suffixed	zənɔv-ó	zan**v**oθ-ehɛ́m

In segolate nouns, there is a stop/fricative alternation in the singular, but none in the plural, as shown in (49).

(49) Paradigm of [mɛ́lɛx] 'king' (second declension, i.e. segolate)

	Singular	Plural
Absolute	mɛ́lɛx	məlɔxím
Construct	mɛ̀lɛx	mal**x**è
Construct suffixed	malk-ó	mal**x**e-hɛ́m

The fact that the segolate paradigm contains both stop and fricative allophones led Benua (1998) to argue that overapplication of spirantization in plural construct forms cannot be attributed to output-output faithfulness.[26] I disagree and would argue that in both (48) and (49), the spirantization of the root-final consonant in the construct plural may be analyzed as analogical to the absolute plural, where the spirantization is phonological. In the case of first-declension nouns like [zɔnɔ́v], the singular may be exerting analogical influence as well. Segolate nouns generally tolerate the stop/fricative alternation in the singular, but there are a few nouns like [bɛ́ɣɛð] 'garment' that consistently retain the fricative even in singular suffixed forms: [biɣ**ð**-í] 'my garment' (Ezra 9:3), [biɣ**ð**-ó] 'his garment' (Gen 39:12); another example is [jiq**v**-ɛ́xɔ] 'your (m. sg.) wine vat' (Deut. 15:14). These cases show that the paradigmatic

26 Instead, she outlines a possible sympathy theory analysis.

pressure for a consistently spirantized root-final consonant has begun to spread to the segolate construct singular as well.

As for the suffixes in (45), they may be analyzed as obeying a high-ranking paradigm uniformity constraint requiring them to surface with [x]. Another option would be to posit /x/ rather than /k/ in the input, but this analysis comes into conflict with richness of the base. In an alternation like [zɔxár] 'he remembered' (Gen. 40:23)/[jizkór] 'he will remember' (Hosea 8:13), richness of the base predicts that the correct allophones will surface even if they are not present on the surface, i.e. even the input /zakar/ should surface as [zɔxár], and even the input /jizxor/ should surface as [jizkór]. So if the constraint ranking is such that the optimal output of /jizxor/ is [jizkór], then the optimal output of /binxɔ/ 'your son' should likewise be *[binkɔ́], not [binxɔ́]. Therefore it is preferable to assume a constraint unique to these three possessive suffixes requiring them to surface with [x], rather than attempting a purely phonological analysis of the facts of (45).

Finally, the data in (46) are also best explained as the result of paradigm uniformity. The forms [ʃə**ɣ**ɔɣɔ́], [gə**v**ól], [lə**v**ɔvó], and [bə**θ**uláθ] have a phonologically expected spirant as their second consonant; this spirant remains in the forms [bi-ʃ**ɣ**ɔɣɔ́], [u-ɣ**v**ól], [ki-l**v**ɔvó], [li-v**θ**uláθ] with a proclitic. If a stop were to occur in the forms with the proclitics, the relationship between the basic form and the extended form would be made less transparent, damaging recoverability. The one exception to the generalization that words beginning [C_1əC_2-] retain the spirantization of C_2 when a proclitic precedes is when the proclitic [lə] attaches to an infinitive like [kəθóv] 'write'. In this case, the result is not *[lixθóv] but rather [lix**t**óv] 'to write' (Josh. 18:8) with a stop. With other proclitics, infinitives behave normally, e.g. [bix**θ**óv] 'in writing' (Ps. 87:6). Idsardi (1998), arguing against an output-output correspondence analysis, accounts for this difference by analyzing [lə] as being [+cyclic] and [bə] as [−cyclic] and arguing that [+cyclic] forms behave in such a way as to delete vowels by syncope before spirantization has a chance to apply, where as [−cyclic] forms trigger syncope only after spirantization has already applied. Similarly, McCarthy (2003, 35) argues that [lə] and [bə] assign different OO correspondence relations. But forms like [li-vθuláθ] beside [bi-ʃɣɔɣɔ́] prove that the difference is not between [lə] and [bə], but rather between [lə] + noun and [lə] + infinitive.[27] Gesenius (1910, 123–24, 348–51) has argued that [lə] + infinitive is a distinct grammatical form (he calls it "a kind of gerund"); if this is so, then a gerund like [lixtóv] is sufficiently removed from the infinitive [kəθóv] that the [t/θ] alternation is accepted between them, whereas [bi-xθóv], being simply a proclitic + infinitive and not a distinct grammatical form, requires a greater degree of faithfulness to [kəθóv]. This suggests that output-output faithfulness may in some cases depend on some sort of semantic proximity, a question that will have to be left for future research.

2.7 Conclusions

In this chapter I have argued that the various alleged opaque relationships of TH do not refute OT, nor do they require any additional mechanism like sympathy theory. My analysis supports the hypothesis of Sanders (2003) that there is no instance of opacity in a purely phonological relationship (i.e. one that is free of morphological influence). All of the apparently opaque relationships in TH are influenced heavily by the morphology, in particular by the presence of trochaic templates for some words, including the declension class of segolate nouns. It is conformity to the trochaic template that causes the apparently unmotivated final epenthetic vowel discussed in §2.3. The overapplication of spirantization discussed in §2.4 is due to

27 Prince (1975, 104–7) argues that there are two different lexemes here: a preposition /la#/ and an infinitive marker /la+/. The idea that boundary markers can be present in input forms is no longer widely held by theoretical phonologists. Coetzee (2002) assumes the underlying distinction is between the preposition /l/ and the infinitive marker /la/. In both cases there are only theory-internal reasons for assuming different underlying forms/inputs; there is no independent evidence to suggest the two are underlyingly distinct.

paradigm uniformity considerations. The results discussed in this chapter point again to the importance of language-specific morphological constraints and the limitation of phonological constraints to those alternations that can be analyzed as the interaction of markedness and faithfulness alone. These conclusions will be confirmed by the next chapter, where cases of multiple inputs (allomorphy) are discussed.

Chapter 3
Allomorphy

3.1 Introduction to allomorphy

In the previous chapters we have seen that phonemic alternations are not always triggered by phonotactic considerations (in OT terms, by markedness constraints), and that those alternations that are not so triggered, e.g. the apparent instances of opacity in Tiberian Hebrew discussed in chapter 2, are best analyzed in terms of language-specific morphological constraints.[1] In this chapter we examine the usefulness of allowing morphemes to have multiple inputs, known as allomorphs, whose distribution can be determined by means of either phonological markedness constraints or language-specific morphosyntactic constraints.

Recent work on certain kinds of nonautomatic alternation within OT has examined the possibility of analyses based on allomorphs; see in particular Kager (1996; 1999, 413–20; forthcoming), Mascaró (1996a, 1996b), Burzio (1996, 1997, 1998, 2000, 2002b), Dolbey (1997), Perlmutter (1998), Tranel (1998), Rubach and Booij (2001), Bonet (2004), and Yip (2004). In such analyses, it is argued that the input of a morphologically complex form may contain more than one allomorph of any given affix or stem, and that phonological markedness constraints decide which of the various allomorphs is optimal in a particular instance. It is important to make clear what is meant

1 Early versions of portions of this chapter appeared as Green (2004a) and Green (2006). Portions were presented at the Fourth Celtic Linguistics Conference, Cambridge, September 2003, at the 11th International Morphology Meeting, Vienna, February 2004, and at the Workshop on Word Domains, Leipzig, April 2004.

by "allomorph" here: if a morpheme has two or more allomorphs under the definition assumed in this chapter, then there are two or more *distinct input forms* associated with the semantic and syntactic properties of that morpheme. I do *not* use the term "allomorph" to mean the different outputs corresponding to a single input, e.g. the English plural ending /z/ which may surface as [z], [s], or [əz] depending on the phonological properties of the preceding sound.

Ideally, the selection of the allomorphs should be the work of the markedness constraints, picking allomorphs that are the least marked in their various contexts. As Rubach and Booij (2001) put it in the abstract to their analysis of Polish sibilant alternations, "While, as a result of diachronic changes, the [phonological shapes of the] allomorphs are arbitrary, their distribution is not. It follows from the interaction of universal phonological and morphological constraints, and from the considerations of segment markedness." When the markedness constraints in question are ranked below input-output faithfulness constraints, they cannot force an output to be unfaithful to its input; they can *only* force the selection of the locally less marked allomorph when both are available. Where only one input is available, the output is faithful, even at the expense of a markedness violation. Thus allomorph selection is a type of "emergence of the unmarked" (McCarthy and Prince 1994, 1999, Mascaró 1996b, McCarthy 2002, 129–38). In this chapter we shall see one example (Welsh vowel alternations) where the allomorph selection is analyzed as following from the interaction of markedness and faithfulness constraints. But in the second example discussed, Celtic initial consonant mutations, it is shown that the allomorph selection is determined not by phonological markedness constraints, but rather by morphological constraints in a manner parallel to the selection of case-marked forms. Nevertheless, as we shall see, even this morphologically determined allomorph selection can be overridden by the requirements of phonological markedness constraints.

The organization of the chapter is as follows. In §3.2 I present a case of phonologically conditioned allomorphy in Welsh, and in §3.3 I argue that the initial consonant mutations of the Celtic languages are cases of morphosyntactically conditioned allomorphy. In §3.4 I examine two cases in which the selection of the mutation allomorph is overridden by phonotactic considerations. In §3.5 I defend the morphological analysis against possible objections, and §3.6 concludes the chapter.

3.2 Phonologically conditioned allomorphy: Welsh vowel alternations

Welsh is characterized by a number of paradigms in which a high vowel in a final syllable alternates with schwa in a nonfinal syllable. Some examples (taken from Thorne 1993, 88–89) are shown in (1). The pronunciations given are typical of North Wales dialects, but the generalizations hold for South Wales dialects as well.[2]

(1) Vowel alternations

a. [u∼ə] (also [uC_0u∼əC_0ə])

burð/bə́rða	'table'/pl.
ku:χ/kə́χod	'boat'/pl.
fru:d/frə́dja	'stream'/pl.
tu:v/tə́vɨ	'growth'/'grow' v.n.
trum/trə́maχ	'heavy'/compar.
kúmul/kəmə́la	'cloud'/pl.

2 A number of word pairs illustrated here exhibit a vowel-length alternation. This is not relevant to the discussion at hand. Vowel length in Welsh is largely predictable, as shown by Awbery (1984). In northern dialects, vowels are long in stressed final syllables that are either open or closed by a voiced stop or by a fricative other than [ɬ]. Vowels are short in unstressed syllables, in nonfinal syllables, and in stressed final syllables closed by a voiceless stop, a noncoronal nasal, or [ɬ] (with some exceptions in the case of foreign words like [ta:p] 'a tape', [ko:t] 'a coat', [dʒo:k], [ge:m] 'a game'). In stressed final syllables closed by a coronal sonorant long and short vowels can contrast, e.g. [sgi:l] 'behind' vs. [sgil] 'skill', [ɬe:n] 'literature' vs. [ɬen] 'curtain', [gwa:r] 'civilized' vs. [gwar] 'nape of the neck' (Thorne 1993, 12).

kúmud/kəmə́da	'commot[3]'/pl.
kúpurð/kəpə́rða	'cupboard'/pl.
múdul/mədə́la	'haycock'/pl.
kúrkud/kərkə́da	'crouching'/pl.

b. [ɨ~ə]

ɬɨ:s/ɬə́soɨð	'court/pl.'
dɨ:n/də́njon	'man/pl.'
módrɨb/modrə́beð	'aunt/pl.'
gwɨn/gwə́ni	'white/whiteness'
də́χrɨn/dəχrə́na	'frighten' (v.n.)/(1sg.)
géɬɨg/geɬə́gen	'pear trees/sg.'

Both of the alternations in (1) are found in numerous sets of words, but there are exceptions. Some words with [u] or [ɨ] in the final syllable do not change it in a nonfinal syllable, as shown in (2).

(2) Words with no alternation

a. Words with invariant [u]

sus/súsɨs	'kiss'/ pl.
gru:p/grúpja	'group'/pl.
urθ/úrθɨv	'to/to me'

b. Words with invariant [ɨ]

gəirjádɨr/gəirjadɨ́ron	'dictionary'/pl.
ə́sdlɨm/əsdlɨ́mod	'bat'/pl.
hápɨs/hapɨ́saχ	'happy'/compar.
ɬɨ:s/ɬɨ́sen	'blueberries/sg.'

A few foreign (English) words have nonalternating [ə], as shown in (3). Native lexical words, however, never have [ə] in a final syllable.

3 A commot is an early Welsh administrative region.

(3) Nonalternating [ə] in foreign words
  a. nərs/nə́rsɨs ‘nurse/pl.’
  b. kət/kə́tja ‘cut/pl.’

The facts of (1) and (2) lead Thomas (1984) (cf. also Williams 1983a) to posit four underlying high vowel phonemes for Welsh: /i/, /y/, /ɯ/ and /u/. /i/ always surfaces as [i] and is therefore of no further interest. /y/ surfaces as [ə] in nonfinal syllables and as [ɨ] in final syllables. /ɯ/ always surfaces as [ɨ] (to which it is featurally identical as [+high, +back, −round]). And /u/ surfaces as [ə] in nonfinal syllables before a morpheme boundary and as [u] elsewhere. His analysis is summed up in (4).

(4) Thomas’s (1984) analysis of high vowel phonemes in Welsh

a. [+high, −round] remains unchanged
   i.e. /i/ → [i] and /ɯ/ → [ɨ]

b. [+high, +round] → [−high, −rnd, +back] / _ C_0 + C_0 V
   i.e. /y, u/ → [ə] in a nonfinal syllable before a morpheme boundary

c. [+high, +round, −back] → [−high, −rnd, +back] / _ C_0 V
   i.e. /y/ → [ə] in nonfinal syllable of a monomorphemic form

d. [+high, +round, −back] → [+high, −rnd, +back] / _ C_0 #
   i.e. /y/ → [ɨ] in final syllable

Thomas justifies the distinction between rules (4)b and (4)c on the basis of monomorphemic forms such as /mynyð/ → [mə́nɨð] ‘mountain’ and /kumul/ → [kúmul] ‘cloud’, where only /y/ lowers to [ə], versus polymorphemic forms such as /dyn+jon/ → [də́njon] ‘people’ and /burð+a/ → [bə́rða] ‘tables’, where both /y/ and /u/ lower to [ə]. Thomas further proposes that all nonalternating instances of nonfinal [ə] (e.g. [kə́varθ/kəvárθjad] ‘bark’/‘barking’) are derived from underlying /y/.

Thomas's analysis more or less reflects the facts of Welsh historical phonology,[4] but as a synchronic analysis it is unsatisfying because it requires the absolute neutralization of two phonemes in final syllables, including the very common monosyllables. It also requires the postulation of a phoneme /y/ that never surfaces as such in Welsh, which has no front rounded vowels. Furthermore, it does not account for the polymorphemic nonalternating [u] cases of (2)a, which Thomas assumes are lexically marked as exceptional.

3.2.1 The [ɨ~ə] alternation

The obvious problem with any phonological analysis of the Welsh data that allows inputs (or, in derivational terms, Underlying Representations) to have only one unvarying form is the fact that while some words exhibit an [ɨ~ə] alternation, other words do not. Thomas's (1984) analysis was, as discussed above, to suggest that surface homophones like [ɬɨːs] 'court' and [ɬɨːs] 'blueberries' have distinct URs, namely /ɬys/ and /ɬɯs/ respectively. Another conceivable approach would be to suggest that certain lexemes, such as [ɬɨːs] 'blueberries', are marked as being exempt from the rule lowering /ɨ/ to /ə/ in nonfinal syllables.[5] But the first suggestion is highly abstract, implausibly expecting learners to posit a phoneme /y/ that they have never heard (since Welsh has no front rounded vowels), and the second suggestion is no solution at all, but merely a formalization of the problem that some words do not undergo a phonological process that other words do.

Under an OT allomorphy analysis, we abandon the idea that every lexical item has exactly one input form. Rather, some lexical items can have more than one input form, and the constraint hierarchy decides which form surfaces in which

4 Historically, Thomas's /y/ (orthographic ⟨y⟩) was [ɨ] and his /ɯ/ (orthographic ⟨u⟩) was [y] or [ʉ].

5 To my knowledge no such analysis of the Welsh data has ever been published, but it is fully consistent with Chomsky and Halle's treatment of lexical exceptions (1968). Thomas argues against such an analysis on the basis of the large number of words with nonalternating [ɨ].

environment. For example, [ɬiːs] 'court', which exhibits the alternation in [ɬiːs] (singular) / [ɬə́soɨð] (plural), would have the allomorphs /ɬis/ and /ɬəs/ in its input, while [ɬiːs] 'blueberries', which exhibits no alternation in [ɬiːs] (plural) / [ɬísen] (singular), would have only the allomorph /ɬis/. The only work that remains to be done is to discover what constraints interact to determine the distribution of the allomorphs in the forms with the alternation.

The typical scenario in phonologically determined allomorphy is that when two sounds alternate, one of them is less marked in an absolute, context-free sense, but the other is less marked in a specific environment. This is the case, for example, with Rubach and Booij's (2001) analysis of sibilants in Polish, where [ʃ] and [ɕ] alternate. Independent of context, [ʃ] is argued to be less marked than [ɕ], reflected in the constraint hierarchy by the ranking *ɕ ≫ *ʃ, which is part of a universally ranked fixed subhierarchy on markedness (cf. McCarthy 2002, 20–22, 117–19.). On the other hand, in the environment before the high front vowel [i], [ɕ] (which is [−back]) is less marked than [ʃ] (which is velarized in Polish and therefore [+back]). We may express the preference for [−back] consonants before [i] by the constraint CorPal, "Coronal consonants must be prepalatal before front vowels" (Rubach and Booij 2001, 43). When the input contains both [ʃ] and [ɕ] allomorphs, CorPal selects [ɕ] before [i], while the fixed subhierarchy *ɕ ≫ *ʃ selects [ʃ] in other environments, as shown by the tableaux in (5)a–b.

(5) Polish [ʃ/ɕ] alternation

a. gwoɕ-iʃ 'you (sg.) voice': Rubach and Booij (2001)

{gwoɕ, gwoʃ}; iʃ	CorPal	*ɕ	*ʃ
☞ gwoɕiʃ		*	*
gwoʃiʃ	* !		**

b. gwoʃ-õ 'they voice'

{gwoç, gwoʃ}; õ	CORPAL	*ç	*ʃ
gwoçõ		* !	
☞ gwoʃõ			*

For Welsh, then, we need to determine firstly which of the two vowels is less marked in an absolute, context-free sense, and secondly the universal constraints that determine the circumstances under which the more marked vowel is to be preferred.

According to the statistics of Maddieson (1984), [ə] is cross-linguistically more common than [ɨ]; moreover, the presence of [ɨ] in a language's vowel inventory often implies the presence of [ə]. These facts suggest that [ɨ] is a more marked sound than [ə], which implies a universal constraint ranking *ɨ ≫ *ə. But since the less marked [ə] does not appear in the final syllable among words that exhibit the alternation, there must be some markedness constraint that bans [ə] from final syllables in Welsh.

In many languages, e.g. English, Irish, German, and Dutch, schwa is banned from stressed syllables. This fact was formalized by Cohn and McCarthy (1998) for Indonesian as the constraint NON-HEAD(ə), which says that schwa may not appear as the head of a foot (i.e. a stressed syllable); in an analysis of Burmese, where schwa may not appear in a syllable with tone, Green (2005) proposes the constraint HEADEDPLACE, which says that the head mora of a foot must dominate place features. Schwa is generally considered to be placeless and therefore if it is found in the head mora of a foot, HEADEDPLACE is violated. However, these constraints are unfortunately not immediately useful for Welsh, since schwa is banned from final syllables, regardless of whether they are stressed or not. Stress in Welsh usually falls on the penultimate syllable of a polysyllabic word, so it is primarily monosyllables in which the final syllable is stressed.[6]

Nevertheless, as Williams (1983b) has shown, the (unstressed) final syllable of a polysyllabic Welsh word is acoustically and auditorily more prominent than the (stressed) penultimate syllable, in that it has higher pitch and longer duration than the penultimate (see also Bosch 1996). Therefore we may recast Cohn and McCarthy's prosodically based constraint Non-Head(ə) as an acoustically based constraint NonProm(ə) that says schwa may not appear in a prominent syllable. The examples of (1)b are repeated as (6) for convenience, but with prominence as well as stress marked. Stress is marked by the acute accent (´) over the vowel the stressed syllable, while prominence is marked by underlining the prominent syllable.

(6) Welsh [ɨ/ə] alternation

ɬɨ́:s/ɬə́soɨð	'court/pl.'
dɨ́:n/də́njon	'man/pl.'
módrɨb/modrə́beð	'aunt/pl.'
gwɨ́n/gwə́ni	'white/whiteness'
də́χrɨn/dəχrə́na	'frighten' (v.n.)/(1sg.)
géɬɨg/geɬə́gen	'pear trees/sg.'

To recapitulate, [ə] is less marked than [ɨ] context-independently, because of the fixed subhierarchy $*ɨ \gg *ə$, but [ə] is more marked in prominent syllables, because of NonProm(ə). An additional constraint that needs to be considered is the faithfulness constraint Ident-IO[high]. This constraint is violated when /ɨ/ corresponds to [ə] in words with only one input allomorph. This ensures that only words with more than one input allomorph will show an alternation. At the moment, the ranking between NonProm(ə) and Ident-IO[high] cannot be determined, but they both must outrank *ɨ; this indeterminate ranking is shown in the tableau by a broken line. The tableaux for [ɬɨ́:s] 'court' and [ɬə́soɨð] 'courts' are

6 There are some polysyllabic words that exceptionally have final stress, such as [əmlɑ́ɨn] 'onwards' and [kəmrɑ́ɨg] 'Welsh (language)'.

shown in (7); those for [ɬɨ́:s] 'blueberries' and [ɬɨ́sen] 'a blueberry' in (8).

(7) [ɬɨ́:s] 'court' and [ɬə́soɨð] 'courts'

{ɬɨs, ɬəs}	NonProm(ə)	Ident-IO[high]	*ɨ	*ə
☞ ɬɨ́:s			*	
ɬə́:s	* !			*

{ɬɨs, ɬəs} -oɨð	NonProm(ə)	Ident-IO[high]	*ɨ	*ə
ɬɨ́soɨð			* !	
☞ ɬə́soɨð				*

(8) [ɬɨ́:s] 'blueberries' and [ɬɨ́sen] 'a blueberry'

{ɬɨs}	NonProm(ə)	Ident-IO[high]	*ɨ	*ə
☞ ɬɨ́:s			*	
ɬə́:s	* !	*		*

{ɬɨs} -en	NonProm(ə)	Ident-IO[high]	*ɨ	*ə
☞ ɬɨ́sen			*	
ɬə́sen		* !		*

In the next section, we will examine words with [u] in the final syllable to see if they can be analyzed without the use of allomorphs, or if here too the facts require an analysis using multiple inputs.

3.2.2 The [u~ə] alternation

As we saw above in (1)a, most words with [u] in the final syllable show an alternation with [ə] when the vowel in question is in a nonfinal syllable. Assuming such forms have but a single input, the alternation may be analyzed by assuming a constraint *u ("Instances of the vowel [u] are penalized"), ranked between NonProm(ə) and Ident-IO[high] (thus, by transitivity, proving the ranking between them). The tableaux for [búrð] 'table' and [bə́rða] 'tables' are shown in (9). All candidates considered in the following tableaux obey the typical Welsh prosodic pattern of penultimate stress and ultimate prominence; monosyllables are of course both stressed and prominent.

(9) The [u/ə] alternation, assuming a single input

/burð/	NonProm(ə)	*u	Ident-IO[high]
☞ búrð		*	
bə́rð	* !		*

/burð-a/	NonProm(ə)	*u	Ident-IO[high]
búrða		* !	
☞ bə́rða			*

As we saw in (2)a, it is not the case that [u] never surfaces in nonfinal syllables in Welsh. The most common occurrences of nonfinal [u] are in loanwords ((10)a), in words where [u] occurs before a vowel ((10)b), and in words where [u] is found in both the penultimate and the ultima ((10)c), but there are other examples that do not fit into one of these categories ((10)d).

(10) Welsh words with [u] in a nonfinal syllable

a. Loanwords
   kúmni ‘company’
   dúsin ‘dozen’
   grúpja ‘groups’

b. Words with [u] before a vowel
   drúoð ‘through’
   dúad ‘come’
   rúan ‘now’

c. Words with [u] in penultimate and ultima
   gúðu ‘neck’
   húnu ‘that’ (masc.)
   múgud ‘mask’

d. Other cases of nonfinal [u]
sbúrjel ‘rubbish’
súsɨs ‘kisses’
trúχɨs ‘thick’

The forms in (10) show that there are circumstances under which [u] appears in nonfinal syllables. Foreign words often behave quite differently phonologically from native words (Yip 1993, Davidson and Noyer 1997, Itô and Mester 1999), so the forms in (10)a do not necessarily tell us anything interesting about Welsh phonology more generally. As for the forms in (10)b, Crosswhite (1999) has shown a cross-linguistic tendency for schwa to be disfavored in hiatus before a low vowel, which has apparently been extended in Welsh to a prohibition on schwa before all vowels.[7] Thus we may propose a constraint *ə.V (“No schwa in hiatus”) which is ranked above *u, as shown in the tableau in (11).[8] Constraints against deletion (MAX-IO) and epenthesis (DEP-IO) are also high-ranking, preventing those two repair strategies.

(11) Avoidance of schwa in hiatus, from [drú.oð] ‘through’

/druoð/	MAX-IO	DEP-IO	*ə.V	*u
☞ drú.oð				*
drə́.oð			* !	
dróð	* !			
drə́.toð		* !		

As for the [uC$_0$u] cases like (10)c, recall that such forms alternate with [əC$_0$ə], as we saw in the last five examples of (1)a, repeated with stress and prominence marks in (12).

7 This constraint is active in English as well, where the determiners *a* [ə] and *the* [ðə] have different forms, [ən] and [ði] respectively, before vowel-initial words. Some varieties of American English do not have the form [ði] but instead insert a glottal stop, e.g. *the apple* [ðə ʔæpəl], which is just a different strategy to avoid schwa in hiatus. Cf. also *Jud*[ə]*h*/*Jud*[i]*ism*.

8 Hall (1999, 115) proposes a similar constraint in a discussion of German.

(12) [uC$_0$u]/[əC$_0$ə] alternations

a. kúmul/kəmə́la ‘cloud’/pl.
b. kúmud/kəmə́da ‘commot’/pl.
c. kúpurð/kəpə́rða ‘cupboard’/pl.
d. múdul/mədə́la ‘haycock’/pl.
e. kúrkud/kərkə́da ‘crouching’/pl.

The most obvious explanation for this alternation is that the change of /u/ to [ə] in nonfinal syllables is blocked by /u/ in the final syllable. In derivational terms, this can be done either by writing the /u/ to [ə] rule in such a way that it fails before /u/ in the following syllable, or by letting it apply and then changing [ə] back to [u] before [u] in the following syllable.[9] In OT, if we assume the roots in (12) have but a single input form each, then we need to find a constraint interaction under which [-úC$_0$u-] and [-əC$_0$ə́-] are the optimal candidates.

Let us assume a constraint *(əC$_0$u)$_f$ that bans [ə] from being followed by [u] within a single foot, any number of consonants intervening. This constraint may appear somewhat ad hoc, but in fact is just a specific instantiation of universal vowel-harmony constraints (Padgett 1995, Gafos and Lombardi 1999, Baković 2000, Harrison and Kaun 2000, Noske 2000, Krämer 2001, Ní Chiosáin and Padgett 2001, Archangeli and Pulleyblank 2002). NonProm(ə), discussed above, ensures that [-úC$_0$u-] is more harmonic than [-ə́C$_0$ə-]; its ranking with respect to *(əC$_0$u)$_f$ cannot be determined. The faithfulness constraint Ident-IO[high] is ranked below *u. The interaction of these constraints is shown in the tableaux in (13).

9 Thomas’s approach is different: he proposes two rules, one changing both /y/ and /u/ to [ə] before a morpheme boundary, and another changing /y/ alone to [ə] in other nonfinal syllables. This explains the failure of lowering in [kúmul], which is monomorphemic, but not the failure of lowering in polymorphemic [sús-ɨs] ‘kisses’.

(13) Tableaux for [kúmul/kəmə́la] ‘cloud/clouds’

/kumul/	*(əC$_0$u)$_f$	NONPROM(ə)	*u	IDENT-IO[high]
☞ (kúmul)			**	
(kúməl)		* !	*	*
(kə́mul)	* !		*	*
(kə́məl)		* !		**

/kumul-a/	*(əC$_0$u)$_f$	NONPROM(ə)	*u	IDENT-IO[high]
ku(múla)			*!*	
ku(mə́la)			* !	*
kə(múla)			* !	*
☞ kə(mə́la)				**

So far, we have been able to explain all nonforeign occurrences of [u] in a nonfinal syllable phonologically, without recourse to multiple inputs (allomorphs), as we needed in §3.2.1 in our analysis of the behavior of [ɨ].

But what of the loanwords in (10)a and the other words in (10)d? They cannot be analyzed under the constraint ranking currently established: the symbol ☹ indicates the ungrammatical optimal candidate in the tableau.

(14) Constraint ranking fails for [súsɨs] ‘kisses’

/susɨs/	NONPROM(ə)	*u	IDENT-IO[high]
súsɨs		* !	
☹ sə́sɨs			*

There are a number of analytical possibilities we could choose from at this point. Following the theory of Lexicon Stratification (Fukazawa, Kitahara, and Ota 1998, Itô and Mester 1999, Féry 2003a), we could propose that words like those in (10)a and d belong to a stratum of the lexicon in which IDENT-IO[high] outranks *u. But usually the words in a particular stratum of the lexicon can be identified by some independent means, such as being foreign words. While the words in (10)a are foreign, those in (10)d are not; the only way to identify words belonging to the stratum with IDENT-IO[high] ≫ *u is to see whether they have [u] in a nonfinal syllable (and cannot be assigned to the class of (10)b or c). This is simply begging the question. The alternative is to posit multiple input allomorphs for those words that do show an [u/ə] alternation, while those words with invariant [u] have but a single input form. The partial constraint ranking established above, *u ≫ IDENT-IO[high], needs to be reversed; as a result, the relative ranking between NONPROM(ə) and IDENT-IO[high] is once again indeterminate.

(15) New constraint ranking with allomorphy for [búrð/bərða]

{burð, bərð}	NONPROM(ə)	IDENT-IO[high]	*u	*ə
☞ búrð			*	
bə́rð	* !			*

{burð, bərð} -a	NONPROM(ə)	IDENT-IO[high]	*u	*ə
búrða			* !	
☞ bə́rða				*

(16) No allomorphy for [sús/súsɨs]

{sus}	NONPROM(ə)	IDENT-IO[high]	*u	*ə
☞ sús			*	
sə́s	* !	*		*

{sus} -ɨs	NONPROM(ə)	IDENT-IO[high]	*u	*ə
☞ súsɨs			*	
sə́sɨs		* !		*

Allomorphy must also be assumed for words like those in (10)c with an alternation of [uC_0u] with [$əC_0ə$], such as [kúmul/kəmə́la] ‘cloud/clouds’, as shown in (17).[10]

10 This analysis will not work for [búθɨn/bəθə́nod] ‘cottage/cottages’: if the input allomorphs are {buθɨn, bəθən}, the optimal candidate for the singular is *[bə́θɨn] by *u ≫ *ə because *($əC_0u$) is not violated. The existence

(17) Allomorphy for [kúmul/kəmə́la]

{kumul, kəməl}	*(əC$_0$u)$_f$	NonProm(ə)	Ident-IO[high]	*u	*ə
☞ (kúmul)				**	
(kə́məl)		* !			**

{kumul, kəməl} -a	*(əC$_0$u)$_f$	NonProm(ə)	Ident-IO[high]	*u	*ə
ku(múla)				*!*	
☞ kə(mə́la)					**

Finally, we can analyze those foreign words like [nə́rs] ‘nurse’ and [kə́t] ‘cut’ that violate NonProm(ə). Such words have a single allomorph, whose vowel is [ə]. The tableaux for [nə́rs] and [nə́rsɨs] in (18) reveal that Ident-IO[high] must outrank *NonProm(ə).

(18) [nə́rs] ‘a nurse’ and [nə́rsɨs] ‘nurses’

{nərs}	Ident-IO[high]	NonProm(ə)	*ɨ	*ə
nɨ́rs	* !		*	
☞ nə́rs		*		*

{nərs} -ɨs	Ident-IO[high]	NonProm(ə)	*ɨ	*ə
nɨ́rsɨs	* !		**	
☞ nə́rsɨs			*	*

It is thus unnecessary to mark foreign words like [nə́rs] and [kə́t] as exceptional in the grammar; it is merely a historical accident that the only words with a single allomorph containing schwa are loanwords. The fact that these words prove the ranking Ident-IO[high] ≫ NonProm(ə) is additional evidence for the correctness of the allomorphy analysis. As we saw in

of forms like [mə́nɨð] ‘mountain’ shows that there is no active constraint *(əC$_0$ɨ)$_f$. To the best of my knowledge, however, this is the only word in Welsh with an alternation of [uC$_0$ɨ] with [əC$_0$ə], so it could be simply learned as an irregular form.

(9), if a pair like [búrð/bə́rða] has but a single input form /burð/, we are forced to posit the opposite ranking, NonProm(ə) ≫ Ident-IO[high], leaving the vowel of [nə́rs] unexplained. The allomorphy analysis, on the other hand, permits the ranking Ident-IO[high] ≫ NonProm(ə), allowing a straightforward analysis of [nə́rs] with no ranking paradox.

Thus the simplest analysis of the Welsh vowel alternation facts is that words with an [ɨ~ə] or an [u~ə] alternation have multiple allomorphic inputs, while words with invariant [ɨ], [u], or [ə] have but a single input. High-ranking faithfulness constraints prohibit variation in the single-input words, but in the multiple-input words the phonological markedness constraints NonProm(ə), *ɨ, and *u conspire to achieve the correct distribution of allomorphs. (But see Hannahs 2007 for an alternative analysis.) In the next section we remain in Celtic to see an example of multiple inputs whose distribution is regulated by morphosyntactic rather than phonological considerations.

3.3 Morphosyntactically conditioned allomorphy: Celtic initial consonant mutations

The initial consonant mutations of the Celtic languages are of great interest in theoretical linguistics because they appear to be (and are frequently argued to be) phonological processes that apply in morphosyntactic rather than phonological environments. Within phonological theory they are interesting also because many of the individual mutations have different effects on different classes of sounds. Thus, for example, eclipsis in Irish voices voiceless stops (e.g. [p] → [b]) and nasalizes voiced stops (e.g. [b] → [m]). The soft mutation in Welsh voices voiceless stops (e.g. [p] → [b]) and spirantizes voiced stops (e.g. [b] → [v]). The processes are thus not uniform and only partially predictable. In derivational phonology, devising phonological rules to account for the mutations is challenging, but not impossible. Derivational phonology allows its rules to be arbitrary and independent of universal markedness principles. But the advent of OT has forced a rethinking of the nature of phonological processes: according to the new theory, phonological processes are predicted to result from the interaction of markedness and faithfulness. In this chapter I will argue that since the morphosyntactically conditioned consonant mutations of Celtic do not result from that interaction, they cannot be phonological. Instead, the mutations are best regarded as being exclusively in the domain of the morphology, not the phonology at all. I will argue that, like inflected forms, mutated forms are listed separately in the lexicon as allomorphs, and that the selection of mutated allomorphs is determined by a form of government similar to that determining the distribution of case.[11]

In this section I will provide a general introduction to the proposal, which is that the mutated forms of words are listed in the lexicon alongside the radical forms. The grammar then picks the correct allomorph for any given environment. Thus, in spite of the phonological appearance of the mutations, they are in fact entirely outside the phonology; their phonological element can be explained only historically, not synchronically.

Probably the most widespread view of the lexicon in generative phonology today is that morphemes are listed in the lexicon under unique underlying representations (URs); these roots and affixes may be joined together and then phonological rules (in derivational phonology) or constraints (in constraint-based phonology like OT) apply to generate the surface form. According to this view, which I will call the UR-based approach, the alternation seen, for example, in Irish *bróg* [bro:g] 'shoe' ~ *bhróg* [vro:g] 'shoe (lenited) ~ *mbróg* [mro:g] 'shoe (eclipsed)' is to be analyzed thus: the Irish lexicon includes a UR /bro:g/ and a variety of lenition- and eclipsis-triggering morphemes, some of which may consist entirely of a floating autosegment, others of which may include a floating autosegment at their right edge. When a mutation-triggering morpheme comes into

11 Trask (1997, 98) defines *government* as "a grammatical relation between two items in a sentence in which the *presence* of the first item determines the *form* of the second," which is as apt a summary of what happens in Celtic mutation as anyone could ask for. I assume that a governor must c-command its governee.

contact with a potential host word, like /bro:g/, phonological processes (rules, constraint interactions, etc.) apply in such a way as to result in the surface form [vro:g] in lenition environments and the surface form [mro:g] in eclipsis environments. If neither process applies then the surface form is radical [bro:g]. In an OT analysis using the UR-based approach, the output [vro:g] engenders a violation of the faithfulness constraint IDENT-IO(cont) (output segments have the same value for the feature [continuant] as their input correspondents) with respect to its UR /bro:g/; the output [mro:g] violates IDENT-IO (nasal).

In contrast with the UR-based approach, the input-based approach endorsed here holds that the input of a lexical item includes all of the allomorphs in which the item may surface. Thus for mutated forms like Irish *bhróg* and *mbróg*, the input-based approach holds that these are not derived from *bróg* in any way, but are listed alongside it in the Irish lexicon. Therefore *bhróg* and *mbróg* do not violate any faithfulness constraints with respect to *bróg*, since *bróg* is not the input to *bhróg* or *mbróg*. The job of the grammar is then not to change *bróg* into *bhróg* or *mbróg* but rather to determine which form is used where.

The situation, I suggest, is parallel to that of case selection in languages like Latin, Russian, and German. Just as prepositions, verbs, and adjectives in those languages subcategorize for what case their complements appear in, so determiners, prepositions, and other proclitics in the Celtic languages can subcategorize for what mutation grade their complements appear in. For example, as shown in (19), nouns undergo mutations after certain possessive pronouns in both Irish and Welsh.

(19) Mutations of nouns (Irish [kat], Welsh [ka:θ], both ‘cat’) after possessive pronouns in Irish and Welsh

Person	Irish		Welsh		Gloss
	Form	Mutation	Form	Mutation	
1 sing.	mə **x**at	Lenition	ə **ŋ̊**a:θ	Nasal	‘my cat’
2 sing.	də **x**at	Lenition	də **g**a:θ	Soft	‘your cat’
3 sing. m.	ə **x**at	Lenition	i **g**a:θ	Soft	‘his cat’
3 sing. f.	ə **k**at	None (radical)	i **x**a:θ	Aspirate	‘her cat’
1 pl.	a:r **g**at	Eclipsis	ən **k**a:θ	None (radical)	‘our cat’
2 pl.	wu:r **g**at	Eclipsis	əx **k**a:θ	None (radical)	‘your cat’
3 pl.	ə **g**at	Eclipsis	i **k**a:θ	None (radical)	‘their cat’

The lexical listing of Irish [mə] ‘my’ includes some sort of diacritic indicating that the noun it governs is to appear in its lenition allomorph. Likewise, the listing of Welsh [ə] ‘my’ indicates that the noun it governs is to appear in its Nasal allomorph. This is parallel to case in a language like German, where the listing of the preposition *zu* ‘to’, for example, indicates that the noun it governs is to appear in the dative case.

Thus the mutations are like inflections, but independent of them. According to context, the nominative of ‘friend’ in Irish is *cara, chara* or *gcara,* the genitive *carad* or *charad* etc. I am *not* arguing that mutation is a form of case-marking, as Zwicky (1984) and Roberts (1997, 2005) did for Welsh. Instead, I am asserting that mutated forms are listed in the lexicon in a manner parallel to the listing of inflected forms.

In §3.3.1, we will see the effects of the mutations in more detail and the types of environments in which mutations are found will be briefly sketched out. In §3.3.2, the nonphonological lenition mutation is contrasted with a truly phonological lenition process in Manx, a language closely related to Irish. In §3.3.3 I discuss further evidence against a phonological analysis and in §3.3.4 I propose a morphological analysis in which the mutated forms of words are listed as allomorphs.

3.3.1 The effects and environments of the mutations

The effects of the mutations vary from language to language. For example, as shown in (20), Irish has two mutations, lenition and eclipsis.

(20) Irish (C′ stands for a phonemically palatalized C)[12]
[phonemic transcription], ⟨orthographic representation⟩

Radical form	Lenition	Eclipsis
[p, p′] ⟨p⟩	[f, f′] ⟨ph⟩	[b, b′] ⟨bp⟩
[t, t′] ⟨t⟩	[h, h′] ⟨th⟩	[d, d′] ⟨dt⟩
[k, k′] ⟨c⟩	[x, x′] ⟨ch⟩	[g, g′] ⟨gc⟩
[b, b′] ⟨b⟩	[v, v′] ⟨bh⟩	[m, m′] ⟨mb⟩
[d, d′] ⟨d⟩	[ɣ, ɣ′] ⟨dh⟩	[ɴ, ɴ′] ⟨nd⟩
[g, g′] ⟨g⟩	[ɣ, ɣ′] ⟨gh⟩	[ŋ, ŋ′] ⟨ng⟩
[f, f′] ⟨f⟩	∅ ⟨fh⟩	[v, v′] ⟨bhf⟩
[s, s′] ⟨s⟩	[h, h′] ⟨sh⟩	*no change*
[m, m′] ⟨m⟩	[v, v′] ⟨mh⟩	*no change*
[ɴ, ɴ′] ⟨n⟩	[n, n′] ⟨n⟩	*no change*

12 The transcription of Irish consonants employed here is quite broad, to facilitate comparison of phonologically related sounds and to enable me to abstract away from the palatalization contrast where this is convenient. The following chart shows a more narrow transcription of the symbols used for Irish:

p = [pˠ]	p′ = [pʲ]	b = [bˠ]	b′ = [bʲ]
t = [t̪ˠ]	t′ = [tʲ]	d = [d̪ˠ]	d′ = [dʲ]
k = [k]	k′ = [c]	g = [ɡ]	g′ = [ɟ]
f = [fˠ]	f′ = [fʲ]	v = [vˠ] (in some dialects, [w])	v′ = [vʲ]
s = [sˠ]	s′ = [ɕ]		
x = [x]	x′ = [ç]	ɣ = [ɣ]	ɣ′ = [j] before vowels,[j̯] before cons.
h = [h]	h′ = [ç] before [u(:), o:], [h] elsewhere		
m = [mˠ]	m′ = [mʲ]		
ɴ = [n̪ˠ]	ɴ′ = [n̠ʲ]	n = [n]	n′ = [nʲ]
ŋ = [ŋ]	ŋ′ = [ɲ]		
ʟ = [ɫ̪]	ʟ′ = [l̠ʲ]	l = [l]	l′ = [lʲ]
r = [ɾˠ]	r′ = [ɾʲ]		

[ʟ, ʟ′] ⟨l⟩	[l, l′] ⟨l⟩	*no change*
[r] ⟨r⟩	*no change*	*no change*
vowel	*no change*	[ɴ] or [ɴ′] ⟨n-⟩ + vowel

Lenition in Irish changes stops and [m(′)] into continuants (fricatives or glides), and deletes [f(′)]; [s(′)] is debuccalized to [h(′)], but only before vowels and coronal sonorants (before [m(′)] and obstruents [s(′)] is unaffected by lenition). The coronals [t(′), d(′)] also undergo debuccalization, becoming [h(′), ɣ(′)] respectively (see Ní Chiosáin 1991, 27f. for a discussion of why [d(′)] → [ɣ(′)] is to be considered debuccalization). In many dialects, the "tense sonorants" [ʟ(′)] and [ɴ(′)] become lenited to their "lax" counterparts [l(′)] and [n(′)].[13] Vowels are not affected by lenition, nor, in most dialects, is [r].[14] Eclipsis changes voiceless stops and [f(′)] into their voiced counterparts, changes voiced stops into the corresponding nasals, and attaches [ɴ(′)] to vowel-initial words. Sonorant consonants are not affected by eclipsis, nor is [s(′)] in most dialects.[15] In the orthography, lenition of obstruents and [m(′)] is indicated by placing an ⟨h⟩ after the first letter; lenition of [ʟ(′)] and [ɴ(′)] is not shown. Eclipsis is shown orthographically by placing the letter of the mutated consonant before that of the radical (unmutated) consonant.

As shown in (21), Welsh has three mutations: soft mutation (also called lenition; abbreviated SM), nasal mutation (NM),

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13 The lenition of *l* and *n* sounds is described for the dialects of Aran (Finck 1899), Erris (Mhac an Fhailigh 1968), and Cois Fhairrge (de Bhaldraithe 1945/1975, 1953/1977) in Connacht and of Meenawannia (Quiggin 1906), The Rosses (Ó Searcaigh 1925), South Armagh (Sommerfelt 1929), Torr (Sommerfelt 1965), and Tangaveane/Commeen (Hughes 1986) in Ulster. Many fieldworkers in the first half of the twentieth century found a contrast between lenited and unlenited *l* and *n* sounds only among older speakers; it may be nearly extinct today.

14 Ó Siadhail (1989, 112) reports that some speakers from the south use palatalized [r′] as the lenited correspondent of [r].

15 There are dialects of Irish where [z] is found as the eclipsis correspondent of [s] (Ó Siadhail 1989, 114).

and aspirate mutation (more accurately called spirantization; abbreviated AM).

(21) Welsh

Radical	SM	NM	AM
[p] ⟨p⟩	[b] ⟨b⟩	[m̥] ⟨mh⟩	[f] ⟨ph⟩
[t] ⟨t⟩	[d] ⟨d⟩	[n̥] ⟨nh⟩	[θ] ⟨th⟩
[k] ⟨c⟩	[g] ⟨g⟩	[ŋ̊] ⟨ngh⟩	[x] ⟨ch⟩
[b] ⟨b⟩	[v] ⟨f⟩	[m] ⟨m⟩	*no change*
[d] ⟨d⟩	[ð] ⟨dd⟩	[n] ⟨n⟩	*no change*
[g] ⟨g⟩	∅ ⟨ ⟩	[ŋ] ⟨ng⟩	*no change*
[f] ⟨ff⟩	*no change*	*no change*	*no change*
[s] ⟨s⟩	*no change*	*no change*	*no change*
[x] ⟨ch⟩	*no change*	*no change*	*no change*
[h] ⟨h⟩	*no change*	*no change*	*no change*
[m] ⟨m⟩	[v] ⟨f⟩	*no change*	*no change*
[n] ⟨n⟩	*no change*	*no change*	*no change*
[ɬ] ⟨ll⟩	[l] ⟨l⟩	*no change*	*no change*
[r̥] ⟨rh⟩	[r] ⟨r⟩	*no change*	*no change*
[j] ⟨i⟩	*no change*	*no change*	*no change*

SM voices voiceless stops and liquids, spirantizes [b, d, m], and deletes [g]. SM does not affect voiceless fricatives, [n], or [j]. NM converts voiceless stops[16] into voiceless nasals and voiced stops into plain nasals; it does not affect other sounds. AM converts voiceless stops into fricatives and does not affect other sounds.

16 Phonetic evidence (e.g. Ball 1984, Jones 1984) shows that aspiration rather than voicing is the most consistence difference between the stops usually referred to as “voiceless” and “voiced” in Welsh. As a result, many researchers assume that Welsh stops contrast phonologically for [spread glottis] rather than [voice]. Among these researchers is Gnanadesikan (1997), who transcribes the Welsh stops as [p^h t^h k^h] versus [p t k]. To avoid confusion, when discussing her work below I will modify her transcription to [p^h t^h k^h] versus [b̥ d̥ g̊]. Elsewhere in this chapter, however, I will use the more traditional transcription of [p t k] versus [b d g]. For Gnanadesikan’s analysis it is crucial that the difference be one of aspiration; for my analysis either interpretation will do.

Consonant mutations are found in the other Insular Celtic languages as well: Scots Gaelic, Breton, Cornish, and Manx (discussed below).

The environments in which the various mutations are found are not phonological but morphosyntactic. Most cases of mutation are found on a lexical word either when this is preceded by a function word (proclitic-triggered mutation) or when it occurs in a specific syntactic environment (syntax-triggered mutation). The environments for the mutations are extremely varied, arbitrary, and unpredictable, and are often subject to dialectal variation.

In (19) above, we saw that nouns are mutated after many possessive pronouns in both Irish and Welsh. Other environments where mutations are encountered in these two languages include those listed in (22).

(22) Some environments of mutation in Irish and Welsh.

a. Nouns after the definite article (varying according to gender and number in both languages and according to case in Irish)
b. Nouns after prepositions (different prepositions having different mutation effects)
c. Nouns after numbers (partially varying according to gender in Welsh)
d. Attributive adjectives after nouns (varying according to gender and number in both languages and according to case in Irish)
e. Verbs after preverbal particles (different particles having different mutation effects)
f. Verbs without preceding particle (past, imperfect, and conditional tenses in Irish; interrogative and negative forms, sporadically also positive forms, in Welsh)
g. Vocatives (with a particle in Irish, without one in Welsh)
h. Definite NPs used genitivally in Irish
i. Nouns after a c-commanding or sister XP in Welsh

We will encounter examples of these throughout this chapter; the interested reader may refer to any good grammar book (e.g. Christian Brothers 1960, for Irish; King 1993 and Thorne 1993 for Welsh) for more detailed discussion with examples.

In the next section, we will contrast two lenition processes in Manx, one that is clearly phonologically triggered, and one that is morphosyntactically triggered.

3.3.2 Manx

3.3.2.1 Morphosyntactically triggered lenition

Manx (Jackson 1955, Broderick 1984–86), a now extinct[17] close relative of Irish, had a single initial consonant mutation, namely lenition, which was however only sporadically used in the spoken language, and mostly only in fixed expressions. The original effects (as attested primarily in Literary Manx) of this morphosyntactically triggered lenition (abbreviated ML) are comparable to those of Irish illustrated above in (20); the effects in Manx are shown in (23).

(23) Effects of ML in Manx

Radical	Lenition
p	f
t, t′	h∼x, h∼x′
k, k′	h∼x, h∼x′
b	w∼v
d, d′	ɣ, j
g, g′	ɣ, j
f	∅
s, s′	h, h∼x′
m	w∼v
n, n′	*no change*
l, l′	*no change*
r	*no change*
vowel	*no change*

17 The last native speaker of Manx died in 1974; the last seminative speaker in 1985.

The environments where ML is found in Manx are also largely comparable to the environments where lenition is found in Irish, although in the late spoken language lenition was probably absent more often than present in most of these environments.

(24) Some environments of ML in Manx

a. feminine singular nouns after the definite article

ən vedn	'the woman'	(bedn)

b. nouns after certain (not all) possessive pronouns

mə xre:wən	'my bones'	(kre:wən)

c. nouns after certain numerals

de: fe:t′s′ə	'two children'	(pe:t′s′ə)

d. nouns after certain prepositions

də ɣulis′	'to Douglas'[18]	(dulis′)

e. dative singular nouns after article

sə xa:rt	'in the cart'	(ka:rt)

f. adjectives after feminine singular nouns

iris′ vai	'good weather'	(mai)

g. verbs in the past tense

vris′	'broke'	(bris′)

An OT analysis assuming that ML is part of the phonology of Manx would have to show that there are circumstances under which the unfaithful correspondence relationships /b/ ℜ [v], /k/ ℜ [x], /p/ ℜ [f], /d/ ℜ [ɣ], /m/ ℜ [v], etc., are more harmonic than the faithful relationships /b/ ℜ [b], etc., as well as other possible unfaithful relationships including /d/ ℜ [ð] and /t/ ℜ [θ]. In principle, such an analysis could probably be made to work, but, as we shall see in the next section, it will be difficult to maintain in the light of the phonologically triggered (specifically, intervocalic) lenition also found in Manx.

18 Douglas is the capital and largest town of the Isle of Man.

3.3.2.2 Phonological lenition

The phonology of late spoken Manx included a variable process of intervocalic lenition of obstruents.[19] Voiceless obstruents were voiced and stops (whether originally voiced or voiceless) were spirantized; underlyingly voiceless stops could undergo both changes. The effects of this process, which I will call phonological lenition or PL, are shown in (25) and examples are shown in (26). Crucially, the effects of PL are different from the effects of ML, with the exception of the voiced stops. While under ML voiceless stops remain voiceless but must become fricatives, under PL voiceless stops must become voiced but may remain stops. Also the fricatives [s, x] become voiced under PL, while under ML [s] debuccalizes to [h] and [x] is not affected.

(25) Effects of phonological lenition (PL) in Manx (domain: word-internal V_V; optional)

p > b~ v	b > v	
t > d~ð	d > ð	s > ð~z
k > g~ɣ	g > ɣ	x > ɣ~h~∅

(26) Examples of intervocalic PL

tapi ~ tabi ~ tavi	‘quick’
bratag ~ bradag ~ braðag	‘flag’
fi:kəl ~ fi:gəl ~ fi:ɣəl	‘tooth’
t′ibərt ~ t′ivərt	‘a well’
edən ~ eðən	‘face’
rugət ~ ruɣət	‘born’
pre:sən ~ pre:zən ~ pre:ðən	‘potatoes’
le:xən ~ le:ɣən ~ le:hən ~ le:ən	‘days’

The first problem encountered in an analysis of PL is the variability of the process. Boersma (1998) has argued that free variation is analyzable in terms of stochastic constraint ranking, where each constraint has a range along a spectrum in

19 There are some examples of /b/ and /d/ being spirantized in word-initial position as well.

which it applies. If two constraints are close to each other, their ranges may overlap, resulting in variable ranking between them: when constraint A and constraint B overlap, sometimes the ranking will be A ≫ B and sometimes it will be B ≫ A. A full analysis of PL would have to take the variation into consideration, but the point of this chapter is not to analyze PL but rather to show that only PL but not ML is part of the phonology of Manx. Therefore, for the sake of simplicity I will assume a variety of Manx where only the voiced fricative outputs are optimal.

Assuming that voiceless stops in the input correspond to voiced fricatives in the output when in intervocalic position, the constraints necessary to an analysis are the faithfulness constraints on voicing IDENT(voi), on continuity IDENT(cont), and on place IDENT(lab), IDENT(cor), IDENT(dor), as well as the markedness constraints *V[−voi]V (no voiceless sound between two vowels) and *V[−cont]V (no non-continuant sound between two vowels). As shown in (27)–(29), the faithfulness constraints for place are high ranking, as are the two markedness constraints. The faithfulness constraints for voicing and continuancy are ranked low.

(27) Markedness outranks faithfulness in Manx PL, from [tavi]

/tapi/	IDENT (lab)	*V[−voi]V	*V[−cont]V	IDENT (voi)	IDENT (cont)
tapi		* !	*		
tabi			*!	*	
☞ tavi				*	*
tafi		* !			*
tahi	* !	*			*

Since coronals are not debuccalized under PL, as they are under ML, the high rank of IDENT(cor) in Manx phonology is established, as shown in (28)–(29).

(28) /t/ → [ð] not [h] in PL (cf. /t/ → [h] in ML)

/bratag/	IDENT (cor)	*V[−voi]V	*V[−cont]V	IDENT (voi)	IDENT (cont)
bratag		* !	*		
bradag			* !	*	
☞ braðag				*	*
brahag	* !	*			*

(29) /d/ → [ð] not [ɣ] in PL (cf. /d/ → [ɣ] in ML)

/edən/	IDENT(cor)	*V[−cont]V	IDENT(cont)
edən		* !	
☞ eðən			*
eɣən	* !		*

In the case of [s], the constraint *V[−cont]V is irrelevant since it is not violated by the candidate that is completely faithful to the input. The result is that no plausible candidate will violate it either, so that IDENT(cont) becomes irrelevant as well. What is interesting in this case is the apparent free variation between [ð] and [z] in the output. As mentioned above, a convenient method of analyzing free variation in OT is through stochastic constraint ranking. In the case at hand, we may say that a markedness constraint banning [ð] and one banning [z] from appearing in the output are found so close to each other on the ranking continuum that they overlap; sometimes *ð outranks *z, and sometimes *z outranks *ð. The ranking of these two with respect to the other constraints cannot be determined; in (30) they have been placed at the bottom of the hierarchy for convenience, but in fact they could be placed at the top or in the middle without affecting the analysis. They are separated with a wavy line to indicate that they overlap in the ranking. The other crucial constraints are IDENT(cor), preventing debuccalization or any other change in place of articulation, *V[−voi]V, prohibiting the most faithful candidate [preːsən] from surfacing, and IDENT(voi), which both optimal candidates violate equally and which therefore cannot decide between them. Once again, the absence of debuccalization is crucial, as it shows the high rank of IDENT(cor) in Manx phonology.

(30) /s/ → [z] or [ð] not [h] in PL (cf. /s/ → [h] in ML)

/preːsən/	IDENT(cor)	*V[−voi]V	IDENT(voi)	*ð	*z
preːsən		* !			
(☞) preːzən			*		*(!)
(☞) preːðən			*	*(!)	
preːhən	* !	*			

The process of PL in Manx is clearly and uncontroversially phonological. Both of its effects, voicing and spirantization in intervocalic position, are cross-linguistically well attested, and above all, the process affects natural classes in a uniform way. The same cannot be said for ML.

3.3.2.3 An attempt at a phonological analysis of ML

A derivational analysis of ML could follow the analyses of Ní Chiosáin (1991), Swingle (1993), and Grijzenhout (1995) for Irish and of Ball and Müller (1992) and Pyatt (1997) for Welsh in proposing a set of rules effecting the changes seen in (23). Since derivational rules are allowed to be arbitrary and to be free from phonetic grounding or universal markedness considerations, nothing specific need be said about the triggers for such rules. But in an OT analysis one would have to posit something specific in the input that triggers the mutation; the output with the mutation must be shown to be more harmonic than an alternate candidate with the radical form. The most obvious choice for that something specific in the input is a floating autosegment, as proposed by Lieber (1987). Kibre (1995) does just this as a first approximation, but ultimately argues that the analysis is insufficient and that a combination of rules and OT constraints is necessary to analyze the mutations of Welsh. Gnanadesikan (1997), whose focus is not on the triggers of the mutations but rather on the representation of the phonology of Irish mutations, also assumes a morpheme consisting of a floating scale value (taking the place of traditional privative or binary features) as the trigger of that mutation. Translating these accounts into an analysis of ML in Manx, one might assume an underspecified morpheme L that contains at least the feature [+cont] (or maybe some sort of scale value as Gnanadesikan argues for Irish); this morpheme appears in ML environments and coalesces with the initial consonant of the stem to cause the changes shown in (23).

The constraint MorphReal requires the distinct realization of a morpheme; it makes the following requirements (Gnanadesikan 1997, 57):

(31) MorphReal
A morpheme must be realized by fulfilling one of the following conditions:
a. the output affixed form contains at least one segment not in the unaffixed form, and that segment(s) is coindexed with a segment(s) in the affix's input;
b. the output affixed form contains a segment which is coindexed with the affix's input and that segment has a scale (or feature) value contained in the affix's input but not in the unaffixed form;
c. the output affixed form contains a segment which is coindexed with the affix's input and that segment has a scale value adjacent to that of the affix's input. That value does not occur in the unaffixed form.

MorphReal is violated by the first candidate in (32) because the morpheme /L/ is not present in the output in a way that is distinct from the radical form of [bedn]. The winning candidate coalesces /L/ and /bedn/ into [vedn].

(32) Lenition trigger as a morpheme L

/ən L bedn/	MorphReal	Ident(cont)
ən bedn	* !	
☞ ən vedn		*

Alternatively, the trigger might be not an independent morpheme /L/ but instead a floating autosegment at the right edge of the definite article, whose input would then be not /ən/ but /ənL/. In this case, L would be almost like a segment, except that it has no root node and consists only of the features necessary to trigger ML (either [+cont], or under Gnanadesikan's theory, a scale value). The constraint ruling out *[ən bedn] would then be not MORPHREAL but rather MAX(L).

(33) Lenition trigger as an autosegment at the right edge of a morpheme

/ənL bedn/	MAX(L)	IDENT(cont)
ən bedn	* !	
☞ ən vedn		*

There are a number of arguments against both of these analyses. In §3.3.3 I discuss some of the arguments against such an analysis for Celtic mutations in general; one argument that is specific to Manx is the fact that we are confronted with a ranking paradox. Above in (29) we saw that IDENT(cor) crucially outranks *ð in PL, but since /d/ becomes [ɣ] under ML, the opposite ranking must hold here, as shown in (34).

(34) Ranking paradox: IDENT(cor) ≫ *ð in (29) but *ð ≫ IDENT(cor) here

/də L_1 $d_2$ulis′/	MORPHREAL	*ð	IDENT(cor)	IDENT(cont)
də $d_{1,2}$ulis′	* !			
də $ð_{1,2}$ulis′		* !		*
☞ də $ɣ_{1,2}$ulis′			*	*

Because the PL facts show that Manx does tolerate [ð] in the output, there is no good reason why a process that changes noncoronal stops into the corresponding fricatives should remove the coronality of /d/. As for /t/, we do not expect it to have the same output under ML (which respects input voicing specifications) as under PL (whose outputs are always voiced), but nevertheless debuccalization of /t/ to [h] appears phonologically unmotivated. According to Broderick (1984–86, 3:5), Manx has surface [θ] as an optional allophone of /t/ after /s/ in word-medial position, e.g. [sa:stən~sa:sθən] 'England', [fa:sti~fa:sθi] 'shelter', implying that there is no blanket prohibition on output [θ] in Manx. Why then should [θ] not be the ML correspondent of /t/? Arguments that ML (but not PL) must be "structure-preserving" (i.e. that it cannot produce sounds that are outside the phonemic inventory of Manx) fail because ML does produce [ɣ], which is not a phoneme of Manx.

Unlike the other Celtic languages, Manx has a phonological lenition whose effects, as we have seen in this section, have serious repercussions on any phonological analysis of ML. A ranking paradox arises if we try to generate both PL and ML from the same constraint ranking. Only PL is clearly an interaction of markedness and faithfulness. An OT-phonological analysis of ML must allow faithfulness to be violated without an improvement in markedness, a situation that is not supposed to occur if the strongest version of the OT phonology hypothesis is correct. As we see in the next section, there are equally strong reasons from other Celtic languages to believe that the mutations are not phonological processes.

3.3.3 Why the mutations cannot be phonological at all

Not only are the environments of the mutations nonphonological, the mutation processes themselves cannot convincingly be analyzed as phonological either. First of all, there is no feature or bundle of features that can effect the wide variety of alternations found within a single mutation. Secondly, in the case of mutations triggered by syntactic position, a phonological account depends on the assumption of a segmentally empty morpheme containing the mutation-triggering features, but in such cases there is almost never independent evidence for the existence of such a morpheme. Rather, morphemes must be posited for no other reason than to "explain" the occurrence of a mutation. Thirdly, mutations are sometimes triggered by proclitics that are not adjacent to the word undergoing mutation. Finally, mutations are subject to a variety of lexical exceptions and irregularities that are inconsistent with a phonological analysis.

3.3.3.1 Phonological models of mutations

The first major problem a phonological account of the mutations encounters is the wide variety of changes triggered. Irish lenition, for example, turns oral stops and /m/ (but not /N/) into fricatives, debuccalizes coronal obstruents, "laxes" tense coronal sonorants, and deletes /f/.[20] What feature(s) could cause these changes? [+continuant] alone will trigger only the spirantization, not the debuccalization, sonorant laxing[21], or f-deletion. [−coronal] could conceivably account for the debuccalization of coronals, but the majority of researchers on distinctive features (Sagey 1986, McCarthy 1988, Hume 1992, Clements and Hume 1995) agree that [coronal] is actually a privative feature with no minus value. If a case can be made that what distinguishes /L, N/ from /l, n/ is the feature [tense] (as assumed, for example, by Ó Siadhail and Wigger 1975, 115–16 and Ó Siadhail 1989, 92–95), then [−tense] could account for the sonorant laxing, but not the other cases. And it is difficult to conceive of any feature that could be added to /f/ to induce deletion. Unlike truly phonological processes (PL in Manx, for example), the mutations do not target natural classes of sounds or have uniform effects. Neither do they improve markedness, as the strong OT phonology hypothesis predicts phonological processes should when faithfulness is violated.

The ternary scale theory of Gnanadesikan (1997) is a bit more promising, but also runs into serious difficulties. According to Gnanadesikan, the properties of inherent voicing and consonantal stricture are determined not by binary features but rather by ternary scalar values. Thus, on the inherent voicing scale, voiceless obstruents are marked [IV1], voiced obstruents

20 This section abstracts away from palatalization in Irish: /m/, /N/, /f/, etc., should be understood to include /m′/, /N′/, /f′/, etc.

21 Lenited [l, n] are still [−continuant], showing that [+continuant] cannot be argued to be a consistent feature of lenition.

[IV2], and sonorants [IV3], as shown in (35)a. On the consonantal stricture scale, stops are marked [CS1], fricatives and liquids [CS2], and vocoids and laryngeals [CS3], as shown in (35)b.

(35) Ternary scales (Gnanadesikan 1997)

a. Inherent voicing (IV) scale

[IV1]	[IV2]	[IV3]
Voiceless obstruents	Voiced obstruents	Sonorants

b. Consonantal stricture (CS) scale

[CS1]	[CS2]	[CS3]
Stops	Fricatives and liquids	Vocoids and laryngeals

Gnanadesikan analyzes Irish eclipsis as a process increasing by 1 the radical consonant's value on the IV scale, if possible.

(36) Irish eclipsis as a chain shift on the IV scale (Gnanadesikan, 1997)

Radical [IV1]	Eclipsed [IV2]	Radical [IV2]	Eclipsed [IV3]
p	b	b	m
t	d	d	ɴ
k	g	g	ŋ
f	v		

Gnanadesikan also analyzes Welsh NM as involving a shift on the IV scale, but rather than a simple chain shift, all [IV1] stops become [IV3] nasals, while retaining their underlying aspiration.

(37) Welsh NM as a shift to 3 on the IV scale (Gnanadesikan, 1997)

Radical [IV1]	NM [IV3]	Radical [IV1]	NM [IV3]
p^h	m^h	b̥	m
t^h	n^h	d̥	n
k^h	$ŋ^h$	g̊	ŋ

Gnanadesikan considers Irish lenition to be a chain shift on the consonantal stricture scale: [CS1] stops become [CS2] fricatives, while [CS2] /s/ becomes [CS3] [h].[22] She attributes the exceptional change of [CS1] /t/ to [CS3] [h] to a high-ranking prohibition on the sound [θ]. A similar prohibition on [ð] is used to account for the lenition of /d/ to [ɣ]. Gnanadesikan acknowledges that her analysis provides no explanation for the deletion of /f/ under lenition, and leaves the question open.

(38) Irish lenition as a chain shift on the CS scale (Gnanadesikan, 1997)

Radical [CS1]	Lenited [CS2]	Radical [CS2]	Lenited [CS3]
p	f	s	h
t	h [CS3]		
k	x		
b	v		
d	ɣ		
g	ɣ		
m	v		

The lenition of the "tense" sonorants /N L/ to [n l] in some Irish dialects is attributed by Gnanadesikan not to a ternary scale but to a vaguely stated "decrease in length or tension" that is characteristic of lenition mutations cross-linguistically. This "decrease in length or tension" is, according to Gnanadesikan, also responsible for the changes /ɬ r̥/ → [l r] and /p^h t^h k^h/ → [b̥ d̥ g̊] under SM in Welsh, neither of which involves a shift along a ternary scale. Gnanadesikan does not discuss the remaining parts of SM in Welsh, in which the labial and coronal voiceless unaspirated stops, as well as /m/, become voiced fricatives (/b̥ d̥/ → [v ð], /m/ → [v]) while the dorsal stop deletes (/g̊/ → ∅). Presumably, her analysis would have /b̥ d̥/ shifting on both the IV scale and the CS scale, and /m/ shifting

22 The Welsh AM, involving /p^h t^h k^h/ → [f θ x], can also be seen as a shift on the CS scale, though Gnanadesikan does not explicitly discuss AM.

on the CS scale; high-ranking prohibitions on [ɣ] and [ɦ] would account for the deletion of /g̊/.

Gnanadesikan's analysis of the mutations of Irish is concerned with presenting a unified explanation of the seemingly very different outcomes of lenition. Her analysis is weakened by its inability to explain why the lenition of /f/ is ∅ rather than, say, [h]; indeed this inability mars most phonological accounts of lenition, including that of Ní Chiosáin (1991), who simply stipulates f-deletion by rule. But the dialects involving lenition of /N L/ to [n l] present a more serious difficulty, as it is not possible to present lenition as a unified process for them. Thus, Gnanadesikan's analysis ultimately does not provide quite as unified a picture as one might have hoped, as shown in (39).

(39) Summary of Irish lenition according to Gnanadesikan (1997)

p t k b d g m s → f h x v ɣ ɣ v h	Increase by 1 on the CS scale where possible, otherwise increase by 2
N L → n l	"Decrease in length or tension"
f → ∅	No explanation

Welsh SM is even more of a mixed bag; the goal of achieving a unified analysis is not even approximated. Indeed, Gnanadesikan does not discuss Welsh SM at any length herself, so it is difficult to know how she would account, for example, for the immunity of /f/ to SM in Welsh: since both the IV and the CS scales are otherwise involved in SM, and since [v] is an occurring sound in Welsh, her theory (and probably any phonological theory of SM) predicts the mutation of /f/ to [v], which does not occur. (The fact that /s/ does not change could be attributed to a high-ranking constraint against [z], which does not occur in Welsh except in unassimilated loanwords.) A summary of Welsh SM according to Gnanadesikan's theory is shown in (40).

(40) Summary of Welsh SM according to Gnanadesikan's theory

p^h t^h k^h ɬ r̥ → b̥ d̥ g̊ l r	"Decrease in length or tension"
b̥ d̥ g̊ → v ð ∅	Increase by 1 on both IV and CS scales; prohibition on [ɣ] and [ɦ]
m → v	Increase by 1 on the CS scale
f *unchanged*	No explanation?

Thus, appealing as Gnanadesikan's theory may seem at first, in fact it does not really provide a unified phonological explanation of the changes found in Celtic mutations, and provides no explanation at all for the behavior of /f/ in either Irish or Welsh.

In the next sections we will examine the various environments of the mutations and show that the predominant assumption about their triggers, namely that floating autosegments coalesce with initial consonants to cause the mutations, cannot be supported. In most cases there is no independent evidence for the existence of the morphemes these floating autosegments are supposed to represent. Furthermore, there are so many irregularities and exceptions to mutations, both on the part of the triggers and on the part of the targets, that an analysis operating within the strict bounds of phonological theory simply falls apart.

3.3.3.2 Syntactically triggered mutations

Analyses that assume a segmentally empty morpheme to trigger mutations are plagued by the inability to provide independent evidence for the morpheme proposed. This is most noticeably the case in mutations that are triggered by syntactic position rather than by an overt proclitic. As shown in (41), attributive adjectives in the nominative/accusative case in Irish are lenited when they modify a feminine singular noun ((41)a); this will be known in what follows as "condition (i)." Adjectives are not lenited, however, when they modify a masculine singular noun ((41)b). When adjectives modify a plural noun they are lenited only if the noun ends in a palatalized consonant ("condition (ii)"); if more than one adjective is present only the first is lenited ((41)b). If the plural noun does not end in a palatalized consonant the adjective is not lenited ((41)d).

(41) Irish lenition of attributive adjectives in the nominative/accusative case

a. Condition (i): After a feminine singular noun
bean **mh**ór **dh**ubh (mór, dubh)
woman big dark
'a big dark woman'

b. Condition (ii): After a plural noun that ends in a palatalized consonant (C′)
fir **mh**óra **d**ubha (fir = [f′ir′]) (móra)
*men big:*PL *dark:*PL
'big dark men'

c. No lenition after a masculine singular noun
fear **m**ór **d**ubh
man big dark
'a big dark man'

d. No lenition after a plural noun that does not end in a palatalized consonant
mná **m**óra **d**ubha
*women big:*PL *dark:*PL
'big dark women'

It is virtually impossible to conceive of a functional element that could be found in the lenition environments of (41): what morpheme could be found in these syntactic positions? Even if an argument could be made for the existence of such an element, there is no independent evidence for it: the only evidence for the presence of a morpheme is the lenition the morpheme has been invented to explain, and the analysis is nothing more than begging the question.

The exact same point can be made for the syntactically triggered lenition in (42). Definite noun phrases in a genitival function undergo lenition, regardless of whether they are morphologically in the genitive case ((42)a) or not ((42)b).

(42) Irish lenition of genitival definite noun phrases

a. muintir **Sh**eáin (Seáin)
family S.:GEN
'Seán's family'

b. mac [**fh**ear an tí] (fear)
son man the house:GEN
'the son of the man of the house; the landlord's son'

Once again, even if we were to argue that there is, for example, a segmentless preposition meaning 'of' in these phrases, there is no independent evidence for it, and we have merely invented an ad-hoc construct that explains nothing.

One of the most contentious mutations among Celtic syntacticians is the Welsh SM commonly called "direct object mutation" illustrated in (43). As shown in (43)a, the direct object of a finite verb undergoes SM, while as shown in (43)b, there is no SM when the verb is nonfinite (examples from Tallerman 2006).

(43) Welsh direct object mutation

a. Prynodd y ddynes **f**eic. (beic)
bought:3SG the woman bike
'The woman bought a bike.'

b. Roedd y ddynes yn prynu **b**eic.
was the woman PROG buy:NONFIN bike
'The woman was buying a bike.'

There are two major schools of thought on this problem. Some researchers (e.g. Zwicky 1984, Roberts 1997) have argued that the SM in (43)a is a manifestation of accusative case (which is otherwise not morphologically indicated in Welsh, not even on pronouns as in English), the idea being that the object of a nonfinite verb is not in the accusative. Roberts (2005) argues that the trigger is a floating-autosegment morpheme located in *v* (a functional head preceding VP, in the Spec position of which the direct object is found).

Other researchers (e.g. Harlow 1989, Borsley and Tallerman 1996, Tallerman 1998, 1999, 2006, Borsley 1997, 1999) have pointed out a number of problems with the case-based analysis and have argued that the SM is triggered instead by a preceding c-commanding phrase or phrasal sister. This suggestion is known as the XP Trigger Hypothesis (XPTH). The evidence for the XPTH comes from the following facts: the direct object of a nonfinite verb *is* lenited when it is separated from the verb by another phrase like a prepositional phrase or adverbial phrase. Compare the absence of SM in (43)b with its presence in (44).

(44) Direct object of verbal noun lenited after PP or AdvP

a. Yr oedd Prŷs yn rhagweld [$_{PP}$ yn 1721] **d**ranc
PRT was PROG foresee:NONFIN in death

yr iaith Gymraeg. (tranc)
the language Welsh
'Prŷs foresaw in 1721 the death of the Welsh language.'

b. yn ffaelio [$_{AdvP}$ 'n glir lân] **dd**yscu 'r
PROG fail:NONFIN PRED completely learn:NONFIN the

gelfyddyd (dyscu)
art
'completely failing to learn the art'

There are also cases where a noun or verbal noun that cannot be in the accusative is lenited after a phrase in a marked word order, as shown in (45).

(45) SM after a phrase in a marked word order

a. Mae [$_{PP}$ yn yr ardd] **g**i. (ci)
is in the garden dog
'There's a dog in the garden.'

b. Mae chwant [$_{PP}$ arnaf i] **f**ynd adref. (mynd)
is desire on:1SG me go:NONFIN home
'I want to go home.'

c. Erfyniodd [$_{PP}$ arnaf i] **f**ynd gydag ef. (mynd)
begged:3SG on:1SG me go:NONFIN with him
'He begged me to go with him.'

The nonfinite verb of an embedded complement clause is lenited after its subject, as shown in (46).

(46) SM of a nonfinite verb after its subject

a. Mae Aled yn awyddus i Rhys **f**ynd adref. (mynd)
is PRED eager to go:NONFIN home
'Aled is eager for Rhys to go home.'

b. Wrth i Aled **dd**od allan, mi aeth Mair i mewn.
as to come:NONFIN out PRT went:3SG in (dod)
'As Aled came out, Mair went in.'

The subject of a sentence lenites whatever follows it, as shown in (47). This instance also subsumes the SM in (43)a. Note in (47)b and d that even the negative particle *dim* can be lenited, proving that not only nouns are subject to this syntactically triggered SM.

(47) SM after the subject

a. Gall y dyn **dd**reifio 'r car. (dreifio)
can the man drive:NONFIN the car
'The man can drive the car.'

b. All y dyn **dd**im dreifio 'r car. (dim)
can the man NEG drive:NONFIN the car
'The man can't drive the car.'

c. Gwnaeth Aled **w**eld y ffilm. (gweld)
did:3SG see:NONFIN the film
'Aled saw the film.'

d. Gwnaeth Aled **dd**im gweld y ffilm. (dim)
did:3SG NEG see:NONFIN the film.
'Aled didn't see the film.'

Not only overt NP subjects but also *pro* and wh-trace trigger SM, as shown in (48) (examples from Borsley and Tallerman 1996).

(48) SM after *pro* and wh-trace

a. Gwelodd *pro* **dd**raig. (draig)
saw:3SG dragon
'S/He saw a dragon.'

b. Pwy a welodd *t* **dd**raig? (draig)
who PRT *saw:3SG dragon*
'Who saw a dragon?'

The conclusion that Tallerman and Borsley come to is that SM is triggered simply by the presence of a preceding XP, not by a functional morpheme like *v*. Even silent morphemes like *pro* and wh-trace can trigger SM when they are case marked. (Non-case-marked silent morphemes like PRO and NP-trace do not trigger SM.) Crucially, when *pro* and wh-trace trigger mutation, they do so because they are filling the role of an NP, not because they carry any autosegmental floating features. This conclusion supports the contention of this chapter that mutations are not triggered by silent morphemes consisting solely of floating features, but rather by lexical or syntactic properties of the elements that govern them.

Hannahs (1996) reinterprets the XPTH in terms of prosodic phonology; specifically, he argues that it is not the syntactic phrases themselves that trigger mutation in examples like (43)–(48), but rather the phonological phrase (whose boundaries depend on syntactic information). Under his analysis, mutation occurs at the beginning of a phonological phrase (ϕ) preceded by another phonological phrase within the same intonational phrase (I). However, while this analyis may succeed in stating the environment where Welsh "direct object mutation" is found, it says nothing at all about *why* the mutation is found there. In optimality theoretic terms, why are the unfaithful correspondence relationships /t/ $\Re$ [d], /d/ $\Re$ [ð], /g/ $\Re$ [$\emptyset$], etc., more harmonic than the faithful /t/ $\Re$ [t], /d/ $\Re$ [d], /g/ $\Re$ [g], etc., in the environment $_{I}[\ _{\phi}[\ldots]\ _{\phi}[\_\ldots]]$? In addition, it is not clear that sentences like *Gwelodd **ddraig*** 's/he saw a dragon' and *Gwelwyd **draig*** 'a dragon was seen' have different prosodic structures. Moreover, the analysis is clearly not transferable (as Hannahs freely admits) to other types of mutation, such as those in (19) and (22)a–g. So even if this one type of mutation does have a phonological rather than morphosyntactic environment (and independent evidence, for example from stress and intonation, has not been presented to confirm Hannahs's hypothesis), it is clear that not all Celtic mutations in general do, and an analysis that covers all instances of mutation in all the Celtic languages is preferable to one that covers only one instance of mutation in only one language.

3.3.3.3 Nonadjacency

There are a number of cases of mutation triggered by a proclitic that is not adjacent to the word undergoing the mutation. For example, in Irish, when a noun is governed both by a possessive pronoun and by *dhá* [ɣa:] 'two', it is the pronoun that determines the mutation. Without a possessive pronoun before, *dhá* always causes lenition.[23] In (49)a–c, both the pronoun and the numeral independently cause lenition, so we cannot tell which is triggering lenition when both occur together. But in (49)d we see that the pronoun triggers the radical form, even when the numeral intervenes. If *dhá* were to end in a floating lenition-triggering autosegment, we have no explanation for why lenition is blocked here. It is the pronoun that determines the mutation or nonmutation of the noun, even when the pronoun is not adjacent to the noun. This is made even more clear in (49)e–g, where the pronoun triggers eclipsis and the numeral lenition. Once again, it is the nonadjacent pronoun rather than the adjacent numeral that determines the mutation of the noun.

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23 A similar pattern in seen in Breton with the adjective *holl* 'all, whole': by itself, *holl* triggers lenition on a following noun, but if a possessive pronoun precedes *holl*, it is the possessive pronoun that determines the mutation of the noun (Stump 1988).

(49) Possessive pronoun + *dhá* + noun (Irish)

a.	mo **mh**ala	'my eyebrow'	(mala)
	dhá **mh**ala	'two eyebrows'	
	mo dhá **mh**ala	'my two eyebrows'	
b.	do **ch**éaslaidh	'your (sg.) paddle'	(céaslaidh)
	dhá **ch**éaslaidh	'two paddles'	
	do dhá **ch**éaslaidh	'your (sg.) two paddles'	
c.	a **gh**lúin	'his knee'	(glúin)
	dhá **gh**lúin	'two knees'	
	a dhá **gh**lúin	'his two knees'	
d.	a **s**úil	'her eye'	(súil)
	dhá **sh**úil	'two eyes'	
	a dhá **s**úil	'her two eyes'	
e.	ár **gc**uid	'our part'	(cuid)
	dhá **ch**uid	'two parts'	
	ár dhá **gc**uid	'our two parts'	
f.	bhur **dt**each	'your (pl.) house'	(teach)
	dhá **th**each	'two houses'	
	bhur dhá **dt**each	'your (pl.) two houses'	
g.	a **gc**loigeann	'their skull'	(cloigeann)
	dhá **ch**loigeann	'two skulls'	
	a dhá **gc**loigeann	'their two skulls'	

Nonadjacency effects are seen also where a preposition governs two nouns conjoined by *agus* 'and'. The conjunction itself does not trigger lenition, as shown by the phrase *sioc agus sneachta* (*shneachta) 'frost and snow', but when a leniting preposition like *trí* 'through' governs this phrase, both nouns are lenited: *trí **sh**ioc agus **sh**neachta* (*sneachta) 'through frost and snow'. If lenition were triggered by a floating autosegment at the right edge of the word *trí*, we would expect only the first noun to be mutated, but not the second noun as well. Nonadjacency is found also in cases where an English expletive like *fuckin'* is placed between a possessive pronoun and a noun. In this case, the mutation triggered by the pronoun skips over the expletive and affects the noun, e.g. *Cá bhfuil mo fuckin' **sh**eaicéad?* 'Where's my fuckin' jacket?' (Stenson 1990, 171). Again, if lenition were triggered by a floating autosegment at the right edge of *mo*, we would not expect lenition of *seaicéad*. (In English words, [f] resists lenition, so we do not expect **mo fhuckin' seaicéad*.)

3.3.3.4 Irregular behavior of triggers and targets

Finally, the large number of lexical exceptions and irregularities in mutation makes a purely phonological analysis implausible. These may be divided into two major classes: those where the mutation-triggering proclitic exhibits irregular behavior, and those where the target of mutation exhibits irregular behavior. There are examples of both kinds from both Irish and Welsh.

Irregular triggers in Irish

The first example of irregular behavior in mutation triggers comes from Irish numbers. In Irish, a noun after a number is usually in the singular form. The numbers three through six cause lenition of the noun, as shown in (50).

(50) Lenition of singular nouns after numbers 3–6

3	trí **ch**oiscéim	'three footsteps'	(coiscéim)
4	ceithre **gh**rád	'four degrees'	(grád)
5	cúig **ch**umhacht	'five powers'	(cumhacht)
6	sé **mh**í	'six months'	(mí)

However, certain nouns, mostly indicating measurements, regularly appear in the plural after numbers (in many cases there is a special plural form used *only* after numbers). If the noun is in the plural after a number, then there is no lenition after the numbers three through six.[24]

24 The numbers 7–10 trigger eclipsis regardless of whether the noun is in the singular or the plural.

(51) No lenition of plural nouns after numbers 3–6

3	trí **b**liana (*bhliana)	'three years'
4	ar do cheithre **b**oinn (*bhoinn)	'on all fours'
5	cúig **c**inn (*chinn)	'five (things, animals)'
6	sé **s**lata (*shlata)	'six yards'

If mutations are triggered by a floating autosegment at the right edge of the triggering proclitic, we cannot explain why lenition fails to appear when the noun is in the plural. Alternatively, it could be argued that a silent morpheme appears between numerals and singular nouns but not before plural nouns, but firstly such a morpheme is difficult to motivate on methodological grounds (why should a morpheme be expected in such a position?) and secondly there is no independent evidence for a morpheme, which would be invented solely to explain the mutation.

Another example of irregular trigger behavior comes from past tense verbs. Historical tenses (past, past habitual, and conditional) of regular verbs (and many irregular verbs) in Irish are characterized by lenition, regardless of whether a proclitic is present or not (cf. (52)a). A systematic exception to this generalization is the past tense of the so-called autonomous verb form (which has an impersonal or passive meaning), where the radical is found, again regardless of whether a proclitic is present or not (cf. (52)b). In the case of the personal forms, there is in fact evidence for a triggering proclitic: vowel-initial verbs are supplied with a preverb *d'* in historical tenses when no other preverb is present (cf. (52)c).[25] Thus a case could be made that there is a preverbal element before historical tense verbs which surfaces as *d'* before vowels and as lenition on consonants. Since *d'* is absent before vowel-initial past autonomous forms (cf. (52)d.i), the absence of lenition in (52)b.i is expected: the triggering particle is absent.

25 In old-fashioned literary style, and to some extent in older varieties of spoken Munster Irish, the full form *do* is found also before consonant-initial verbs.

(52) Mutation in the past tense in Irish

a. Lenition in personal forms

i.

bhris	mé	(bris)
*break:*PAST	*I*	

'I broke'

ii.

níor	**bh**ris	mé	(bris)
NEG-HIST	*break:*PAST	*I*	

'I did not break'

b. Radical in autonomous forms

i.

briseadh	an	chathaoir
*break:*PAST-AUT	*the*	*chair*

'The chair got broken'

ii.

níor	**b**riseadh	an	chathaoir
NEG-HIST	*break-*PAST-AUT	*the*	*chair*

'The chair did not get broken'

c. *D'* before vowel-initial personal forms in absence of other preverb

i.

d'	oscail	mé
HIST	*open:*PAST	*I*

'I opened'

ii.

níor	oscail	mé
NEG-HIST	*open:*PAST	*I*

'I did not open'

d. No *d'* before vowel-initial autonomous forms

i.

osclaíodh	an	doras[26]
*open:*PAST-AUT	*the*	*door*

'The door was opened'

26 Optionally also ***h**osclaíodh an doras* (cf. Ní Chiosáin 1991, 77). In general in Irish, vowel-initial nouns take a prothetic [h] after radical-triggering vowel-final proclitics like *na* 'the (nom. pl.)', *chomh* [xo] 'so', *go* 'to, until', *le* 'with', etc. Thus the pattern became established that vowel-initial words take prothetic [h] in environments where consonant-initial words take the radical form.

ii. níor *NEG-HIST* osclaíodh *open:PAST-AUT* an doras *the door*
'The door was not opened'

But a problem arises with (52)b.ii: the preverb *níor* triggers lenition ((52)a.ii) by itself; it is not followed by the *d'* preverb ((52)c.ii). If the mutation is to be represented as a floating autosegment at the right edge of *níor*, we predict *níor* to mutate autonomous forms as well, which it does not.

A third example of irregular behavior in a mutation trigger is the negative particle *cha* of the Ulster (northern) dialect of Irish. This particle triggers eclipsis of /t/, /d/, and vowels[27], leaves /s/ in the radical (which may be a vacuous application of eclipsis), but triggers lenition of noncoronal lenitable consonants, as shown in (53). This phenomenon is known as "mixed mutation."[28]

(53) Mixed mutation after *cha* in Ulster

a.	cha **dt**ugann	'does/will not give'	(tugann)
b.	cha **nd**éanaim	'I do/will not do'	(déanaim)
c.	cha**n** abróchainn	'I would not say'	(abróchainn)
d.	cha **s**ílfinn	'I would not think'	(sílfinn)
e.	cha **bh**íonn	'is not (habitual)/will not be'	(bíonn)
f.	cha **ch**reidim	'I do not believe'	(creidim)

The Ulster mixed mutation is even more complicated than any of the usual mutations: it voices /t/, nasalizes /d/ and vowels, spirantizes noncoronal stops, and deletes /f/, but does not

27 It is an orthographic convention that the prothetic [N] that vowels acquire under eclipsis is written at the end of *cha* rather than the beginning of the following word, hence *chan abróchainn* rather than *cha n-abróchainn* for 'I would not say'.

28 This is the pattern prescribed by Ó Dónaill (1977, s.v. *cha*), but in texts written in Ulster Irish (searched on the Tobar na Gaedhilge database, Ó Duibhín 2003) the usage is more variable, with eclipsis found not only on /t/ and /d/ but sometimes on other eclipsable consonants as well. In some texts, /d/ is left in the radical after *cha*.

affect /s/. It is highly improbable that a single feature or bundle of features, or scale value (Gnanadesikan 1997) can do all of that. And even if one could, why should *cha* be the only word where this feature (bundle) or scale value appears?

The Irish preposition *le* 'with' generally has no effect on a following consonant, but adds *h* to a following vowel, as shown in (54)a. However, before verbal nouns (in contexts expressing purpose, where it is more usually translated 'to'), it adds *n-* to a following vowel in some western dialects, as shown in (54)b (Finck 1899, 118, de Bhaldraithe 1953/1977, 293). The addition of *n-* to a vowel is usually a characteristic of eclipsis, but as shown in (54)c, *le* does not trigger eclipsis of consonant-initial verbal nouns.

(54) Mutation pattern of *le* 'with, to'

a. Generally has no effect on consonants but adds *h* to vowels

i.	le **t**onn	'with a wave'	
ii.	le **b**aladh	'with a smell'	
iii.	le **h**éirí na gréine	'at sunrise'	(éirí)
iv.	le **h**Art	'with Art'	(Art)

b. In western dialects, adds *n-* to vowel-initial verbal nouns to express purpose

i.	tada le **n-**ól	'nothing to drink'	(ól)
ii.	rud le **n-**ithe	'something to eat'	(ithe)
iii.	an mhéid le **n-**íoc	'the amount to pay'	(íoc)
iv.	mórán le **n-**insint	'much to tell'	(insint)

c. No effect on consonant-initial verbal nouns

Tugadh	an	corp	abhaile	le	**c**ur	é.
*bring:*PAST-AUT	*the*	*corpse*	*home*	*to*	*bury:*NONFIN	*it*

'The corpse was brought home to bury.'

Since *le* has a different effect on vowel-initial words depending on its usage, it is implausible to imagine that it ends in an empty segment that adds *h* to vowels, since there would be no explanation for the addition of *n-* in (54)b. Positing a morpheme that triggers eclipsis after *le* when it expresses purpose runs afoul of the fact that consonants are *not* eclipsed here ((54)c).

The Irish preposition *gan* 'without' has a very irregular mutation pattern. In general, it triggers lenition, as shown in (55)a. However, it fails to lenite nouns that are qualified ((55)b), or when it functions as the negation in a nonfinite clause ((55)c). It does not lenite the coronals /t, d, s/ (which is not surprising since coronals are usually blocked from leniting after other coronals: see Ní Chiosáin 1991), nor does it lenite /f/ (which is surprising as *gan* is the only leniting proclitic that fails to lenite /f/), except that it does lenite the word *fios* 'knowledge', as shown in (55)d. It does not lenite proper names, as shown in (55)e, although other leniting prepositions do lenite proper names (e.g. *ó* ***Mh****ícheál* 'from Mícheál').[29]

(55) Mutation pattern of *gan* 'without'

a. Generally triggers lenition

i. gan **ch**iall	'without sense; senseless'	(ciall)
ii. gan **mh**aith	'without good; useless'	(maith)
iii. gan **bh**réag	'without lie; indisputable'	(bréag)

b. No lenition when the noun is qualified

i. gan **b**réag ar bith	'without any lie at all; completely indisputable'
ii. gan **p**ingin ina phóca	'without a penny in his pocket'

c. No lenition when functioning as negation in a nonfinite clause

i. B' fhearr duit gan **c**orraí.
COP-COND *better for-you without move:*NONFIN
'It would be better for you not to move.'

ii. Abair leis gan **p**ósadh.
*say with-him without marry:*NONFIN
'Tell him not to marry.'

29 This contrasts with Welsh, where personal names generally fail to undergo mutation in *any* environment.

iii.	Mol	dó	gan	**p**ingin	a	chaitheamh.
	advise	*to-him*	*without*	*penny*	*to*	*spend:NONFIN*

‘Advise him not to spend a penny.’

d. No lenition of coronals or [f] (except *fios* ‘knowledge’)

i.	gan **t**eip	‘without fail’	
ii.	gan **d**abht	‘without a doubt; doubtless’	
iii.	gan **s**agart	‘without a priest’	
iv.	gan **f**reagra	‘without an answer’	
v.	gan **fh**ios	‘without knowledge, unknowing’	(fios)

e. No lenition of proper names

Tháinig tú gan **M**ícheál. ‘You came without Mícheál.’

The only failure of lenition in (55) that can be explained phonologically is that of (55)d.i–iii, where coronals fail to lenite after the [n] of *gan*. All the other cases where *gan* does not trigger lenition are unexplainable if we believe that *gan* contains a floating lenition-triggering autosegment at its right edge.

The preposition *ar* ‘on’ also generally triggers lenition, as shown in (56)a. However, unqualified phrases of location using *ar* have the radical form ((56)b), but once these same phrases are qualified, *ar* once again triggers lenition ((56)c).

(56) Mutation pattern of *ar* ‘on’

a. Generally lenites

ar **bh**ád	‘on a boat’	(bád)
ar **bh**ord	‘on a table’	(bord)
ar **ch**lé	‘on the left’	(clé)
ar **ch**untar	‘on condition’	(cuntar)

b. Radical in unqualified phrases of general location

ar **b**arr	‘on top’
ar **c**olba	‘on the outside’
ar **c**orr	‘on edge’
ar **m**uir	‘at sea’
ar **t**ír	‘on land’
ar **t**osach	‘in front’

c. Usually, lenition when phrases of location are qualified

ar **bh**arr an tí	'on the top of the house'	(barr)
ar **ch**olba na leapa	'on the side of the bed'	(colba)
ar **ch**orr an bhoird	'on the edge of the table'	(corr)
ar **Mh**uir Meann	'on the Irish Sea'	(muir)
ar **th**ír na hÉireann	'on the land of Ireland'	(tír)
ar **th**osach an tslua	'at the head of the crowd'	(tosach)

Similarly, the preposition *thar* 'over' does not mutate indefinite, unqualified nouns, as shown in (57)a, but once these same phrases are qualified, *thar* once again triggers lenition ((57)b).[30]

(57) Mutation after *thar* 'over'

a. Radical of indefinite, unqualified nouns

thar **d**roichead	'over a bridge'
thar **s**liabh	'over a mountain'

b. Lenition of qualified nouns

thar **dh**roichead na habhann	'over the bridge of the river'	(droichead)
thar **Sh**liabh an Iolair	'over Mount Eagle[31]'	(sliabh)

The peculiar mutation behavior of *ar* and *thar* is a strong argument against a phonological trigger analysis. If mutations are triggered by floating autosegments at the right edge of the triggering proclitic, we cannot explain why lenition fails to appear in cases like (56)b and (57)a. Alternatively, it could be argued that a silent lenition-triggering morpheme appears between these two prepositions and qualified nouns but not before unqualified nouns, but such a morpheme is particularly difficult to motivate in light of the mutation behavior of *gan*,

30 When *thar* means 'over' in the sense of 'more than' it does lenite indefinite, unqualified nouns: *thar **ph**ingin* 'over a penny', *thar **bh**liain* 'over a year', *thar **ch**úigear* 'over five people'.

31 A mountain on the Dingle Peninsula, County Kerry.

where the behavior of qualified and unqualified nouns is exactly the opposite ((55)a, b).

Irregular triggers in Welsh

Mixed mutation similar to that seen above in (53) for Ulster Irish is found also in Welsh, namely after the particles *ni* 'not', *na* 'not (relative)', and *oni* 'not (interrogative); if not'. As shown in (58), these particles trigger AM of voiceless stops and SM of voiced stops, voiceless liquids, and /m/.[32]

(58) Mixed mutation after *ni, na,* and *oni* in Welsh

a.	ni **ph**lesiai	'did not please'	(plesiai)
b.	oni **ch**lywodd	'has (he) not heard?'	(clywodd)
c.	ni **f**eiddiai	'did not dare'	(beiddiai)
d.	pam na **dd**ylai	'why shouldn't'	(dylai)
e.	oni **l**wydda	'unless (he) succeeds'	(llwydda)
f.	ni **r**aid	'there is no need'	(rhaid)
g.	na **f**eddylier	'do not think'	(meddylier)

Since this mixed mutation turns all stops into fricatives[33] (unlike regular SM which turns only voiced stops into fricatives) it might be tempting to assume here that *ni, na* and *oni* carry a floating [+cont] feature at their right edge, different from the usual trigger of SM. But this analysis still does not capture the voicing of /ɬ, r̥/ to [l, r], nor is it particularly satisfying in light of the fact that *ni, na,* and *oni* are the only particles that behave this way.

There are a number of environments in Welsh where obstruents and /m/ are lenited, but /ɬ, r̥/ remain in the radical. These environments include: feminine nouns after the definite article and after *un* 'one' ((59)a), adjectives after *cyn* 'as', *mor* 'so', and

32 In the spoken language, the particle *ni* itself is often omitted but its mutation effects remain. In some dialects, AM is moribund and usually replaced by SM.

33 Except /g/, which is deleted as usual under SM in Welsh.

pur 'quite' ((59)b), and nouns and adjectives after the predicative particle *yn* ((59)c).

(59) SM of consonants except /ɬ, r̥/ in Welsh

a. Feminine nouns after the definite article and after *un* 'one'

i.	y **g**yllell	'the knife'	(cyllell)
ii.	y **ll**ysywen	'the eel'	
iii.	un **f**erch	'one girl'	(merch)
iv.	un **rh**wyd	'one net'	

b. Adjectives after *cyn* 'as', *mor* 'so' and *pur* 'quite'

i.	cyn **w**ynned â	'as white as'	(gwynned)
ii.	cyn **ll**awned â	'as full as'	
iii.	mor **d**eg	'so fair'	(teg)
iv.	mor **rh**wydd	'so easy'	
v.	pur **dd**ieithr	'quite strange'	(dieithr)
vi.	pur **ll**wyddiannus	'quite successful'	

c. Adjectives and nouns after the predicative particle *yn*

i.	yn **dd**yn	'a man' (pred.)	(dyn)
ii.	yn **w**ag	'empty' (pred.)	(gwag)
iii.	yn **rh**aid	'necessary' (pred.)	
iv.	yn **ll**ygaid	'eyes' (pred.)	

The failure to lenite in (59)a cannot be attributed to any underlying phonological property of the definite article and *un* 'one' (such as a specific feature or feature bundle that fails to lenite /ɬ, r̥/), because the voiceless liquids are in fact lenited in feminine *adjectives* after these determiners. Examples are shown in (60).

(60) SM of /ɬ, r̥/ in feminine adjectives after the definite article and *un*

a.	y **l**wyd wawr	'the grey dawn'	(llwyd)
b.	y **l**onnaf	'the happiest (woman)'	(llonnaf)
c.	un **r**yfedd yw hi	'she is a strange one'	(rhyfedd)

As for (59)b–c, although there is no direct evidence like (60) showing that the failure to lenite /ɬ, r̥/ cannot be attributed to the phonology of the triggering proclitic, it seems a priori unlikely since that explanation cannot be right for (59)a.

Another case of lexeme-specific mutation is found with the Welsh words *blwydd* 'years old', *blynedd* 'years', and *diwrnod* 'days'. These words undergo NM (optionally in the case of *diwrnod*) after the numbers *pum* '5', *saith* '7', *wyth* '8', *naw* '9', *deng* '10', *pymtheng* '15', *ugain* '20', and *can* '100'. Some examples are shown in (61)a. However, these are the only words mutated after these numbers. As shown in (61)b, other words use the radical form in this context.

(61) Mutation of *blwydd, blynedd*, and *diwrnod* after certain numbers

a.	5	pum **m**lwydd	'five years old'	(blwydd)
	7	saith **m**lynedd	'seven years'	(blynedd)
	8	wyth **n**iwrnod/**d**iwrnod	'eight days'	(diwrnod)
	9	naw **m**lwydd	'nine years old'	(blwydd)
	10	deng **m**lynedd	'ten years'	(blynedd)
b.	5	pum **d**yn	'five men'	
	7	saith **c**ath	'five cats'	
	8	wyth **b**laidd	'eight wolves'	
	9	naw **b**achgen	'nine boys'	
	10	deng **m**erch	'ten girls'	

Once again, a phonological analysis involving a floating autosegment at the right edge of the trigger is highly implausible, since such a floating element would have to marked as applying to only three lexical items and to no other words.

Irregular targets in Irish

Forms of the Irish verb 'to say' that begin with *d-* (e.g. *deir* (present) and *dúirt* (past)) do not undergo lenition in the standard language after particles that otherwise cause lenition, such as the negative particle *ní* and the direct relative particle *a*: *ní deirim* ‘I do not say’ (**ní* ***dh****eirim*), *nuair a dúirt tú* ‘when you said’ (**nuair a* ***dh****úirt tú*). If leniting proclitics like *ní* end in a floating autosegment, it is difficult to explain why those features fail to trigger lenition in this word. Other words that regularly resist lenition are *méid* ‘amount’, *Dé* ‘-day’ (in names of days), and *t(o)igh* ‘at the house of’ (Ó Siadhail 1989, 114).

In Old Irish, the normal lenition of [s] was [h], as it is in Modern Irish. But the word *siur* ‘sister’ exceptionally became *fiur* rather than *[hiur] under lenition.[34] If a feature or feature bundle is supposed to be responsible for debuccalization, why is there no debuccalization in this word? And when debuccalization fails, why should the coronal fricative become a labial fricative?

The Irish irregular verb *faigh* ‘get, find’ is irregular not only in its inflection but in its mutation behavior as well. Whereas the negative particle *ní* causes lenition of every other verb in the language that begins with a lenitable consonant, it causes eclipsis of *faigh*, as in the examples in (62).

(62) Eclipsis of *faigh* after *ní*

a. ní **bhf**aighidh sé ‘he will not get/find’

b. ní **bhf**uair sé ‘he did not get/find’

Other leniting particles, such as the direct relative particle *a*, do lenite *faigh* as expected, e.g. *nuair a* ***fh****aigheann siad* ‘when they get/find’. The behavior of *faigh* after *ní* is unexplainable under a phonological analysis of mutation: if *ní* ends with a lenition-triggering floating autosegment, or if it is always followed by a silent lenition-triggering morpheme, why should the lenition-triggering element *ní* switch to an eclipsis-triggering element before the forms of the verb *faigh*?

In English loanwords, lenition applies only if it does not cause debuccalization or deletion; in other words, lenition does

34 There are a few other words that show [s] → [f] lenition, but only word-internally, e.g. *seiser* ‘group of six people’ vs. *mór-feiser* ‘group of seven people’ (lit. ‘large group of six people’) and *sephainn* [s′efəɴ′] ‘played’ (reduplicated preterite of *seinn-*).

not apply to English loanwords that begin with [t, d, s, f]. The examples in (63) are taken from de Bhaldraithe (1953/1977, 257–58).

(63) Lenition of English words only without debuccalization/deletion

a.	a **Mh**ary	'Mary!' (vocative)
b.	a **Bh**ridgy	'Bridgy!' (vocative)
c.	faoi **D**an	'about Dan'
d.	droch-**t**ae	'bad tea'
e.	déanta de ***twine***	'made of twine'
f.	aon ***fag***	'any fag (cigarette)'
g.	Seán **F**rank	'Seán (son) of Frank'
h.	a **S**arah	'Sarah!' (vocative)

If lenition were an automatic phonological process, we would expect it to apply to English words used in Irish as regularly as it applies to native Irish words. A case could be made within a phonological analysis that the reason English [t, d, s, f] fail to lenite is recoverability, which could be expressed in OT terms as high-ranking faithfulness to place of articulation. Such an argument would require the assumption that faithfulness constraints on foreign words are higher ranked than faithfulness constraints on native words, an argument that has been made in slightly different forms by Davidson and Noyer (1997), Fukazawa, Kitahara, and Ota (1998), Itô and Mester (1999), and Féry (2003a). If other evidence were stronger that lenition is truly a phonological process, then an analysis based on different rankings of faithfulness constraints in loanwords and native words could be made here. But, as I have been showing throughout this chapter, phonological analyses of the mutations are very problematic, and the data in (63), rather than calling for an analysis within a phonological treatment, are instead additional evidence against the mutations being phonological processes at all. As a functional explanation, the intuition is strong that foreign words resist lenition if the phonological changes are "too extreme" (debuccalization and deletion being more severe—and their effects less recoverable—than simple spirantization); but since the mutations in general resist a formal phonological analysis, we unfortunately cannot convert that functional intuition into a formal statement.

Irregular targets in Welsh

As in Irish, foreign words in Welsh resist mutation if the effect is deletion (i.e. if they begin with /g/), as shown in (64)a. This restriction applies to some monosyllabic native Welsh words beginning with /g/ as well. Foreign place names usually do not get mutated (although there is some variation in this respect) regardless of their initial consonant, as shown in (64)b, although Welsh place names (including the Welsh names of places outside Wales) do get lenited: *i **F**anceinion* 'to Manchester' (Manceinion), *i **F**ryste* 'to Bristol' (Bryste). Personal names usually resist mutation whether they are of Welsh or foreign origin ((64)c), although in formal texts they can be mutated. In the literary language at least, the adjective *braf* 'fine' (a French loanword) resists SM as well.

(64) Words resisting SM in Welsh

a. Foreign (and some monosyllabic Welsh) words beginning with *g*

garej	'garage'
gêm	'game'
gôl	'goal'
gro	'gravelly shore'

b. Foreign place names

i **B**uffalo	'to Buffalo'
i **B**onn	'to Bonn'
yn **B**erlin	'in Berlin'

c. Personal names

i **D**afydd	'to Dafydd'

d. braf 'fine'

As with the foreign words that resist lenition in Irish, the Welsh forms in (64) could conceivably be analyzed as belonging to a stratum of the Welsh lexicon to which faithfulness applies more stringently than to native words, if a phonological analysis of mutations were otherwise plausible. But as has been shown throughout this chapter, such a phonological analysis is not plausible, and the functional intuition that foreign words resist alteration more than native words do must remain unformalized.

In this section we have seen several ways in which the Celtic mutations fail to exhibit behavior typical of phonological processes: they do not target natural classes of features, have uniform, predictable effects, or reduce phonological markedness in any obvious way. Rather, they are idiosyncratic and arbitrary, both in their environments and in their effects. For these reasons it is preferable to view the mutations not as phonological processes but as morphological effects.

3.3.4 Selection of the mutation allomorph

In the past section we saw a number of reasons why the effects of the mutations cannot be captured as unified phonological processes, either with binary features or with ternary scales. We also saw that the most nearly plausible phonological analysis of the triggers of the mutations, namely floating autosegments, cannot be accurate. In this section I will outline a preferable analysis, according to which the triggers are lexically or syntactically marked with a diacritic requiring the elements they govern to appear in a certain mutation grade ("radical" being considered a possible mutation grade as well). An agreement constraint ensures that the correct allomorph is selected. I further propose that the generalizations regarding the effects of the mutation are stored as morphological word-formation strategies (Ford, Singh, and Martohardjono 1997) rather than as phonological processes.

An analogue to mutation allomorph selection may be found in case selection. In both phenomena, there is a government relationship between two elements, and the form of the second element is determined by the nature of the first. Consider, for example, the dative case in German. As illustrated in (65), the German dative is used with indirect objects (65)a, with the complements of certain verbs and adjectives (65)b–c, and with prepositions indicating non-goal-oriented location (65)d. In most instances the dative case of a full NP is marked morphologically on the determiner, not the noun itself.

(65) Dative case in German

a. Indirect objects

Er	bietet	seinem	Freund	eine	Zigarette	an.
he	*offers*	*his:*DAT	*friend*	*a:*ACC	*cigarette*	PRT

'He offers his friend a cigarette.'

b. Complements of certain verbs

Sie	hilft	ihrem	Vater.
she	*helps*	*her:*DAT	*father*

'She helps her father.'

c. Complements of certain adjectives

Der	Schüler	ist	seinem	Vater	ähnlich.
*the:*NOM	*schoolboy*	*is*	*his:*DAT	*father*	*similar*

'The schoolboy is similar to his father.'

d. Prepositions indicating non-goal-oriented location

i.

Das	Heft	liegt	im	Schrank.
*the:*NOM	*booklet*	*lies*	*in-the:*DAT	*cupboard*

'The booklet is (lying) in the cupboard.'

ii.

Der	Schrank	steht	an	der	Wand.
*the:*NOM	*cupboard*	*stands*	*against*	*the:*DAT	*wall*

'The cupboard is (standing) against the wall.'

iii.

Das	Kind	läuft	auf	der	Straße.
*the:*NOM	*child*	*runs*	*on*	*the:*DAT	*street*

'The child is running on the street.' (i.e. running around there)

With (65)d may be contrasted the forms in (66), where we see that the object of a preposition indicating goal-oriented motion is in the accusative.

(66) Accusative after prepositions indicating goal-oriented motion

a. Er legt das Heft in den Schrank.
*he puts the:*ACC *booklet in the:*ACC *cupboard*
'He puts the booklet in the cupboard.'

b. Sie schieben den Schrank an die Wand.
*they push the:*ACC *cupboard against the:*ACC *wall*
'They push the cupboard against the wall.'

c. Das Kind läuft auf die Straße.
*the:*NOM *child runs on the:*ACC *street*
'The child is running onto the street.' (i.e. towards it)

Interestingly, the preposition *zu* 'to' always governs dative case, even when goal-oriented motion is indicated, as shown in (67).

(67) Wir gehen zum Bahnhof.
*we go to-the:*DAT *railroad-station*
'We're going to the railroad station.'

Thus, case selection in German can be determined by either syntactic ((65)a, d, (66)) or lexical ((65)b, c, (67)) criteria. Mutation selection in Celtic languages, I argue, works the same way. Just as prepositions in German can subcategorize for what case they govern (the one in (67) even overriding syntactic generalizations), so determiners, prepositions, and other proclitics in the Celtic languages can subcategorize for what mutation grade they govern.

For example, the feminine singular definite article in Welsh governs the lenited form of a noun (unless it begins with [ɬ] or [r̥]); all other forms of the definite article govern the radical form. Examples are shown in (68).

(68) Mutations of nouns after the definite article in Welsh

Masc. sing.	Radical	y **b**ardd	'the poet'	
Fem. sing.	SM	y **f**aner	'the flag'	(baner)
Plural	Radical	y **b**eirdd	'the poets'	
		y **b**aneri	'the flags'	

The feminine singular article is marked with a diacritic [+SM], meaning its complement is to appear in its SM allomorph. The other forms are marked [+RAD], meaning their complements are to appear in their radical allomorphs. In OT terms, this relationship is controlled by the constraint MUTATIONAGREEMENT (MUTAGREE), which states that the mutation required by a trigger must be realized on its target. Since both radical and SM forms are listed in the input, there is no violation of faithfulness (in the case at hand, of IDENT(cont), the constraint requiring an output segment to carry the same value of the feature [continuant] as its input correspondent). Tableaux illustrating the effect of MUTAGREE are shown in (69)–(70).

(69) Radical after the masculine singular article: *y **b**ardd*

$ə_{+RAD}$ {$barð_{RAD}$, $varð_{SM}$}	MUTAGREE	IDENT(cont)
☞ ə barð		
ə varð	* !	

(70) SM after the feminine singular article: *y **f**aner*

$ə_{+SM}$ {$baner_{RAD}$, $vaner_{SM}$}	MUTAGREE	IDENT(cont)
ə baner	* !	
☞ ə vaner		

The fact that IDENT(cont) plays no role in mutation is crucial in an analysis of Manx, where PL and ML are completely independent of each other. Consider, for example, the phrases [ə be:ðə] 'the boat', where the radical form of the noun [be:ðə] 'boat' (input /be:tə/) appears after the masculine singular definite article, and [ə ve:ðə] 'his boat', where the lenited form appears after the third person masculine singular possessive pronoun.[35] As we saw above in (28), the lenition of [t] to [ð] is due to the ranking *V[−voi]V, *V[−cont]V ≫ IDENT(voi), IDENT(cont). But the selection of [be:ðə] over lenited [ve:ðə] is made entirely on the basis of MUTAGREE.

(71) IDENT(cont) violated only by PL, not ML, in Manx

a. [ə be:ðə] 'the boat'

$ə_{+RAD}$ {$be{:}tə_{RAD}$, $ve{:}tə_{LEN}$}	MUT AGREE	*V[−voi]V	*V[−cont]V	IDENT (voi)	IDENT (cont)
ə be:tə		* !	*		
☞ ə be:ðə				*	*
ə ve:tə	* !	*	*		
ə ve:ðə	* !			*	*

b. [ə ve:ðə] 'his boat'

$ə_{+LEN}$ {$be{:}tə_{RAD}$, $ve{:}tə_{LEN}$}	MUT AGREE	*V[−voi]V	*V[−cont]V	IDENT (voi)	IDENT (cont)
ə be:tə	* !	*	*		
ə be:ðə	* !			*	*
ə ve:tə		* !	*		
☞ ə ve:ðə				*	*

In (28)–(30) above we saw that IDENT(cor) is high-ranked in Manx, because coronals retain their place of articulation under PL, and in (34) we encountered a ranking paradox that arises when we attempt a phonological explanation of ML. Under the current analysis, where lenited forms are listed as allomorphs,

35 Note that I am assuming an ideal state of Manx, in which the presence or absence of mutations is as strictly adhered to as it is in more robust languages like Irish and Welsh. In fact, lenition in Late Spoken Manx (in the last decades before its death) was very sporadic, often failing to appear where the literary language required it, and sometimes appearing where the literary language required the radical. See Broderick, 1984–86, 1:9–20, for examples and discussion.

the tableau for [də ɣulis′] ‘to Douglas’ (cf. (34)) is fully compatible with the tableau for [eðən] ‘face’ in (29).

(72) No ranking paradox between [də ɣulis′] ‘to Douglas’ and [eðən] ‘face’

/də$_{+\text{LEN}}$ {dulis′$_{\text{RAD}}$, ɣulis′$_{\text{LEN}}$}/	MUT AGREE	IDENT (cor)	*V[−cont]V	IDENT (cont)	*ð
də dulis′	* !				
☞ də ɣulis′					
/edən/	MUT AGREE	IDENT (cor)	*V[−cont]V	IDENT (cont)	*ð
edən			* !		
☞ eðən				*	*
eɣən		* !		*	

Just as syntactic position can determine case in German, so can it determine mutation grade in Celtic languages: for example, the first word in an NP following a c-commanding or sister XP in Welsh (assuming the XPTH is correct) appears in the SM form. The difference here, though, is that syntactically triggered case marking in German (e.g. marking an indirect object as dative) is determined by semantic principles like theta role assignment, while syntactically triggered mutation in Celtic is not.[36]

Allowing the morphology and the syntax to directly choose mutation grade has a number of advantages over the hypothesis that mutation is triggered by floating autosegments. For one thing, we are not required to posit silent morphemes in environments where there is no independent evidence for them, nor do we have to resort to highly idiosyncratic phonology in order to achieve the alternations attested. When a feminine noun is lenited after the definite article, as are any adjectives

36 This is not to say there is no functional reason for syntactically triggered mutation: there probably is, such as marking the edges of phrases.

modifying that noun, it is because the syntax of feminine NPs requires it, not because feminines end in a floating autosegment. The nonadjacency cases of §3.3.3.3 are easily explained under this view: in a phrase like *ár dhá gcuid* 'our two parts' ((49)e), *ár* requires its noun to appear in the eclipsed form, while *dhá* requires its noun to appear in the lenited form. We may hypothesize that the requirement of *ár* takes precedence, perhaps because it is higher in the tree than *dhá*. At any rate, the fact that the trigger *ár* is not adjacent to its target *mbád* is not a problem under this view. The same holds true of the other nonadjacency cases like *trí shioc agus **sh**neachta* 'through frost and snow' and *Cá bhfuil mo fuckin' **sh**eaicéad?* 'Where's my fuckin' jacket?', where the mutation trigger still governs its target even without being adjacent to it.

The irregular behavior of mutation triggers discussed in §3.3.3.4 can be analyzed by fine-tuning the subcategorization frames of the triggers (e.g. the numbers 3–6 subcategorize for the lenited form of singular nouns but the radical form of plural nouns in Irish; the particles *ni, na,* and *oni* subcategorize for the AM form of a word in Welsh where it is available, otherwise the SM form, etc.) The irregular behavior of mutation targets can be analyzed by proposing that individual lexical items can have mutation allomorphs that deviate from the usual pattern. For example, the verb *deir* 'to say' in Modern Irish has allomorphs marked "lenited" that nevertheless begin with /d/ rather than expected /ɣ/; the noun *siur* 'sister' in Old Irish has an allomorph marked "lenited" that begins with /f/ rather than expected /h/; and so on.

My analysis is similar to Stewart's analysis of Scots Gaelic mutations (2004), in which he picks up on Janda's point (1987) that not all linguistic rules that affect sound structure are necessarily part of a language's phonology. Stewart argues that the mutations are a morphological constellation, a term defined by Joseph (1996) as "a group of elements which share at least one characteristic property of form but are distinguished by individual idiosyncrasies, both of form and of function, that prevent their being collapsed with one another." Specifically, Stewart argues that every noun, verb, and adjective in Scots Gaelic has four stem forms that in most cases are distinct from each other (although syncretism of two or more of the forms is possible); the mutated forms of words are among these. For example, the Gaelic word for 'cat', *cat* [k^haht], consists not only of that form, but also of *chat* [xaht] (the form with a lenited initial consonant), *cait* [k^hatʃ] (the form with a palatalized final consonant), and *chait* [xatʃ] (the form with both a lenited initial consonant and a palatalized final consonant). Morphological rules then determine which form is selected in which morphosyntactic environment.

In this section we have seen that the selection of the mutation allomorph is determined by a diacritic on the mutation trigger, by means of the constraint MUTAGREE, which requires agreement between the diacritic on the trigger and the form of the mutation target. Although mutation grade itself is not a reflection or indication of case, the two phenomena are analogous in that the nature of a governing element determines the form of the element governed. In the next section, I will discuss a case in Irish where the selection of the correct mutation allomorph is overridden by phonological considerations.

3.4 Phonological restrictions on allomorph selection: Coronals in contact in Irish

When two coronals come in contact in an environment where lenition is expected in Irish, unmutated or peculiarly mutated forms appear instead of regular mutated forms.[37] As we shall see, a constraint requiring a coronal consonant to be followed by another coronal consonant within the same prosodic word (pword; symbolized ω) is responsible for the blocking of lenition at the junction of two coronals and for the exceptional

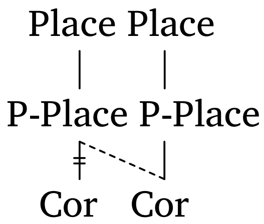
37 Portions of this section appear in Green (2004a), where it is also argued that head-initial and head-final compounds form recursive prosodic words in Irish, while noncompound complex NPs form independent words incorporated directly into phonological phrases.

mutation of /s/ to /t/ (instead of expected /h/) in certain environments.

3.4.1 Coronal fusion

In many environments in Irish, the second of two adjacent coronals fails to undergo an expected mutation. Ní Chiosáin (1991) attributes this to a rule called coronal fusion (henceforth CF), stated in (73), that makes adjacent coronals share a single place node. The resulting structure is then immune to rules causing lenition because of geminate inalterability (Guerssel 1977; Hayes 1986; Schein and Steriade 1986; Inkelas and Cho 1993; Keer 1999; Kirchner 2000).

(73) Coronal fusion



(= primary Place)

As for the environments in which CF applies, Ní Chiosáin (1991, 108) states, "adjacent heteromorphemic coronal consonants undergo coronal fusion in certain word-formation domains, namely, in compounds and prefixed forms as well as in a clitic domain." Some examples of CF applying in environments where lenition would otherwise be expected are shown in (74). In all of these cases we may assume a recursive pword.

(74) Environments of CF where lenition is expected

a. Right-headed compound
$_{\omega}$($_{\omega}$(a:rd) $_{\omega}$(**s**agərt)) 'high priest'
high *priest*

b. Left-headed compound
$_{\omega}$($_{\omega}$(tu:N$_{FEM}$) $_{\omega}$(**t**il′ə)) 'tidal wave'
wave *flood:GEN*

c. Prefix + root
$_\omega$($_\omega$(an) $_\omega$(**d′**as)) ‘very nice’
very nice

d. Proclitic + host
$_\omega$(ən $_\omega$(**t**ar′əv′)) ‘the bull’ (gen. sg.)[38]
the bull:GEN

In other leniting environments, CF is not found; thus lenition is not blocked but applies regularly. We may assume that in these cases there is no recursive pword and that therefore the (recursive) pword is the domain of CF. Examples are shown in (75).

(75) No CF (i.e. lenition is not blocked):

a. Definite NPs used genitively
$_\omega$(d′i:n) $_\omega$(**h′**upə) $_\omega$(ə $_\omega$(vu:s′t′e:rə)) (s′upə)
roof shop the butcher:GEN
‘the roof of the butcher’s shop’

$_\omega$(fer′əɴ) $_\omega$(**ɣ**er′ə) (der′ə)
team Derry:GEN
‘the Derry team’

b. Indefinite genitives in conditions (i) and (ii) (cf. (41))
$_\omega$(m′il′s′əxt$_{FEM}$) $_\omega$(**h′**u:krə) (s′u:krə)
sweetness sugar:GEN
‘the sweetness of sugar’

$_\omega$(bid′e:l′) $_\omega$(**h**u:) (su:)
bottles juice:GEN
‘bottles of juice’

38 The assumption that proclitics are incorporated into a recursive pword contradicts the position of Green (2000), where it is argued that proclitics are not incorporated into any pword in Irish.

c. Attributive adjectives in conditions (i) and (ii)

$_{\omega}$(kos$_{\text{FEM}}$) $_{\omega}$(**h′**i:ɴ′) (t′i:ɴ′)
leg *sore*
'a sore leg'

$_{\omega}$(et′l′a:n′$_{\text{PL}}$) $_{\omega}$(**ɣ′**arəgə) (d′arəgə)
airplanes *red:*PL
'red airplanes'

If the prosodic structures of (74) and (75) are correct, then the domain of CF is the pword: CF applies (blocking lenition) inside recursive pwords, as shown in (76), while CF is blocked (allowing lenition to apply) between pwords whose next highest level is the phonological phrase (ϕ), as shown in (77). Recall that the lenition of coronals is manifested by debuccalization, interpreted by Ní Chiosáin (1991) as the delinking of the coronal node.

(76) Coronal fusion (lenition blocked) inside recursive pwords

$_{\omega}$($_{\omega}$(a:rd) $_{\omega}$(sagərt)) — Coronal
$_{\omega}$($_{\omega}$(tu:ɴ) $_{\omega}$(til′ə)) — Coronal

$_{\omega}$($_{\omega}$(an) $_{\omega}$(d′as)) — Coronal
$_{\omega}$(ən $_{\omega}$(tar′əv′)) — Coronal

(77) No coronal fusion (lenition applies in the form of coronal node delinking) between pwords within p-phrase

$_{\phi}$[$_{\omega}$(fer′əɴ) $_{\omega}$(ɣer′ə)] — Cor Cor
$_{\phi}$[$_{\omega}$(m′il′s′əxt) $_{\omega}$(h′u:krə)] — Cor Cor

$_{\phi}$[$_{\omega}$(kos) $_{\omega}$(h′i:ɴ′)] — Cor Cor

The rule of coronal fusion given in (73) can be restated as an OT markedness constraint CORONAL HOMORGANICITY (CORHOM), as in (78).

(78) CORONAL HOMORGANICITY (CORHOM)
In $_{\omega}(\ldots C_iC_j\ldots)$, if C_i is coronal, then C_j is coronal.

The effect of CORHOM in Irish is not immediately apparent since there are a number of words in which coronal consonants are followed by noncoronal consonants, as shown in (79).

(79) Coronal + noncoronal clusters

admhaigh	[a**dw**iː]	'admit'
olc	[o**lk**]	'bad'
dualgas	[duə**lg**əs]	'duty'
ceolmhar	[k′oː**lw**ər]	'musical'
greannmhar	[g′r′aː**ɴv**ər]	'funny'
briosca	[b′r′i**sk**ə]	'biscuit, cookie'
smaoineamh	[**sm**iːn′əv]	'thought'
aspal	[a**sp**əl]	'apostle'

The data in (79) force us to conclude that CORHOM is ranked below FAITH(Place) in Irish, so that a noncoronal consonant in the input cannot surface as a coronal in order to meet CORHOM.

(80) FAITH(Place) ≫ CORHOM

/olk/	FAITH(Place)	CORHOM
☞ $_{\omega}$(olk)		*
$_{\omega}$(olt)	* !	

But if two allomorphs are available, as is the case with the mutations, CORHOM can force the selection of the homorganic one, because as long as the output is faithful to one of the input allomorphs, there is no violation of faithfulness. In Irish, CORHOM outranks MUTAGREE, so that a coronal-initial allomorph is selected after a coronal rather than the allomorph with the correct mutation. In other words, the mutation is suppressed in order to fulfill CORHOM. This is illustrated in (81) for the compound *seanduine* 'old person': the form *sean* is marked [+LEN] because ordinarily its complement must be lenited (e.g. *seanbhean* 'old woman'). But if the complement begins with a coronal, then the radical is selected so that CORHOM can be fulfilled.

(81) CORHOM ≫ MUTAGREE, from *seanduine* 'old person'

/s′an$_{+\text{LEN}}$ + {din′ə$_{\text{RAD}}$, ɣin′ə$_{\text{LEN}}$}	FAITH(Place)	CORHOM	MUTAGREE
☞ $_\omega$($_\omega$(s′an) $_\omega$(din′ə))			*
$_\omega$($_\omega$(s′an) $_\omega$(ɣin′ə))		* !	

However, where no homorganic allomorph is available, MUTAGREE decides in favor of the lenited allomorph, as shown in (82) for *seanghoimh* 'old sore'. The allomorphs of *goimh* are radical /giv′/ and lenited /ɣiv′/; neither begins with a coronal. This being the case, CORHOM cannot decide between them, and high-ranking FAITH(Place) blocks unfaithful [div′], so low-ranking MUTAGREE makes the decision in favor of the lenited allomorph /ɣiv′/.

(82) MUTAGREE decides when CORHOM cannot be met, from *seanghoimh* 'old sore'

/s′an$_{+\text{LEN}}$ + {giv′$_{\text{RAD}}$, ɣiv′$_{\text{LEN}}$}	FAITH(Place)	CORHOM	MUTAGREE
$_\omega$($_\omega$(s′an) $_\omega$(giv′$_{\text{RAD}}$))		*	* !
☞ $_\omega$($_\omega$(s′an) $_\omega$(ɣiv′$_{\text{LEN}}$))		*	
$_\omega$($_\omega$(s′an) $_\omega$(div′$_{\text{RAD}}$))	* !		*

As stated in (78), the domain of CORHOM is the pword. As a result, a pword-final coronal followed by a pword-initial non-coronal does not engender a violation of CORHOM unless the two pwords are incorporated into a recursive pword. Thus lenition applies regularly in noncompound complex NPs (83).

(83) CORHOM does not apply outside pword: noncompound *foireann Dhoire* 'the Derry team'

/fer′ən$_{+LEN}$ + {der′ə$_{RAD}$, ɣer′ə$_{LEN}$}/	CORHOM	MUTAGREE
$_\phi$[$_\omega$(fer′ən) $_\omega$(der′ə)]		* !
☞ $_\phi$[$_\omega$(fer′ən) $_\omega$(ɣer′ə)]		

The facts of CF, analyzed here as the interaction between CORHOM and MUTAGREE, thus show that selection of the correct mutation allomorph can be overridden by phonotactic considerations. In the next section we analyze s-fortition, which provides additional evidence for the same conclusion.

3.4.2 S-fortition

S-fortition is the process by which /s/ becomes /t/ after /n/ and sometimes /l/ in Irish. S-fortition occurs only in environments where lenition of noncoronals and CF of /t, d/ would be expected. In the standard language, the only environment of s-fortition is in leniting environments after the definite article, as illustrated in (84).

(84) S-fortition after the definite article (only environment in the standard language)

ən **t**agərt′	'the priest' (masc. sg. gen.)	(sagərt′)
ən **t′**axtən′	'the week' (fem. sg. nom.)	(s′axtən′)
don **t**agərt	'to the priest' (masc. sg. dat.)[39]	(sagərt)
d′en **t′**axtən′	'of the week' (fem. sg. dat.)	(s′axtən′)

While the s-fortition in (84) is obligatory and belong to the standard language, there are other, optional environments for it outside the standard. Thus in some dialects, s-fortition is found variably after /n/ and /l/ in any environment where lenition of noncoronals and CF of /t, d, s/ is found in the standard language, cf. (74). Examples are shown in (85).

39 The standard language permits also *don sagart*, with CF rather than s-fortition.

(85) Nonstandard: s-fortition (variably) after /n, l/ in the same environments as CF

a. Right-headed compound

$_{\omega}$($_{\omega}$(la:n) $_{\omega}$(**t**a:stə)) (Std. la:nsa:stə) 'fully happy'
full happy

$_{\omega}$($_{\omega}$(ku:l) $_{\omega}$(**t′**o:mrə)) (Std. ku:ls′o:mrə) 'back room'
back room

b. Left-headed compound in conditions (i) and (ii)

$_{\omega}$($_{\omega}$(b′an$_{\text{FEM}}$) $_{\omega}$(**t′**i:)) (Std. b′an s′i:) 'banshee'
woman fairy-mound:GEN

$_{\omega}$($_{\omega}$(skel′$_{\text{FEM}}$) $_{\omega}$(**t**i:hər′)) (Std. skel′ si:hər′)
school industry:GEN 'industrial school'

c. Prefix + root

$_{\omega}$($_{\omega}$(an) $_{\omega}$(**t**a:stə)) (Std. ansa:stə) 'very happy'
very happy

d. Proclitic + host

$_{\omega}$(e:n $_{\omega}$(**t′**ans)) (Std. e:n s′ans) 'any chance'
any chance

In environments where CF does not apply, such as noncompound complex NPs (cf. (75)), s-fortition also does not apply, so that the regular lenition of /s/ to /h/ is found, as shown in the examples in (86).

(86) No s-fortition in leniting environments where there is also no CF, e.g. noncompound complex NPs

a. Definite NPs used genitively

$_{\omega}$(d′i:n) $_{\omega}$(**h′**upə) $_{\omega}$(ən $_{\omega}$(vu:s′t′e:rə) (s′upə)
roof shop the butcher:GEN
'the roof of the butcher's shop'

$_{\omega}$(asəl) $_{\omega}$(**h′**a:n′) 'Seán's donkey' (s′a:n′)
donkey Seán-GEN

b. Indefinite genitives in conditions (i) and (ii)
$_{\omega}$(mad′ən′$_{\text{FEM}}$) $_{\omega}$(**h**auri:) ‘a summer morning’ (sauri:)
morning *summer:GEN*

$_{\omega}$(bid′e:l′) $_{\omega}$(**h**u:) ‘bottles of juice’ (su:)
bottles *juice:GEN*

c. Attributive adjectives in conditions (i) and (ii)
$_{\omega}$(b′an$_{\text{FEM}}$) $_{\omega}$(**h**i:ltə) ‘a worldly woman’ (si:ltə)
woman *worldly*

$_{\omega}$(fokəl′) $_{\omega}$(**h**′e:v′ə) ‘mild words’ (s′e:v′ə)
words *mild.PL*

Because s-fortition occurs only in lenition environments, we may assume that the t-initial forms are also lenition allomorphs. Thus an s-initial word like *sagart* ‘priest’ has not one lenition allomorph in the input, but rather two: /hagərt/ and /tagərt/.[40] The t-initial allomorphs occur only after /n/ and /l/, not after other coronals. Examples are shown in (87).

(87) t-initial lenition forms only after /n, l/
a. $_{\omega}$($_{\omega}$(la:n) $_{\omega}$(**t**a:stə)) ‘fully happy’
full *happy*

b. $_{\omega}$($_{\omega}$(skel′) $_{\omega}$(**t**i:hər′)) ‘industrial school’
school *industry:GEN*

c. $_{\omega}$($_{\omega}$(a:rd) $_{\omega}$(**s**agərt)) *$_{\omega}$(tagərt) ‘high priest’
high *priest*

d. $_{\omega}$($_{\omega}$(kos) $_{\omega}$(**s**luə) *$_{\omega}$(tluə) ‘infantry’
foot *army*

40 The surface form [tagərt] cannot correspond to input /hagərt/, because such an analysis would require that the input sequences /lh/ and /nh/ optimally surface as [lt] and [nt] in Irish. But in fact such sequences surface faithfully, e.g. *fillfidh* [f′il′h′i:] ‘will return’, *an hata* [ən hatə] ‘the hat’.

In (87)a–b the t-initial allomorph is selected because it allows both CORHOM and MUTAGREE to be met. The form [la:nsa:stə], with the radical of *sásta*, would violate MUTAGREE, and [la:nha:stə], with the h-initial lenition allomorph, would violate CORHOM, as shown in the tableau in (88).

(88) t-initial lenition forms selected after *n* and *l*, from *lán*[t]*ásta* 'fully happy'

/la:n$_{+LEN}$ + {sa:stə$_{RAD}$, ha:stə$_{LEN}$, ta:stə$_{LEN}$}	CORHOM	MUT AGREE	IDENT (cont)	DEP(Cor)
$_{\omega}$($_{\omega}$(la:n) $_{\omega}$(sa:stə$_{RAD}$))		* !		
$_{\omega}$($_{\omega}$(la:n) $_{\omega}$(ha:stə$_{LEN}$))	* !			
☞ $_{\omega}$($_{\omega}$(la:n) $_{\omega}$(ta:stə$_{LEN}$))			*	*

A problem arises, however, in limiting the selection of the t-initial lenition allomorphs to the position after coronal sonorants. As we saw in (87)c–d, the s-initial radical allomorph is selected after coronal obstruents: [a:rdsagərt] 'high priest', [kossluə] 'infantry'. This is unexpected, since the competing candidates *[a:rdtagərt] and *[kostluə] meet both CORHOM and MUTAGREE, while the optimal candidates violate MUTAGREE. There must be some higher constraint the losing candidates violate.

The first option to consider is a phonological constraint. If it were the case that obstruent + fricative sequences were universally less marked than obstruent + stop sequences, then we could have an explanation for the selection of [a:rdsagərt] and [kossluə] rather than *[a:rdtagərt] and *[kostluə]. Since the sequences in question always cross a syllable boundary, and since an obvious difference between stops and fricatives is the difference in sonority, we may look to the Syllable Contact Law (Murray and Vennemann 1983; Vennemann 1988), which requires an onset consonant to be less sonorant than a preceding coda consonant, to provide an answer. Unfortunately, the SCL is violated by both stop + stop and stop + fricative sequences, so it cannot decide between [a:rd.sagərt] and *[a:rd.tagərt].

Moreover, the SCL is violated by fricative + fricative sequences but obeyed by fricative + stop sequences, so it falsely predicts *[kos.tluə] to be better than [kos.sluə].[41] Apart from the issue of syllable contact, stops are less marked than fricatives not only in an absolute sense (stops occurring cross-linguistically more frequently than fricatives and being acquired by children earlier than fricatives), but also specifically in syllable onset position (Vennemann 1988). So both context-sensitive and context-insensitive markedness considerations falsely predict the t-initial forms to be preferred to the s-initial forms.

Thus it seems no phonological constraint can rule out *[a:rd.tagərt] and *[kos.tluə]. Rather, a morphological alignment constraint tX-TO-CORSON is necessary, requiring a t-initial lenition allomorph to follow a coronal sonorant.[42]

(89) tX-TO-CORSON
Align(tX_{LEN}, L; [+son, COR], R)
The left edge of every t-initial lenition allomorph is aligned with the right edge of some coronal sonorant.

The effect of tX-TO-CORSON is shown for *ardsagart* 'high priest' by the tableau in (90).

41 Note that *tl-* is an acceptable onset cluster in Irish, as in *tláith* [tla:] 'weak' and *tlú* [tlu:] 'tongs'.

42 In the standard language, where t-initial lenition allomorphs like *tsagart* appear only after the definite article, the alignment constraint apparently targets the definite article specifically rather than any coronal sonorant. In the dialects with generalized s-fortition, the target of the alignment constraint has been broadened to that stated here.

(90) s-initial lenition forms selected after coronal obstruents, from *ardsagart* 'high priest'

/a:rd$_{+\text{LEN}}$ + {sagərt$_{\text{RAD}}$, hagərt$_{\text{LEN}}$, tagərt$_{\text{LEN}}$}	CorHom	tX-to-CorSon	MutAgree
☞ $_\omega$($_\omega$(a:rd) $_\omega$(sagərt$_{\text{RAD}}$)			*
$_\omega$($_\omega$(a:rd) $_\omega$(hagərt$_{\text{LEN}}$)	* !		
$_\omega$($_\omega$(a:rd) $_\omega$(tagərt$_{\text{LEN}}$)		* !	

As discussed above, the domain of CorHom is the pword, crucially including the recursive pword. In forms where there is no recursive pword, CorHom is not active. In this case, the choice between the h-initial and the t-initial lenition allomorphs is made by the fact that glottals are cross-linguistically less marked than coronals (Lombardi 2002), stated by the universal constraint ranking *Cor ≫ *h. This is illustrated in the tableau in (91), where however only relevant violations of *Cor and *h are listed.

(91) h-initial allomorph in noncompound NP: *bean Shéamais* 'Séamas's wife'

/b′an +$_{\text{LEN}}$ {s′e:məs′$_{\text{RAD}}$, h′e:məs′$_{\text{LEN}}$, t′e:məs′$_{\text{LEN}}$}/	MutAgree	*Cor	*h
$_\phi$[$_\omega$(b′an) $_\omega$(s′e:məs′)]	* !	*	
☞ $_\phi$[$_\omega$(b′an) $_\omega$(h′e:məs′)]			*
$_\phi$[$_\omega$(b′an) $_\omega$(t′e:məs′)]		* !	

In this section we have seen how an OT analysis enables us to unify the phenomena of CF and s-fortition: both processes result from the ranking CorHom ≫ MutAgree, i.e. it is more important to have a coronal consonant followed by another coronal consonant (where one is available) in the same pword than it is to pick the morphologically correct mutation grade.

Although the lenition mutation of Irish is not a phonological process, and the selection of the lenition allomorph is made on purely morphological grounds, not phonological ones, this selection can be overridden by phonological considerations, specifically the desire for a coronal consonant to be followed by another coronal consonant within the same pword. In the next section, I will defend a nonphonological analysis against the charges of being nonpredictive and uneconomical.

3.5 Defending a nonphonological analysis

Ball and Müller (1992, 123–24) anticipate the present analysis in a section considering whether Welsh mutations may be outside the phonology. They criticize this idea thus:

> While this on the face of things does remove mutations from the phonology, we are left with sets of forms for each lexical item that are clearly very similar phonologically. If we resort to suppletion (i.e. implicitly claiming they are all totally unrelated) the resultant analysis would be seen as eccentric to say the least, and as inadequate in that it refused to account for an obvious set of similarities between the forms. If, on the other hand, we attempt to link the forms, we can only do so via a phonological description. It would seem, therefore, that whatever phonological approach we adopt, and wherever the rules are situated, there is no adequate account of mutations that does not involve some kind of phonological formalism.

It would indeed be eccentric and inadequate to claim that the mutated and radical forms of words were totally unrelated and to refuse to account for the similarities. However, it is not the case that the relationships and similarities among the form can be accounted for *only* phonologically. Generalizations like "nonlenited [−cont] ↔ lenited [+cont]" are still expressible under the present account, but they are not phonological rules. Instead, they are statements of behavior in the Irish lexicon comparable to the word-formation strategies (WFSs) of Ford, Singh, and Martohardjono (1997). The schema of a WFS is laid out in (92).

(92) Word formation strategies (WFSs) (Ford, Singh, and Martohardjono, 1997)
$/X/_{\alpha} \leftrightarrow /X'/_{\beta}$

where:

(i) X and X′ are words
(ii) α and β are morphological categories
(iii) $\leftrightarrow$ indicates an equivalence relation (a bidirectional implication)
(iv) X′ is a semantic function of X
(v) ′ indicates a formal difference between the two poles of the morphological operation
(vi) ′ can be null iff $\alpha \neq \beta$ (i.e. X and X′ can be identical in form only if they belong to different morphological categories)

For example, the class of French adjectives in which the feminine is formed by the addition of [s] to the masculine (e.g. *bas* [ba] ~ *basse* [bas] 'low', *divers* [divɛr] ~ *diverse* [divɛrs] 'various') is subject to the strategy $/X/_{\text{Adj.masc.}} \leftrightarrow /Xs/_{\text{Adj.fem.}}$. Similarly, the Irish lenition of [p k b g] to [f x v ɣ] can be stated by the generalized strategy shown in (93).

(93) A lenition generalization for Irish
$$/C_{[-\text{cont},\ -\text{son},\ \{\text{labial, dorsal}\}]}X/_{\text{radical}} \leftrightarrow /C_{[+\text{cont},\ -\text{son},\ \{\text{labial, dorsal}\}]}X/_{\text{lenition}}$$

This strategy is acquired as learners pick up on alternations like *p~f* and *k~x* in the same morphosyntactic environments and spread them analogically to new forms without either adding phonological rules or setting up phonological constraint interactions to handle these alternations. Other lenition strategies are made more specifically, as shown in (94). Again, these are not statements of phonological rules or processes of any kind; they are WFSs in the Irish lexicon that speakers deduce from the lenited/nonlenited pairs they learned during acquisition.

(94) Additional lenition generalizations for Irish
$/C_{[\text{coronal}, -\text{voi}]}X_{[\{V, \text{coronal} +\text{sonorant}\}]}Y/_{\text{radical}} \leftrightarrow /hXY/_{\text{lenition}}$[43]
$/dX/_{\text{radical}} \leftrightarrow /ɣX/_{\text{lenition}}$
$/fX/_{\text{radical}} \leftrightarrow /X/_{\text{lenition}}$
$/mX/_{\text{radical}} \leftrightarrow /vX/_{\text{lenition}}$

Idiosyncratic exceptions to these generalizations, such as the blocking of lenition in *deir* 'says' and related forms in Irish, must be learned individually and set up as word-specific strategies (e.g. $/d'er'/_{\text{radical}} \leftrightarrow /d'er'/_{\text{lenition}}$), and will tend to regularize. Indeed, some Ulster Irish texts in the Tobar na Gaedhilge database (Ó Duibhín 2003) do have lenited forms like *níor dhúirt* 'did not say' for standard *níor dúirt*. The Old Irish pair *siur* ~ *fiur* 'sister (radical ~ lenited)' with an idiosyncratic /s/↔/f/ alternation has been regularized in Modern Irish as *siúr* ~ *shiúr* with a regular /s/↔/h/ alternation and in Scots Gaelic as *piuthar* ~ *phiuthar* with a regular /p/↔/f/ alternation.

As for lexical economy, even though speakers may have a listed f-initial allomorph marked "lenited" corresponding to every (or almost every) p-initial allomorph marked "radical," their awareness of the generalization means that the f-initial allomorph does not necessarily "cost anything." If only independent ("new") information adds to the complexity of the grammar, as Bochner (1993) has proposed, then for a pair like /pa:r'k' ~ fa:r'k'/ 'field', only /pa:r'k'/ and the lenition generalization are counted; /fa:r'k'/ does not add to complexity in spite of being accessible to the speaker as a listed form in the lexicon. Even languages like Finnish, with huge numbers of forms within a single paradigm (Bauer 2003, 173), pose no problem to a theory involving listing of whole words once WFSs stating the generalizations come into the picture. The interested reader is referred to Bybee (1988) for a general

43 The variable $X_{[\{V, \text{coronal} +\text{sonorant}\}]}$ is present because [s] in Irish lenites only when followed by a vowel or coronal sonorant consonant. Word-initial [t] is never followed by an obstruent or [m] anyway, so it fulfills this condition vacuously.

response to the charge of uneconomicalness in word-based morphology.

Questions may also arise concerning the predictive power of the present analysis. Since I have removed the mutations from the restrictions of the phonology and put them in the lexicon, where virtually everything is idiosyncratic, some readers may wonder if there are any limits on what kinds of alternations I predict can happen; indeed, it may seem that I am predicting languages where, in the lexicon at least, anything can alternate with anything. To this I respond that morphologized remnants of historical phonological changes are full of very peculiar things cross-linguistically. Consider English velar softening: what originated as a palatalization of velar stops before front vowels in late variety of Vulgar Latin remains as a set of /k/~/s/ and /g/~/dʒ/ alternations that are no longer phonologically predictable. As mentioned at the beginning of the chapter, the strongest theory of phonology concerns itself only with the interaction of markedness and faithfulness. To allow phonology to be powerful enough to account for the quirkiest phoneme alternations is to weaken phonological theory to the point of being unfalsifiable. The lexicon, which is by definition arbitrary, is the natural home of idiosyncrasies and language-specific peculiarities; the phonology is not. The only limits on alternations found in the lexicon are imposed by what alternations historical sound change is likely to result in.

3.6 Conclusions

In this chapter we have seen some cases of phonemic alternations for which it was argued that the most successful analysis involves allomorphy in the form of multiple inputs. In the first part, I argued that Welsh words with /ɨ/~/ə/ and /u/~/ə/ alternations must have both vowels available in the input, and that the choice between them is made by the interaction of phonological markedness constraints with faithfulness constraints. In the second part, I argued that the traditional view of the Celtic mutations as phonological processes that apply in morphosyntactically determined environments is not tenable.

The mutations cannot be shown to reflect the interaction of faithfulness with universal markedness principles, in violation of the strong OT-phonology hypothesis that all phonological processes reflect such an interaction. The morphosyntactically triggered lenition of Manx contrasts sharply with an intervocalic lenition process in the same language, which is palpably phonological in both its environment and its effects. In all the Celtic languages, the morphosyntactically triggered mutation alternations themselves are not expressible in terms of predictable changes of phonological features, nor can the environments of the changes be convincingly attributed to floating autosegments, as has frequently been claimed since Massam (1983). Furthermore, the large number of irregularities and exceptions among both triggers and targets strongly suggests that the mutations are properties of the lexicon, not the phonology. Instead, the Celtic mutations are encoded directly in the items listed in the lexicons of the languages, resulting in patterns that are discernible to speakers and that can spread analogically to new forms. The grammar of each language allows proclitics and syntactic positions to determine which mutation grade of a lexical item is grammatical in which environment, in a manner parallel to the selection of case by prepositions and syntactic positions in languages like German.

As we have seen, the selection of allomorphs requires the use of language-specific morphological constraints as distinct from purely phonological constraints on markedness. In the next chapter, we examine static irregularities and lexical exceptions, which will also lead to the conclusion that language-specific morphological constraints are necessary for an analysis of phenomena that cannot be captured with phonological markedness constraints alone.

Chapter 4
Static irregularities and lexical exceptions

4.1 Introduction and theoretical background

As we have seen in the preceding chapters, there are many kinds of apparently phonological processes that cannot be analyzed as purely an interaction between markedness (or well-formedness) constraints and faithfulness constraints, but rather must involve language-specific constraints that make reference to morphological structure.[1] In this chapter we will investigate lexical exceptions to patterns of phonotactic well-formedness (Tranel 1996, Inkelas, Orgun, and Zoll 1997, Inkelas 1999), as well as cases where phonotactic well-formedness is regularly violated by the commonest words, while it is obeyed only in a handful of rare (mostly foreign) words.

As will be discussed in §4.2, the dichotomy between tense and lax vowels is blurred in the low back region in Eastern General American English (henceforth EGA): While there are certain environments in which tense vowels are prohibited, and other environments in which lax vowels are prohibited, the low back vowels [ɔ] and [ɑ] show an ambiguous distribution. While [ɔ] generally patterns as a tense vowel, it is allowed before [ŋ] and tautomorphemic [ft], which are otherwise lax-only environments. And while [ɑ] generally patterns as a lax vowel, it may stand in normally tense-only environments in recent loanwords. More surprisingly, lax [ɑ] may stand before [ŋ] and tautomorphemic [ft] *only* in recent loanwords, even though other lax vowels stand freely in these positions. There are also some varieties of EGA that have the tense vowel (or

1 An early version of this chapter appeared as Green (2001).

diphthong) [æ̰]; this can stand before [mp, ft, sk, sp], although usually only lax vowels may stand there. I will argue that these exceptions to well-formedness are attributable to the influence of a set of output-output (OO) correspondence constraints known as *analogical constraints*. More isolated lexical exceptions are attributed to the influence of morpheme-specific faithfulness constraints called *parochial constraints*.

The role that analogical constraints and parochial constraints play in this analysis demonstrates an important consequence for OT: Constraints can actually encourage the proliferation of a phonologically marked pattern, and can also require specific lexical items to have a certain phonological shape.

EGA, the dialect I focus on here, has the following properties: It is rhotic (i.e. [r] may be present in syllable rhymes); it has merged the [ɑː] and [ɒ] of British English into [ɑ], so that *Kahn* and *con* are homophonous as [kɑn], and *father* and *bother* rhyme as [fɑðɚ, bɑðɚ]; it has merged historical [ɔr] and [or] so that *horse* and *hoarse* are homophonous as [hors]. I reject Halle and Mohanan's (1985) split of [ɑ] into two sounds, lax [ɑ] and tense [$ɑ_t$], on the grounds that they are phonetically identical in the dialect under investigation. Unlike many other dialects of North American English, EGA as examined here has NOT merged the vowels of *caught* [kɔt] and *cot* [kɑt]. Many varieties of EGA have an additional tense vowel [æ̰], which I discuss below in §4.4.

The organization of the chapter is as follows. In §4.2.1 the distribution of tense and lax vowels in EGA is described and in §4.2.2 is given an OT-based analysis. In §4.2.3 lexical exceptions to the usual pattern are discussed and analyzed. In §4.3 the exceptional behavior of the two low back vowels, lax [ɑ] and tense [ɔ] is described and analyzed. In §4.4 the analysis is extended to the tense vowel [æ̰] present in some varieties of EGA. §4.5 summarizes and concludes the chapter.

4.2 Distribution of tense and lax vowels in English

4.2.1 Description

English is generally described as having a distinction between tense and lax vowels. Minimal pairs such as *hit~heat, bet~bait, soot~suit, butt~boat* illustrate this contrast. In each pair, the lax vowel has a short, monophthongal pronunciation rather centralized with respect to the corresponding cardinal vowel: [hɪt], [bɛt], [sʊt], [bʌt]. The tense vowel in each case is somewhat longer, has a quality more nearly that of the cardinal vowel, and may tend to diphthongization, this tendency being greater in some dialects than in others: [hiˑt~hɪit], [beˑt~beɪt], [suˑt~sʊut], [boˑt~boʊt~bəʊt].

I am not concerned here with the articulatory or acoustic differences between the two groups; for a review of the debate the reader is referred to Halle (1977). Instead, I use purely distributional criteria to classify vowels into the groups "tense" and "lax." An arbitrary labeling could have also been used, such as the terms "free" and "checked" found, for example, in Kurath and McDavid (1961, 5) and Wells (1982, 119). Since diphthongs uniformly pattern with tense vowels, they are considered tense as well, regardless of the phonetics of their component parts.

Using distributional rather than phonetic criteria for this vowel classification allows us to avoid the problem that some vowels and diphthongs behave like tense vowels but are phonetically more similar to lax vowels. This is especially clear in the case of [ɔ], which is a mid lax vowel in many languages (e.g. Dutch, French, German), but in English [ɔ] really does pattern as a tense vowel, namely the tense counterpart to British [ɒ]/American [ɑ]. Wells (1982, 145) points out that American [ɔ] is quite open, falling between cardinal [ɒ] and cardinal [ɔ].

The distribution of tense and lax vowels in English has been discussed by a variety of authors, including Chomsky and Halle (1968), Kahn (1976), Lass (1976), Halle (1977), Halle and Mohanan (1985), Borowsky (1986, 1989), and Hammond (1999a). Tense vowels may stand in stressed final open syllables and in syllables closed by one of the marked voiced coronal fricatives [ð, ʒ]; lax vowels may not stand in either of those environments. Examples of (usually) tense-only environments are shown in (1). For the moment, I abstract away from the low back vowels [ɑ, ɔ].

(1) Distribution of vowels in stressed final open syllables and before final [ð, ʒ]
[i] *see, tree, degree; breathe, bequeath; liege, prestige*
[e] *day, play, delay; bathe; beige*
[u] *too, do, review; soothe; rouge*
[o] *sew, know, tableau; loathe; loge*
Note: The lax vowels [ɪ, ɛ, ʊ, ʌ, æ] are generally prohibited in these environments, but cf. [ɛð] (name of the letter "ð"), *with* [wɪð] (for some; many EGA speakers pronounce this [wɪθ]), and the French loanword *cortège* which may be pronounced with final [ɛʒ] or [eʒ]. [ɛ] is prohibited from stressed final open syllables even in loanwords, e.g. *cabaret* [kæ̀bəré] < French [kabarɛ], *café au lait* [kæfèolé] < French [kafeolɛ].

Note that the (nearly absolute) prohibition of lax vowels before [ð] and [ʒ] applies only when these consonants are in word final position. Word internally, lax vowels may stand before them, as in *gather*, *azure*; *feather*, *measure*; *wither*, *vision*; *mother*.

Conversely, lax vowels may stand before [ŋ] and before certain consonant clusters containing one noncoronal consonant (henceforth referred to as a "noncoronal cluster"); tense vowels may not stand in these environments. The clusters in question are those of obstruent + obstruent and sonorant + obstruent.[2] (Most obstruent + sonorant clusters can be preceded by both types of vowel.) The velar nasal [ŋ] has traditionally been

2 Included among the noncoronal clusters considered here are [ps, ks, pt, kt]; it must be pointed out that tense vowels are prohibited only before *tautomorphemic* clusters. Tense vowels freely appear here when the [s] or [t] in such clusters forms an inflectional ending (*peeps, peaks, peeped, peaked*). I do not have space here to develop an analysis of this fact.

assumed to be the surface representation of underlying /ng/, so it might be considered just another instance of a noncoronal cluster; but in my opinion this view is untenable because of pairs like *anger* [æŋgɚ] vs. *hangar* [hæŋɚ], *lingam* [lɪŋgəm] vs. *gingham* [gɪŋəm], *dingo* [dɪŋgo] vs. *dinghy* [dɪŋi][3], which suggest that [ŋ] is an independent phoneme. The restriction to lax vowels before noncoronal clusters and [ŋ] holds both when the consonants are word final and when they are intervocalic, showing that the distribution of tense and lax vowels in English is not always dependent on syllable structure (as was argued for Dutch by van der Hulst 1984 and Kager 1989, for German by Moulton 1962, Wiese 1996, and Féry 1997, and for French by Féry 2003b).[4] Blevins (2003) has argued that many phonotactic restrictions conventionally held to be attributable to syllable structure are actually best stated in terms of strings; the prohibition of tense vowels in English before [ŋ] and noncoronal clusters is apparently one such case.

(2) Distribution of vowels before noncoronal clusters and [ŋ]

[ɪ] *lisp, whisper; eclipse, gypsy; script, triptych; lift, nifty; risk, whisker; mix, pixie; strict, victim; filbert; sylph, pilfer; silver; film; milk; pilgrim; limp, simple; limber; link, trinket; linger; sing, gingham*

[ɛ] *vesper*; *biceps*, *epilepsy*; *accept*, *Neptune*; *left*; *desk*, *rescue*; *sex*, *exit*; *sect*, *nectar*; *help*; *Melba*; *shelf*, *belfry*; *twelve*, *velvet*; *elm*, *helmet*; *elk*, *welcome*; *hemp*, *tempest*; *ember*; *ginseng*

[ʊ] *pulpit*; *wolf*

[ʌ] *cusp*; *abrupt*; *tuft*, *mufti*; *tusk*, *musket*; *crux*, *buxom*; *duct*; *pulp*, *culprit*; *bulb*; *gulf*, *sulfur*; *culminate*; *bulk*; *vulgar*; *pump*, *trumpet*; *number*; *hunk*, *bunkum*; *hunger*; *tongue*

3 This is the pronunciation I use; it is listed first (followed by [dɪŋki] and [dɪŋgi]) in *Webster's Third New International Dictionary* and is recommended by Wells (2000) as a model for learners of English. Kenyon and Knott (1944), however, list only [dɪŋgi].

4 There is a large literature on English syllable structure. Some representative examples of this work are: Kahn (1976), Selkirk (1982), Clements and Keyser (1983), Borowsky (1986), and Lamontagne (1993).

[æ] *hasp, jasper*; *draft, after*; *lapse*; *rapt, captain*; *mask, basket*; *ax, taxi*; *act, practice*; *scalp*; *album*; *Ralph*; *valve*; *talc, falcon*; *amalgam*; *camp, pamper*; *amber*; *sank, Yankee*; *anger*; *fang, hangar*

Note: [i, e, o, u] are usually prohibited in such words, but cf. *chamber*, *cambric*, *Cambridge*, *traipse* with [e], *coax*, *hoax* with [o] and (for some speakers only) *rumba* with [u] (normally [rʌmbə] or [rʊmbə]).

The diphthongs [aɪ, ɔɪ, aʊ] pattern with the tense vowels, as shown in (3).

(3) Distribution of diphthongs: tense environments

[aɪ] *die*, *try*, *buy*, *lithe* (no examples before [ʒ])

[ɔɪ] *boy*, *joy*, *annoy* (no examples before [ð, ʒ])

[aʊ] *cow*, *allow*, *bough*, *mouth* (vb.) (no examples before [ʒ])

Note: These are usually prohibited before [ŋ] and noncoronal clusters, but cf. *deixis/deictic* with [aɪ].

The rhotacized diphthongs [ir ɛr ɝ ɑr or ur] do not occur before [ŋ] or, usually, noncoronal clusters (some exceptions listed below); neither do usually they occur before word final [ð, ʒ]. But they can stand at the end of stressed final syllables, implying that they have the distribution of tense vowels.

(4) Distribution of rhotacized diphthongs: tense environments

[ir] *peer*, *tear* (n.), *beer*

[ɛr] *pear*, *tear* (v.), *bear*; *concierge* [kɑnsiɛrʒ]

[ɝ] *spur*, *fir*, *myrrh*

[ɑr] *par*, *tar*, *bar*

[or] *pour*, *tore*, *boar*

[ur] *poor*, *tour*, *boor*

Exceptions: (*ant*)*arctic*, *coarctation*, *harpsichord*, *infarct*, *Marx* with [ɑr]; *excerpt*, *Xerxes* with [ɝ]; *corpse*, (*ab*-, *ad*)*sorption/-sorptive* with [or].

To sum up, although tense and lax vowels can contrast in stressed syllables that are closed by a single consonant (other than [ð, ʒ, ŋ]) or by a consonant cluster in which all members are coronal, in other environments the two sets are in complementary distribution (with some exceptions, as noted above). In word final stressed syllables that are either open or closed by [ð, ʒ], only tense vowels may occur. Before noncoronal clusters or [ŋ], only lax vowels may occur.

4.2.2 The basic constraint interaction

These facts can be submitted to an OT analysis by means of several interacting constraints. First of all, Foot Binarity (FTBIN) requires that feet be at least bimoraic. Second, TNS↔$\mu\mu$ says that vowels are tense if and only if they are bimoraic.[5] The constraint *3μ bans trimoraic syllables. The constraint NOMORA(ð,ʒ) prohibits these two voiced coronal fricatives from being moraic; as we see below, this has the result of banning short lax vowels before syllable final ð, ʒ. The constraint *TNSCLUS prohibits tense vowels before noncoronal clusters. Finally, the constraint MORA(ŋ) requires ŋ to be moraic, a constraint which could also play a role in the cross-linguistic tendency to disfavor [ŋ] in onset position.

(5) Constraints on prosodic structure active in EGA

a.	FTBIN	Feet are minimally bimoraic.
b.	TNS↔$\mu\mu$	Vowels are tense if and only if they are bimoraic.
c.	*3μ	Syllables are maximally bimoraic
d.	NOMORA(ð,ʒ)	[ð] and [ʒ] are not associated with a mora.
e.	*TNSCLUS	A tense vowel does not occur before a consonant cluster including a noncoronal consonant.
f.	MORA(ŋ)	[ŋ] is associated with a mora.

5 This constraint is regularly violated when tense vowels are unstressed: *pretty* [príti], *yellow* [jɛ́lo], *virtue* [vɝ́tʃu], etc. I will not be further concerned with unstressed tense vowels here.

In the data we have seen so far (abstracting away from the handful of exceptions like *traipse*, which will be discussed below), all of these constraints are unviolated, and assuming that all outrank IDENT(tense), requiring output vowels to have the same specification for [tense] as their corresponding inputs, it does not matter whether underlying vowels are marked as [+tense] or [−tense] in the environments where there is no contrast. The high-ranking markedness constraints will assure that the output is well formed regardless of what the input supplies.

So FTBIN and TNS↔$\mu\mu$ conspire to permit only tense vowels to surface in stressed open syllables, as shown for *see* in (6).[6] Since [ɪ] and [i] cannot contrast in this environment, it does not matter which of them is in the input, as only the tense [i] can surface in the output.

(6) Only tense vowels may appear in stressed open syllables

(α) /sɪ/ (β) /si/	FTBIN	TNS↔$\mu\mu$	IDENT(tense)	
sɪ$_{\mu}$	* !		(α)	
			(β)	*
sɪ$_{\mu\mu}$		* !	(α)	
			(β)	*
si$_{\mu}$	* !	*	(α)	*
			(β)	
☞ si$_{\mu\mu}$			(α)	*
			(β)	

6 Tracy Hall (p.c.) points out that full lax vowels are prohibited from word final position in unstressed syllables as well in EGA, e.g. *happy* [hǽpi], *[hǽpɪ], and suggests that it is a constraint banning full lax vowels from word final position rather than FTBIN that excludes *[sɪ] in (6). This seems unlikely, however, as there are many dialects of English (e.g. RP, Southern US English) where [hǽpɪ] is well formed, but there is no dialect of English that allows *[sɪ]. So I maintain that FTBIN is responsible for *[sɪ], and some other constraint rules out *[hǽpɪ] in EGA.

Adding NoMora(ð,ʒ) to the high ranking constraints ensures that only tense vowels appear before these two consonants. The tableau in (7) illustrates this for *bathe*, and it would be the same for *beige*.

(7) Only tense vowels appear before [ð] and [ʒ]

(α) /bɛð/ (β) /beð/	FtBin	NoMora(ð,ʒ)	Tns↔$\mu\mu$	Ident(tense)	
bɛ$_\mu$ð$_\mu$		* !		(α)	
				(β)	*
bɛ$_\mu$ð	* !			(α)	
				(β)	*
bɛ$_{\mu\mu}$ð			* !	(α)	
				(β)	*
be$_\mu$ð$_\mu$		* !	*	(α)	*
				(β)	
be$_\mu$ð	* !		*	(α)	*
				(β)	
☞ be$_{\mu\mu}$ð				(α)	*
				(β)	

In the environments where only lax vowels are permitted, Tns↔$\mu\mu$ conspires with *3μ, *TnsClus, and Mora(ŋ) to prohibit tense vowels from the relevant contexts. The tableau in (8) illustrates this for *sing* and the tableau in (9) for *whisper*.

(8) Only lax vowels appear before [ŋ]

(α) /sɪŋ/ (β) /siŋ/	*3μ	TNS↔$\mu\mu$	MORA(ŋ)	IDENT(tense)	
☞ sɪ$_\mu$ŋ$_\mu$				(α)	
				(β)	*
si$_\mu$ŋ$_\mu$		* !		(α)	*
				(β)	
si$_{\mu\mu}$ŋ			* !	(α)	*
				(β)	
si$_{\mu\mu}$ŋ$_\mu$	* !			(α)	*
				(β)	

(9) Only lax vowels appear before noncoronal clusters

(α) /wɪspɚ/ (β) /wispɚ/	TNS↔$\mu\mu$	*TNSCLUS	IDENT(tense)	
☞ wɪ$_\mu$spɚ			(α)	
			(β)	*
wi$_\mu$spɚ	* !	*	(α)	*
			(β)	
wi$_{\mu\mu}$spɚ		* !	(α)	*
			(β)	

In environments where tense and lax vowels contrast, namely in syllables closed by a single consonant other than [ð, ʒ, ŋ] and in position before coronal clusters, the inputs must not be as rich as they are in (6)–(9), because IDENT(tense) will be crucial in determining the optimal form. In other words, *pest* has only the input /pɛst/ and *paste* has only the input /pest/, and because of IDENT(tense) the desired surface forms will be judged optimal in each case. The remaining question is how to deal with lexical exceptions to the prohibition of tense vowels before noncoronal clusters, like *traipse*.

4.2.3 Lexical exceptions

According to Inkelas (1995, 1996) and Inkelas, Orgun, and Zoll (1997), lexical exceptions to otherwise robust well-formedness principles within a language are best treated by allowing a three-way underlying contrast between [+F], [−F], and [0F] and ordering the relevant faithfulness constraint above the relevant markedness constraint. This enables the fully specified forms always to surface faithfully, while the underspecified form, which cannot surface faithfully (all features being fully specified as either + or − on the surface), is subject to the markedness constraint. So, for example, most Turkish words are subject to coda devoicing, as shown by the contrast between (10)a and (10)b, but some words are exempt from coda devoicing, as shown in (10)c.[7] The tableaux illustrating the analysis of Inkelas, Orgun, and Zoll are given in (11). (/D/ represents a stop underspecified for voice.)

(10) Turkish coda devoicing

a. kanat — 'wing'
   kanatlar — (plural)
   kanadɯ — (accusative)

b. devlet — 'state'
   devletler — (plural)
   devleti — (accusative)

c. etyd — 'study'
   etydler — (plural)
   etydy — (accusative)

(11) The analysis of Inkelas, Orgun, and Zoll

a. Alternating [t ~ d] has input /D/

/kanaD/	FAITH	CODA DEVOICING
☞ kanat	*	
kanad	*	* !

7 See Artstein (1998) for further discussion of this example.

b. Nonalternating [t] has input /t/

/devlet/	FAITH	CODA DEVOICING
☞ devlet		
devled	* !	*

c. Nonalternating [d] has input /d/

/etyd/	FAITH	CODA DEVOICING
etyt	* !	
☞ etyd		*

Inkelas, Orgun, and Zoll argue that this analysis is superior to a rule-based one that requires cophonologies, but it comes at the cost of allowing a three-way underlying contrast among [+voice], [−voice], and [0voice]. This is in violation not only of the Contrastive Underspecification hypothesis (Calabrese 1988), according to which features that contrast (e.g. [voice] in Turkish) cannot be left unspecified underlyingly, but also of the convention of (both contrastive and radical) underspecification theory, going back to Stanley (1967), that assumes, in the words of Kiparsky (1993, 285),

> strict binarity of feature specifications in underlying lexical representations. In each environment, we can have at most [0F] and [αF], where [$-\alpha$F] is the value assigned by the most specific rule (language-particular or universal) which is applicable in that environment.

That alone is worrying enough, but when we consider the arguments that have been presented against input underspecification within OT in general, the analysis becomes even weaker. For example, Smolensky (1993) argues that in an OT approach to markedness, unmarked features are phonologically inert not because they are absent the input (in fact, they are present there), but because they are literally unmarked, i.e. engender no violation marks under harmony evaluation (cf. also Golston 1996). Smolensky's approach would then not predict any difference between [−voice] and [0voice] in obstruents. Itô, Mester, and Padgett (1995), examining redundant feature specifications (in particular [voice] in nasals), show that there is no requirement of underlying feature minimization, implying that underlying [0voice]—whether on sonorants or on obstruents—is an unnecessary and therefore undesirable tool. Harrison and Kaun (2000, 2001) argue that underspecification is found only in response to pervasive, surface true patterns and is not found in idiosyncratic patterns. Exceptions to Turkish coda devoicing and to the distribution of tense and lax vowels in English are certainly idiosyncratic patterns, and therefore should not lead to underspecification under their theory.

A phonological theory allowing morpheme-specific faithfulness constraints, however, allows an analysis of lexical exceptions that relies neither on cophonologies nor on underspecification. I will refer to these morpheme-specific faithfulness constraints as *parochial constraints*. Parochial constraints require particular morphemes to surface with particular features. When a parochial constraint outranks a markedness constraint, which in turn outranks the general faithfulness constraint, we get the situation where well-formedness is violated in a portion of the lexicon while being obeyed more generally. Frequently, the words governed by parochial constraints belong to an exceptional category of the lexicon, such as foreign words, onomatopoeias, hypocoristics, etc. This is the case in the Turkish example, where the words that are exempt from final devoicing are all foreign words, e.g. *etüd* 'study' < French *étude*. Nevertheless, it does not seem to be the case that exceptional words are *necessarily* identifiable as a member of a category like foreign words, etc.

In (1)–(4) I listed words showing that, for the most part, only tense vowels are allowed before word final [ð, ʒ] and only lax vowels are permitted before tautomorphemic noncoronal clusters, but there were some exceptions to this tendency. I repeat some of those exceptions here for convenience.

(12) Exceptions to the distribution of tense and lax vowels

a. *with* wɪð

b. *cortège* kortɛʒ

c. *chamber* tʃembɚ
d. *coax* koks
e. *deixis/deictic* daɪksəs/daɪktɪk
f. *excerpt* ɛksɝpt
g. *traipse* treps
h. *corpse* korps

In (12)a–b, NoMora(ð,ʒ) is violated; in (12)c–h, *TnsClus is. I therefore propose that exceptional words like those in (12) have parochial constraints requiring them to have the vowel with which they surface. For example, the constraint $_{traipse}$(e) requires the lexical item *traipse* to surface with the vowel [e]. This constraint outranks *TnsClus.

(13) A parochial constraint for the vowel of *traipse*

/treps/	$_{traipse}$(e)	*TnsClus	Ident(tense)
☞ treps		*	
trɛps	* !		*

Similarly for *cortège*, the parochial constraint $_{cortège}$(ɛ) outranks NoMora(ð,ʒ). The majority of words, however, have no such parochial constraint. In this case, *TnsClus determines that the optimal candidate must have a lax vowel before a noncoronal cluster, as we saw above in (9). The parochial constraints are a kind of special faithfulness constraint. Exceptional words require stronger faithfulness, achieved through high-ranking lexeme-specific faithfulness constraints (parochial constraints), than words that follow the usual phonological pattern.

We have now analyzed the distribution of most tense and lax vowels in EGA, including the lexical exceptions. We have seen that attributing lexical exceptions to the presence of high ranking parochial constraints allows an analysis that does not require the highly questionable step of permitting a three-way [+F]/[−F]/[0F] distinction in the input of a constraint-based grammar. In the next section we move our attention to the low back vowels [ɑ] and [ɔ], which we have ignored up to now, and whose distribution blurs the distinction between tense and lax vowels.

4.3 Ambiguity in low back vowels

4.3.1 The distribution of [ɑ] and [ɔ]

EGA has two low back vowels, [ɑ] and [ɔ]. Since [ɔ] is often longer than [ɑ], and because [ɔ] but not [ɑ] is blocked before most noncoronal clusters (as will be discussed presently), it is attractive to consider these vowels a lax/tense pair like the ones discussed in §4.2.1. As shown in (14), [ɑ] and [ɔ] contrast in environments where both tense and lax vowels are permitted.

(14) Minimal pairs illustrating lax [ɑ] vs. tense [ɔ]

a.	*collar*	kɑlɚ	*caller*	kɔlɚ
b.	*cot*	kɑt	*caught*	kɔt
c.	*stock*	stɑk	*stalk*	stɔk
d.	*don*	dɑn	*dawn*	dɔn
e.	*knotty*	nɑti	*naughty*	nɔti

However, unlike the pairs seen above, [ɑ] and [ɔ] may contrast also in stressed open final syllables and before [ŋ].[8]

(15) Contrast of [ɑ] and [ɔ] in stressed open final syllables and before [ŋ]

a.	*Shah*	ʃɑ	*Shaw*	ʃɔ
b.	*la*	lɑ	*law*	lɔ
c.	*pa*	pɑ	*paw*	pɔ
d.	*ma*	mɑ	*maw*	mɔ
e.	*Hong Kong*	hɑŋkɑŋ	*long*	lɔŋ
f.	*dugong*	dugɑŋ	*gong*	gɔŋ

8 The contrast between [ɑŋ] and [ɔŋ] is not very robust. Although [lɔŋ] is probably nearly universal for speakers of EGA who contrast [ɑ] and [ɔ], the pronunciations [hɑŋkɑŋ], [dugɑŋ], and [gɔŋ] must be taken merely as common variants beside [hɔŋkɔŋ], [dugɔŋ], and [gɑŋ].

Thus we see that both [ɑ] and [ɔ] can occur in environments where only tense vowels are allowed, as well as in environments where only lax vowels are allowed. The distribution of [ɑ] and [ɔ] is illustrated in (16)–(17).

(16) Distribution of [ɑ]
Tense environments: *bra*, *spa*, *Shah*, *mirage*
Lax environments: *wasp*, *copse*, *mosque*, *ox*, *opt*, *concoct*, *pomp*, *somber*, *conquer*, *conger*, *Hong Kong*
Other environments: *father*, *bother*, *balm*, *bomb*, *Mali*, *Molly*

(17) Distribution of [ɔ]
Tense environments: *jaw*, *law*, *saw*
Lax environments: *soft* (and most words in *-oft*), *long* (and most words in *-ong*), *bauxite*, *auction*, *auxiliary*, *auspice*, *auscultation*, *palfrey*, *Balkan*
Other environments: *thought*, *hawk*, *daub*, *cloth*, *cross*, *off*

In the next two subsections we will look at this ambiguous distribution in more detail and begin to form an analysis.

4.3.2 Lax [ɑ] in tense-only environments

We begin with the distribution of [ɑ], which we are assuming to be [−tense]. In words like *bra*, *spa*, *Shah*, the [ɑ] is presumably bimoraic, indicating that TNS↔$\mu\mu$, the constraint against long lax vowels, is violated. Take for example the word *spa*. Given the constraint hierarchy shown above in (6), even the input /spɑ/ should give the output *[spɔ].

(18) Constraint hierarchy falsely predicts *spa* to be *[spɔ]

/spɑ/	FTBIN	TNS↔$\mu\mu$	IDENT(tense)
spɑ$_{\mu}$	* !		
spɑ$_{\mu\mu}$		* !	
☹ spɔ$_{\mu\mu}$			*

Similarly, the constraint hierarchy predicts *[mərɔ$_{\mu\mu}$ʒ] for *mirage* because NoMora(ð,ʒ) $\gg$ Ident(tense). But following the analysis of lexical exceptions outlined in §4.2.3, we may propose a high ranking parochial constraint specific to the lexical items *spa* and *mirage* requiring them to have lax vowels: $_{spa}$(ɑ) and $_{mirage}$(ɑ). The tableaux illustrating this analysis, given in (19), also show that FtBin outranks Tns$\leftrightarrow\mu\mu$, which was not provable before. The parentheses in (19)b show foot boundaries.

(19) Parochial constraints force lax [ɑ] to show up in tense contexts

a. In a stressed open syllable (*spa*)

/spɑ/	FtBin	$_{spa}$(ɑ)	Tns$\leftrightarrow\mu\mu$	Ident(tense)
spɑ$_{\mu}$	* !			
☞ spɑ$_{\mu\mu}$			*	
spɔ$_{\mu\mu}$		* !		*

b. Before [ʒ] (*mirage*)

/mərɑʒ/	FtBin	$_{mirage}$(ɑ)	NoMora (ð,ʒ)	Tns$\leftrightarrow\mu\mu$	Ident(tense)
mə(rɑ$_{\mu}$ʒ$_{\mu}$)			* !		
mə(rɑ$_{\mu}$ʒ)	* !				
☞ mə(rɑ$_{\mu\mu}$ʒ)				*	
mə(rɔ$_{\mu\mu}$ʒ)		* !			*

It is especially interesting that all words in which [ɑ] appears in contexts otherwise restricted to tense vowels are either foreign words like *spa* and *mirage* or hypocoristics like *ma* and *pa*. These are two categories where normal phonotactic restrictions are often lifted and exceptional faithfulness, by means of parochial constraints, is necessary. Ordinary native words like *law*, on the other hand, need no parochial constraint and surface with a tense vowel because of ordinary constraint interaction, regardless of whether the input provides /ɑ/ or /ɔ/.

(20) No parochial constraints for “ordinary” words (i.e. neither foreign nor hypocoristics)

(α) /lɑ/ (β) /lɔ/	FTBIN	TNS↔μμ	IDENT(tense)	
lɑ$_{\mu}$	* !		(α)	
			(β)	*
lɑ$_{\mu\mu}$		* !	(α)	
			(β)	*
☞ lɔ$_{\mu\mu}$			(α)	*
			(β)	

Once again, exceptional words require parochial constraints to achieve lexeme-specific faithfulness, while ordinary words follow the general pattern.

The case of *mirage* is not isolated: there are a fair number of French loanwords ending in *-age* [ɑʒ], such as *badinage, barrage, camouflage, collage, corsage, entourage, espionage, fuselage, garage, massage, ménage, persiflage, sabotage*, etc. Thus it may be useful to think of a constraint family $_{\textit{-age}}$(ɑ) consisting of individual constraints like $_{\textit{mirage}}$(ɑ).

4.3.3 Tense [ɔ] in lax-only environments

We can now move on to the [ɔ] cases. Notice in (17) that [ɔ] is not permitted in *all* lax environments: It occurs before [ŋ] and [ft], and in a few isolated words like *bauxite* and *auction*, but otherwise not before noncoronal clusters. Also, if we compare words that have [ɔ] before [ŋ] with those that have [ɑ] before [ŋ] we see that most words have [ɔ], but some foreign and echoic words can vary between [ɑ] and [ɔ] (i.e. some speakers use [ɑ] and others use [ɔ]). Before [ŋk, ŋg], however, [ɑ] is usual.

(21) Distribution of [ɔ] and [ɑ] before [ŋ]

a. [ɔ] before [ŋ] in most words
along, belong, ding-dong, (di-, mono-, tri-)phthong, dong, furlong, gong, long, mah-jongg, Mekong, oblong, oolong,

prolong, prong, sarong, scuppernong, song, strong, thong, throng, tongs, wrong

b. [ɑ ∼ ɔ] variability before [ŋ] in some foreign and echoic words
bong, dugong, Hong Kong, Ping-Pong, Vietcong

c. [ɑ] fairly consistently before [ŋk, ŋg][9]
bongo, bonkers, bronchial, bronco, Bronx, conch, concubine, conga, conger, Concord, Congo, congress, congruence, conquer, donkey, honk, honky-tonk, humongous, jongleur, jonquil, Mongol, mongoose, mongrel, Rancho Cucamonga, Songhai, Tonga, Yonkers, zonked

We begin our analysis with common native words like *long*, pronounced [lɔŋ] in EGA. Given the constraint hierarchy given above in (8), even the input /lɔŋ/ should give the output *[lɑŋ].

(22) Constraint hierarchy falsely predicts *long* to be *[lɑŋ]

/lɔŋ/	*3μ	Tns↔$\mu\mu$	Mora(ŋ)	Ident(tense)
lɔ$_{\mu\mu}$ŋ			* !	
lɔ$_{\mu\mu}$ŋ$_{\mu}$	* !			
lɔ$_{\mu}$ŋ$_{\mu}$		* !		
☹ lɑ$_{\mu}$ŋ$_{\mu}$				*

One conceivable solution (which we will later reject) would be to follow the same route we took for *spa* and *mirage* and propose parochial constraints requiring words like *long* to have [ɔ].

(23) Parochial constraint forces *long* to be [lɔŋ]

/lɔŋ/	$_{long}$(ɔ)	*3μ	Tns↔$\mu\mu$	Mora(ŋ)	Ident(tense)
☞ lɔ$_{\mu\mu}$ŋ				*	
lɔ$_{\mu\mu}$ŋ$_{\mu}$		* !			
lɔ$_{\mu}$ŋ$_{\mu}$			* !		
lɑ$_{\mu}$ŋ$_{\mu}$	* !				*

9 Some of these words may have [ɔ] or [ʌ] for some speakers.

Under this analysis, the other words listed in (21)a would also have parochial constraints requiring that they have [ɔ], and these parochial constraints would be ranked above MORA(ŋ). Other words, such as those in (21)c, those in (21)b for speakers who use the variant [ɑ] rather than [ɔ], and all words with any vowel besides a low back vowel before [ŋ], would not have any parochial constraint requiring them to have a certain kind of vowel, but would be taken care of solely by the usual phonotactic and faithfulness constraints, as shown in (24) for *dugong* with the pronunciation [dugɑŋ]. (For simplicity's sake I exclude candidates that violate *3μ and TNS↔$\mu\mu$.)

(24) No parochial constraints for words with [ɑŋ]

(α) /dugɑŋ/ (β) /dugɔŋ/	MORA(ŋ)	IDENT(tense)	
☞ dugɑ$_\mu$ŋ$_\mu$		(α)	
		(β)	*
dugɔ$_{\mu\mu}$ŋ	* !	(α)	*
		(β)	

The idea, therefore, would be that the words in (21)a, i.e. the native words, form a class of lexical exceptions to the generalization that tense vowels are prohibited before [ŋ], and that these lexical exceptions are accounted for by high ranking parochial constraints. Newer words, such as those in (21)b, follow the phonotactically expected pattern and thus are not subject to this kind of parochial constraint.

This analysis, however, flies in the face of the usual treatment of exceptional loanword phonology, according to which native words conform to phonotactically expected patterns, while loanwords can violate markedness constraints that native words are subject to (Itô and Mester 1995, 1999, Davidson and Noyer 1997, Fukazawa, Kitahara, and Ota 1998, Féry 2003a).

The problem then is to find a way to capture the intuition that the native words in (21)a are less marked than the foreign words in (21)b. To do this, I turn to the principle of analogical output-output faithfulness constraints.

The first point to make is that the forms in (21)a include the most commonly occurring (and probably earliest acquired) words of all that contain a low back vowel followed by ŋ: *along, belong, ding-dong, long, song, strong, wrong*. These words establish in the lexicon a correlation between [ɔ] and [ŋ] that overrides MORA(ŋ); this correlation can be stated as a set of output-output (OO) faithfulness constraints relating the [ɔŋ] sequence in each of these words to the [ɔŋ] sequence in each of the others. I call this kind of OO faithfulness constraint an *analogical constraint*.[10] Assuming just these seven words, there are 21 OO constraints requiring that both members of any pair have the sequence [ɔŋ] (as exemplified in (25)).[11]

(25) IDENT-OO(*long, song*; ɔŋ), IDENT-OO(*long, strong*; ɔŋ), IDENT-OO(*song, strong*; ɔŋ), etc.

The constraints in (25), acting together, are strong enough to attract the rest of the words in (21)a and, for many speakers, some or all of the words in (21)b into it.[12] A representative

10 My concept of analogical constraints was originally inspired by J. Myers (1999, 2002), who, however, considers them to be constraint conjunctions.

11 An issue I do not have space to go into here is how this pattern got started. Briefly, I suspect that only a historical explanation is possible: at some point in the history of the dialect(s) in question there was a sound change tensing [ɒ] (the ancestor sound of EGA [ɑ] in lax environments) to [ɔ] before [ŋ]. The phonetic or phonological rationale for such a sound change is unclear to me, and it may not have originally applied to all words simultaneously. Instead, it may have begun in just a few forms and then spread by lexical diffusion.

12 See Burzio (2002a, b) for discussion of how lexical items become attracted into patterns. The remaining words in (21)b and those in (21)c do not have such a strong connection with those in (21)a, either because of their low frequency (see Bybee 1995, 2003 on the importance of frequency in establishing lexical connections), their status as recent loanwords, or the presence of [k] or [g] after [ŋ].

tableau for *diphthong* [dɪfθɔŋ] is given in (26). In practice, there would not be just a single OO conjunction, but at least seven, one pairing *diphthong* with each of the most common [ɔŋ] words.

(26) *diphthong* [dɪfθɔŋ] influenced by analogy with *long* etc.

(α) /dɪfθɑŋ/ (β) /dɪfθɔŋ/	OO(*long*, *diphthong*; ɔŋ)	MORA(ŋ)	IDENT(tense)
dɪfθɑ$_\mu$ŋ$_\mu$	* !		(α) (β) *
☞ dɪfθɔ$_{\mu\mu}$ŋ		*	(α) * (β)

Words like those listed in (21)b, which vary between [ɑ] and [ɔ] before [ŋ], have parochial constraints requiring them to have lax vowels, but only in the grammars of some speakers. Different speakers of the same language may have slightly different grammars, and the presence or absence of these parochial constraints is one of the differences that may be found among speakers. Speakers who pronounce *Vietcong* [viɛtkɑŋ] have a high ranking parochial constraint $_{Vietcong}$(ɑ); speakers who pronounce it [viɛtkɔŋ] do not. For them, the analogical constraints linking *Vietcong* with familiar words like *long* are decisive.

(27) Variability in *Vietcong*

a. Grammar with the parochial constraint

(α) /viɛtkɑŋ/ (β) /viɛtkɔŋ/	$_{Vietcong}$(ɑ)	OO(*long*, *Vietcong*; ɔŋ)	MORA(ŋ)	IDENT(tense)
☞ viɛtkɑ$_\mu$ŋ$_\mu$		*		(α) (β) *
viɛtkɔ$_{\mu\mu}$ŋ	* !		*	(α) * (β)

b. Grammar without the parochial constraint

(α) /viɛtkɑŋ/ (β) /viɛtkɔŋ/	OO(*long, Vietcong*; ɔŋ)	MORA(ŋ)	IDENT(tense)	
viɛtk$ɑ_{\mu}$$ŋ_{\mu}$	* !		(α)	
			(β)	*
☞ viɛtk$ɔ_{\mu\mu}$ŋ		*	(α)	*
			(β)	

This analysis now lets us mark foreign words like *Vietcong* as special and unusual, while native words like *long, song, strong,* and *wrong* obey the basic constraint ranking of the language. Note, however, that the basic constraint ranking of the language is not simply a matter of conflicting markedness and faithfulness constraints. Rather, analogical constraints play a role as well, establishing strong patterns that violate otherwise robust phonotactic tendencies. This approach allows us to treat the difference between foreign words and native words in a much more intuitively satisfying way.

Now we can return to the words in (21)c, showing [ɑ] before [ŋk, ŋg]. I suggest that these words show that [ŋk, ŋg], unlike [ŋ] alone, are not attracted into the [ɔŋ] analogy of *long* ∼ *strong* ∼ *song* etc. This may be because the place features of [ŋ] in *long, strong, song,* etc., are independent, while in [ŋk, ŋg] sequences the place features are shared with the following stop. Whatever the reason, words with [ŋk, ŋg] are free from the analogical influence of the [ɔŋ] words and therefore subject to the markedness constraints MORA(ŋ) and *TNSCLUS. Thus *conquer* [kɑŋkɚ] has a lax vowel for precisely the same reason *sing* in (8) and *whisper* in (9) do: high ranking MORA(ŋ) and *TNSCLUS.

(28) [-ɑŋk-] by regular phonology

(α) /kɑŋkɚ/ (β) /kɔŋkɚ/	MORA(ŋ)	*TNSCLUS	IDENT(tense)	
☞ kɑ$_{\mu}$ŋ$_{\mu}$kɚ			(α)	
			(β)	*
kɔ$_{\mu\mu}$ŋkɚ	* !	*	(α)	*
			(β)	

The sequence [ɔŋg] is otherwise found only in the morphologically complex forms *longer*, *longest*, *stronger*, *strongest*, *diphthongal*. The analysis as described so far falsely predicts [ɑ] rather than [ɔ] in these words, because [ŋg] is not supposed to be attracted into the [ɔŋ] analogy. As shown in the tableau in (29), the theory predicts *[lɑŋgɚ] for *longer*.

(29) Falsely predicted [-ɑŋg-] in *longer*

(α) /lɑŋgɚ/ (β) /lɔŋgɚ/	MORA(ŋ)	*TNSCLUS	IDENT(tense)	
☹ lɑ$_{\mu}$ŋ$_{\mu}$gɚ			(α)	
			(β)	*
lɔ$_{\mu\mu}$ŋgɚ	* !	*	(α)	*
			(β)	

Appealing to a high ranking parochial constraint requiring *longer* etc. to contain a tense vowel is unsatisfying, for the same reasons that the similar constraint for *long* given in (23) was unsatisfying: these forms do not seem to be lexical exceptions in any way, and should be able to be accounted for directly. To do this, we need an OO constraint requiring that vowels in the positive and comparative forms of an adjective agree for the feature [tense]: IDENT-OO(A_{pos}, A_{cmp}; [tense]). Ranking this constraint above *TNSCLUS achieves the desired result, as shown in the tableau in (30). As discussed above, the [ɔ] of *long* is an effect of analogical constraints among the various words ending in *-ong*; only one of these is shown in the tableau.

(30) [-ɔŋg-] in *longer* by faithfulness to *long*

(α) pos:/lɑŋ/ cmp:/lɑŋgɚ/ (β) pos:/lɔŋ/ cmp:/lɔŋgɚ/	OO(*long*, *song*; ɔŋ)	IDENT-OO(A_{pos}, A_{cmp}; [tense])	MORA(ŋ)	*TNSCLUS	IDENT(tense)
pos: lɔ$_{\mu\mu}$ŋ cmp: lɑ$_{\mu}$ŋ$_{\mu}$gɚ		* !	*		(α) * (β) *
☞ pos: lɔ$_{\mu\mu}$ŋ cmp: lɔ$_{\mu\mu}$ŋgɚ			**	*	(α) ** (β)
pos: lɑ$_{\mu}$ŋ$_{\mu}$ cmp: lɑ$_{\mu}$ŋ$_{\mu}$gɚ	* !				(α) (β) **

The relationship between the vowels in *diphth*[ɔ]*ng* and *diphth*[ɔ]*ngal* can presumably be analyzed in a similar way, although this is obviously not a positive/comparative adjective pair.

As mentioned briefly above, [ɔ] occurs regularly not only before [ŋ] but also before the noncoronal cluster [ft] in native words and names of English origin: *aloft*, *Ashcroft*, *Bancroft*, *loft*, *oft*, *often* (when pronounced with [t]), *soft*. Here again, analogical constraints connecting tense [ɔ] with the cluster [ft] outrank *TNSCLUS, as shown in the tableau in (31). (As above, one analogical constraint is shown in the tableau, but this must be understood as standing for many of them, one for each pair of words with [ɔft].)

(31) Analogical constraints for [-ɔft]

(α) /lɑft/ (β) /lɔft/	OO(*loft, soft*; ɔft)	*TNSCLUS	IDENT(tense)	
lɑft	* !		(α)	
			(β)	*
☞ lɔft		*	(α)	*
			(β)	

There is even a lexical exception to the pattern of having [ɔ] rather than [ɑ] before [ft]: the Yiddish loanword *zaftig*, which is usually pronounced [zɑftɪg]. For this word, there is a high ranking parochial constraint requiring a lax vowel that outranks the analogical constraints establishing the [ɔft] pattern, as illustrated in (32).

(32) *Zaftig* as a lexical exception

(α) /zɑftɪg/ (β) /zɔftɪg/	$_{zaftig}$(ɑ)	OO(*zaftig, soft*; ɔft)	*TNSCLUS	IDENT(tense)	
☞ zɑftɪg		*		(α)	
				(β)	*
zɔftɪg	* !		*	(α)	*
				(β)	

So there are a number of instances where the usual distributional restrictions on tense vowels are suspended for [ɔ], such that [ɔ] occurs nearly to the exclusion of [ɑ] before [ŋ] (but not usually before [ŋk, ŋg]) and before [ft], but there are foreign words like *dugong* and *zaftig* that are exceptions to this exceptional behavior.

4.4 The low front tense vowel [æ̩]

In many varieties of EGA there is a tense partner to lax [æ]; its exact phonetic realization varies from region to region, but in general it is either a vowel slightly higher and somewhat longer than [æ] or else a diphthong beginning with a front vowel and ending with [ə], so somewhere along the spectrum [æə~ɛə~eə ~ɪə]. For some speakers this vowel may also be spontaneously nasalized (i.e. even when not preceding a nasal consonant). I will use the symbol [æ̩] to indicate any variety of this "tense [æ]." Unlike the other tense vowels of English, [æ̩] does not occur in stressed open final syllables. This is because it is historically derived from lax [æ], which could not stand there; therefore there are no words in which [æ̩] has the opportunity to stand in a stressed open final syllable.[13] Discussions of this vowel and its patterning can be found in Trager (1930, 1934, 1940, 1941), Labov (1966, 1972, 1981), Ferguson (1972), Kahn (1976), Wells (1982, 477–79, 510–12), Benua (1995), and Morén (1997) (who analyzes the vowel in question as lax).

In most dialects that have [æ̩], it occurs in stressed final syllables before nasals (except [ŋ]) and voiceless fricatives (not all dialects allow it before [ʃ]); some varieties allow it before voiced obstruents as well.[14] Interestingly, noncoronal clusters beginning with one of the permitted segments are *not* excluded. Some examples of words with [æ̩] are shown in (33).[15]

(33) Words with [æ̩]

a.	*ram*	ræ̩m
b.	*ran*	ræ̩n
c.	*laugh*	læ̩f
d.	*path*	pæ̩θ
e.	*pass*	pæ̩s
f.	*camp*	kæ̩mp

---

13 The only exceptions I know of are *yeah* and *nah*, pronounced [jæ̩] and [næ̩]. In nonrhotic accents, diphthongal [æ̩] may also be found in words like *pair* [pæ̩], *care* [kæ̩]. For some speakers, then, *scarce* [skæ̩s] rhymes with *pass* [pæ̩s].

14 And within voiced obstruents, there is also variation. For example, some people have [æ̩] before voiced fricatives and [d] but [æ] before [b, g]. Other people have [æ̩] before voiced fricatives and [d, b], but [æ] before [g].

15 Many thanks to my informants: Nate Brown (Schenectady, NY), Ellen DeSoto (Poughkeepsie, NY), Jeff Kaplan (Philadelphia), Cindy Schneider (Watchung, New Jersey), and Alan Stevens (New York City).

g. *shaft* ʃæ̩ft
h. *task* tæ̩sk
i. *grasp* græ̩sp

There are some words that unexpectedly have [æ] in these environments, resulting in minimal pairs between [æ̩] and [æ], such as *can* 'tin container' [kæ̩n] vs. *can* 'be able' [kæn], or *halve* [hæ̩v] vs. *have* [hæv] and (for some people) *bad* [bæ̩d] vs. *bade* [bæd] in the varieties that allow [æ̩] before voiced obstruents. [æ̩] does not generally occur in open syllables, e.g. *manage* [mænɪdʒ], *tassel* [tæsəl], with the proviso that while Class 1 suffixes cause [æ̩ ~ æ] alternations (*class* [klæ̩s] ~ *classic* [klæsɪk]), Class 2 suffixes do not (*classy* [klæ̩si]). Also, monosyllables that are truncations of longer words maintain the vowel of the original, resulting in pairs like *caf* [kæf] (truncation of 'cafeteria') vs. *calf* [kæ̩f], *path* [pæθ] (truncation of 'pathology') vs. *path* [pæ̩θ] (as in 'footpath'), or *Mass* [mæs] (truncation of 'Massachusetts') vs. *mass* [mæ̩s] (Benua 1995). In some varieties, [æ̩] can occur (even in open syllables) also before [r], as in *Mary* [mæ̩ri], which is then distinct from both *merry* [mɛri] and *marry* [mæri]; in other varieties, *Mary* and *merry* (and sometimes *marry* as well) are homophonous as [mɛri].[16]

Like most tense vowels, [æ̩] is prohibited before [ŋ] and before most noncoronal clusters (except [mp, ft, sk, sp]), as shown in (34).

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16 For some people, the distribution of [æ] and [æ̩] is apparently in lexical diffusion (cf. Labov 1994). One of my informants has, for example, [æ] in *graph*, *half*, and *staff* but [æ̩] in *laugh* and *riff-raff*; before a noncoronal cluster she has [æ] in *Basque*, *cask*, *casket*, *flask*, *paschal*, *rascal* but [æ̩] in *ask*, *bask*, *basket*, *mask*, *task*. As often seems to be the case with lexical diffusion, there is great variation: one informant has [æ] in *clasp*, *grasp*, *hasp*, *rasp* and [æ̩] in *asp*, *gasp*; another informant has [æ] in *asp*, *gasp*, *hasp* and [æ̩] in *clasp*, *grasp*, *rasp*; a third has [æ] in *asp*, *clasp*, *grasp*, *hasp* and *rasp* and [æ̩] in *gasp*; a fourth has [æ] in *asp* and *hasp* and [æ̩] in *clasp*, *gasp*, *grasp*, *rasp*. So all four have [æ] in *hasp*, but otherwise there is no agreement. A fifth informant has [æ̩] in all these words.

(34) Only [æ], not [æ̝]

a.	*lapse*	læps	*læ̝ps
b.	*rapt*	ræpt	*ræ̝pt
c.	*ax*	æks	*æ̝ks
d.	*act*	ækt	*æ̝kt
e.	*scalp*	skælp	*skæ̝lp
f.	*Ralph*	rælf	*ræ̝lf
g.	*valve*	vælv	*væ̝lv
h.	*talc*	tælk	*tæ̝lk
i.	*fang*	fæŋ	*fæ̝ŋ
j.	*sank*	sæŋk	*sæ̝ŋk

The prohibition of [æ̝] in the environments in (34) can be analyzed in the same way as the prohibition of other tense vowels in these environments was analyzed in §4.2.2. Tableaux for *fang* and *lapse* are shown in (35)–(36).

(35) [æ] not [æ̝] before [ŋ]

(α) /fæŋ/ (β) /fæ̝ŋ/	*3μ	TNS↔$\mu\mu$	MORA(ŋ)	IDENT(tense)
☞ fæ$_\mu$ŋ$_\mu$				(α) (β) *
fæ̝$_\mu$ŋ$_\mu$		* !		(α) * (β)
fæ̝$_{\mu\mu}$ŋ			* !	(α) * (β)
fæ̝$_{\mu\mu}$ŋ$_\mu$	* !			(α) * (β)

(36) [æ] not [æ̝] before noncoronal clusters

(α) /læps/ (β) /læ̝ps/	TNS↔μμ	*TNSCLUS	IDENT(tense)	
☞ læps			(α)	
			(β)	*
$læ̝_{\mu}ps$	* !	*	(α)	*
			(β)	
$læ̝_{\mu\mu}ps$		* !	(α)	*
			(β)	

As for (33)f–i, the analysis is basically the same as it was for words like *long* and *soft*: high ranking analogical constraints force the members of these classes to rhyme with each other. For example, each pair of words in the set {*ask*, *bask*, *cask*, *flask*, *mask*, *task*} establishes a correlation between the cluster [sk] and the preceding vowel [æ̝]. In the tableau in (37), just one of these analogical constraints is illustrated, but it stands for all of them.

(37) Analogical constraints for [æ̝sk]

(α) /tæsk/ (β) /tæ̝sk/	OO(*task, ask*; æ̝sk)	*TNSCLUS	IDENT(tense)	
tæsk	* !		(α)	
			(β)	*
☞ tæ̝sk		*	(α)	*
			(β)	

There are lexical exceptions to this pattern as well. For example, one of my informants reports that he generally has [æ̝] before [sk] in stressed penults: *basket*, *casket*, *rascal* all have [æ̝]. But *paschal*, which is a rather rare word, is exceptional in having [æ]. Once again, a parochial constraint, this time requiring *paschal* to have a lax vowel, can take care of this, as shown in (38).

(38) Parochial constraint for *paschal* with [æ]

(α) /pæskəl/ (β) /pæ̟skəl/	${}_{paschal}$(æ)	OO(*paschal*, *rascal*; æ̟sk)	*TnsClus	Ident(tense)
☞ pæskəl		*		(α) (β) *
pæ̟skəl	* !		*	(α) * (β)

So, just as we saw with [ɔ] in §4.3, there are circumstances under which the tense vowel [æ̟] occurs in environments where normally only lax vowels are allowed. The facts can be analyzed in a theory that assumes analogical constraints relating rhyming words, which outrank phonotactic constraints like *TnsClus. Unusual words like *paschal* can be lexically marked with a parochial constraint to ensure faithfulness.

4.5 Conclusions

In this chapter, I have discussed data from Eastern General American English that show regular exceptions to the distribution of lax and tense vowels. Namely, while it is usually the case that lax vowels cannot stand in stressed final syllables that are either open or closed by [ð, ʒ], there are lexical exceptions like *with* [wɪð] and a fair number of exceptions involving [ɑ] in foreign words: *spa*, *bra*, *mirage*, etc. Furthermore, while tense vowels (and diphthongs) usually cannot stand before [ŋ] or noncoronal clusters, there are a number of lexical exceptions such as *traipse* and *coax*. The tense vowel [ɔ] is remarkable in that it usually stands before [ŋ, ft], and (in the varieties of EGA that have this sound) the tense [æ̟] is remarkable in that it usually stands before [sk, sp, ft, mp]. But each of these unexpected generalizations has lexical exceptions too, which tend to vary from speaker to speaker; mostly these are rare or foreign words: *dugong* with [ɑ] rather than [ɔ] before [ŋ], *zaftig* with [ɑ] rather than [ɔ] before [ft], and *paschal* with [æ] rather than [æ̟] before [sk].

I have argued that lexical exceptions are best analyzed as resulting from parochial constraints requiring specific lexical items to contain specific phonological information (such as a particular vowel) which can outrank general phonotactic well-formedness constraints; the majority of lexical items will not have parochial constraints and will thus be subject to phonotactic markedness. In cases like [ɔŋ, ɔft, æ̞sk], etc., the fact that more words violate markedness than obey it, and the fact that the words that *do* obey it tend to be rare or foreign words, make it unlikely that this is a simple case of parochial constraints outranking markedness. Rather, the members of the set of words containing sequences like [ɔŋ, ɔft, æ̞sk], etc., reinforce each other by means of analogical constraints. These analogical constraints then outrank markedness, and can be themselves outranked by parochial constraints governing rare and foreign words like *dugong, zaftig, paschal.*

These conclusions, like those of the other chapters in this book, contribute to phonological theory by showing that constraint interaction is not always a matter of conflict between faithfulness constraints and markedness constraints; analogical constraints reinforcing exceptional patterns as well as parochial constraints governing specific lexical items have roles to play as well.

Chapter 5
Summary and directions for future research

This final chapter has two purposes: first to summarize the conclusions of the book, and second to raise some questions that could not be adequately addressed here and so must be left for future research.

5.1 Summary of the book

In this book we have seen how the usefulness of optimality theory as a tool in phonological analysis can be enhanced by restricting phonological constraints to those that reflect truly universal markedness considerations, and using language-specific morphological constraints to analyze apparently "morphophonemic" phenomena that cannot be reduced to the simple interaction of universal markedness constraints with faithfulness constraints.

As we saw in chapter 2, using language-specific constraints in the analysis of phonological opacity can save optimality theory from the charge that there are phonological processes that it cannot explain, or can explain only with the help of extremely powerful mechanisms like sympathy theory. Since it appears that there are no cases of purely phonological opacity, but rather that opaque processes are always sensitive to morphological information, the various opaque processes found in Tiberian Hebrew are best analyzed with constraints that make reference to language-specific morphological information. In particular, we have seen that it is useful to assume Tiberian Hebrew had a lexical diacritic marking on some words requiring them to surface as trochees, rather than the iambs usual in the language. It is this diacritic, rather than a phonological prohibition on word-final consonant clusters, that is responsible for the epenthesis both in "transparent" /malk/ ℜ [mélɛx] and in "opaque" /daʃʔ/ ℜ [déʃɛ]. Similarly, we have seen that the apparent overapplication of spirantization found in some morphological categories in Hebrew is the result of paradigm uniformity effects rather than an opaque interaction of phonological processes. Once the importance of morphological constraints is recognized, opacity is no longer "OT's Achilles heel," as Kager (1999, 377) put it.

In chapter 3 we examined phonologically and morphologically conditioned allomorphy in the Celtic languages. In particular, we saw that while the [ɨ/ə] and [u/ə] alterations of Welsh and the intervocalic voicing and spirantization of Manx are purely phonological in character, and can thus be analyzed using universal markedness constraints, the initial consonant mutations of the modern Celtic languages are too idiosyncratic in their behavior and too irregular in their application to be anything but morphological, and thus must be analyzed with language-specific constraints. Specifically, the initial consonant mutations are a kind of agreement pattern, and mutated forms of words are listed in the lexicon in manner parallel to, but independent of, case-marked forms. That the constraints regulating the mutations are violable is shown by the fact that a phonological markedness constraint requiring a coronal to be followed by another coronal can block mutation in Irish.

Finally, in chapter 4 we examined the distribution of tense and lax vowels in American English, and saw that while many generalizations can be made and can be justified on the basis of universal markedness constraints, there are certain lexical exceptions and, especially in the case of the low back vowels [ɑ] and [ɔ], static irregularities that contravene the markedness constraints. As we saw, families of language-specific output-output faithfulness constraints requiring specific groups of phonologically similar (usually rhyming) words to have specific vowels can outrank the universal markedness constraints, and can themselves be outranked by constraints specific to individual lexemes in the case of exceptions to the general pattern.

This book has thus presented strong arguments in favor of limiting the role of phonology to those processes that can be analyzed solely in terms of universal markedness constraints and their interaction with faithfulness constraints, while placing the responsibility for processes that make reference to language-specific properties in the domain of morphology, by using language-specific morphological constraints that are ranked in the same hierarchy with faithfulness constraints and universal markedness constraints. Nevertheless there are still many questions that must be left unanswered in this book, as we shall see in the following section.

5.2 Directions for future research

5.2.1 Opacity

In chapter 2 it was claimed that there are no cases of purely phonological opacity, i.e. opaque interactions that do not somehow involve morphological information or lexical exceptions, a claim already made by Sanders (2003). This is clearly an empirical question, and it is clear that further investigation into opaque phenomena is required to determine whether there are any that can be shown to be free of morphological influence and to be lexically exceptionless, as one would expect from a purely phonological phenomenon.

5.2.2 Lexical frequency and lexical diffusion

In footnote 15 of chapter 4, it was briefly mentioned that high-frequency words may be more likely to have an analogical influence on each other than low-frequency words. The issue of lexical frequency and how to accommodate its effects in a formal theory of phonology has long been an issue, and much research still remains to be done on the question. The importance of frequency, and the related concept of productivity, has been examined by Aronoff (1983), Bybee (1995, 1996, 1999, 2002, 2003), Frisch (1996), Alegre and Gordon (1999), Gordon and Alegre (1999), Gürel (1999), Penke, Janssen, and Krause (1999), Phillips (1999), Sumner (2002), and approaches to it in within an OT framework include Alcántara (1998) and Hammond (1999b, 2004).

The concept of lexical diffusion (mentioned in footnotes 14 and 21 of chapter 4) is closely related; according to this theory, diachronic sound change does not simultaneously affect all words in which its environment is met, but rather starts in a small group of words and then spreads to other words. It is generally hypothesized that relatively frequent words are more likely to be affected by lexical diffusion than relatively rare words (Phillips 1999, Bybee 2002). To the best of my knowledge, there is no published research attempting an analysis of lexical diffusion within an OT framework, so this is clearly an area where future research is necessary.

5.2.3 Productive but nonphonological processes

There are in many languages alternations of sounds which, while highly predictable and productive, nevertheless seem not to be analyzable in terms of universal markedness constraints and faithfulness constraints, and so by the theory espoused in this book, should be analyzed in terms of language-specific morphological constraints. Two well known examples from English phonology are laxing (especially so-called "trisyllabic laxing") and velar softening.[1]

5.2.3.1 English laxing

A well known and much discussed phenomenon of English phonology is the alternation of certain tense vowels or diphthongs with certain lax vowels in a very disparate set of environments. Some examples are shown in (1).

1 I presented preliminary analyses of the material in the following two sections at the Conference on the Lexicon in Linguistic Theory (Düsseldorf, August 2001) and at the Conference on English Phonology (Toulouse, June 2002), but the results were too inconclusive to be published here.

(1) Tense vowel or diphthong alternating with lax vowel

a.	[aɪ]	[ɪ]
	div**i**ne	div**i**nity
	der**i**ve	der**i**vative
	s**i**gn	s**i**gnature
	fin**i**te	infin**i**te
	f**i**nal	f**i**nish
	wr**i**te	wr**i**tten
	ch**i**ld	ch**i**ldren
b.	[i]	[ɛ]
	ser**e**ne	ser**e**nity
	diab**e**tes	diab**e**tic
	comp**e**te	comp**e**titive
	pl**ea**se	pl**ea**sant
	cl**ea**n	cl**ea**nliness
	k**ee**p	k**e**pt
	sh**ee**p	sh**e**pherd
c.	[e]	[æ]
	n**a**ture	n**a**tural
	r**a**bies	r**a**bid
	expl**ai**n	expl**a**natory
	pl**a**cate	impl**a**cable
	Sp**ai**n	Sp**a**nish
	sh**a**de	sh**a**dow
d.	[o]	[ɑ]
	verb**o**se	verb**o**sity
	t**o**ne	t**o**nic
	neur**o**nal	neur**o**n
	h**o**ly	h**o**liday
e.	Various	
	p**u**nitive	p**u**nish
	prof**ou**nd	prof**u**ndity
	j**oi**nt	j**u**nction

I will follow established tradition by referring to the phenomenon in (1) as "laxing," as if it were a unified phonological process, although this point is controversial.

Traditional analyses of laxing (especially (1)a–d), from *SPE* (Chomsky and Halle 1968) and S. Myers (1987) to OT analyses like those of Burzio (1994, 1997) and Alcántara (1998), treat the alternations as demonstrating a phonological process whereby some underlying vowel phonemes surface as [aɪ, i, e, o] in some phonological contexts and as [ɪ, ɛ, æ, ɑ] in other contexts. However, defining precisely what those contexts are has proved very difficult. Often the short allophone surfaces in the antepenultimate syllable, but there are famous cases such as *nightingale, nicety,* and *obesity*, where a tense vowel surfaces there, and only the first of these can be accounted for by appealing to nonderived environment blocking (Kiparsky 1973, 1993, Łubowicz 2002). Another common environment for the lax vowels is before noncoronal clusters, such as the [pt] cluster of *kept*; conversely, vowels are said to undergo tensing as compensatory lengthening in forms like *sign* (cf. *signature*) and *paradigm* (cf. *paradigmatic*). However, there are exceptions here as well, such as *steeped* and *phlegm, diaphragm* (cf. *phlegmatic, diaphragmatic*). There are also cases like *finite~infinite, rabies~rabid* and *tone tonic* where the laxing seems to be triggered by the addition of an affix, but the phonotactic environment of the vowel undergoing laxing has not changed. Burzio (1994, 320–21; 1997) argues that underlying lax vowels cannot become tense in the environment of an affix, but here too there are plenty of exceptions, such as *legal~illegal, base~basic,* and *phobia ~phobic,* which Burzio treats as having underlyingly tense vowels that surface faithfully.

No less difficult is the problem of determining what the underlying phonemes are whose allophones are [aɪ, ɪ], [i, ɛ], [e, æ], [o, ɑ], because the surface allophones are featurally often more distinct from each other than they are from allophones of a different phoneme. Thus [i] and [ɛ], purportedly from the same phoneme, differ from each other in both [tense] and [high], whereas [i] and [ɪ], held to be from separate phonemes, differ from each other only in [tense]. *SPE* accounts for this with a complicated series of ordered rules and an underlying phonemic inventory whose abstractness makes it unpalatable to modern phonologists; others simply gloss over the problem completely. Burzio (1997), for example, dismisses the problem as "very language specific and synchronically idiosyncratic." But if the main premise of this book is right, namely that language-specific phenomena are governed by morphological rather than universal phonological constraints, then it is clear that laxing is not a phonological process in English. This suggestion is supported by exceptions and irregularities like *obese ~obesity* or *antique~antiquity*, which strongly imply that the alternations in (1) are conditioned not phonologically but morphologically.

Nevertheless it is not immediately clear what kind of language-specific morphological constraint or group of constraints should be called upon here. The high degree of regularity between the sound pairs in (1) makes it seem that an analysis using constraints on individual lexemes misses a generalization. Perhaps sets of conjoined OO faithfulness constraints, like those proposed for the correlation between [ɔ] and [ŋ] in chapter 4, would be beneficial. At any rate, a really satisfying analysis of laxing within OT is long overdue.

The same can be said for the phenomenon of velar softening in English, as we see in the next section.

5.2.3.2 Velar softening

The alternation between the velar stops [k, g] and the sibilants [s, dʒ] in English, known as velar softening, is well known in English phonology (Chomsky and Halle 1968, Kiparsky 1982a, Jensen 1993). Examples of the alternation are shown in (2).

(2) Alternations of [k~s] and [g~dʒ]

a.	*critic*	krɪtɪ**k**	*criticism*	krɪtə**s**ɪzəm
b.	*electric*	əlɛktrɪ**k**	*electricity*	əlɛktrɪ**s**əti
c.	*analogue*	ænəlɔ**g**	*analogy*	ənælə**dʒ**i
d.	*colleague*	kɑli**g**	*collegiality*	kəli**dʒ**iæləti

The analysis proposed in *The Sound Pattern of English* (Chomsky and Halle 1968, 219) is a phonological rule changing /g/ into [dʒ] and /k/ into [s] before a nonlow front vowel.

(3) SPE's velar softening rule

$$\left\{\begin{matrix} \text{g} & \rightarrow & \text{dʒ} \\ \text{k} & \rightarrow & \text{s} \end{matrix}\right\} \; / \; \_ \begin{pmatrix} -\text{low} \\ -\text{back} \\ \text{V} \end{pmatrix}$$

In order for this analysis to go through, however, SPE is required to assume some highly abstract underlying representations, because many of the surface sibilants do not in fact appear before nonlow front vowels, and some of the surface velar stops do. Some examples of the abstract underlying representations assumed in SPE are given in (4).

(4) Alternations requiring highly abstract underlying representations

a.	*critic*	krɪtɪk	<	/krit + ik/
	critical	krɪtəkəl	<	/krit + ik + æl/
	criticize	krɪtəsaɪz	<	/krit + ik + īz/
b.	*medical*	mɛdəkəl	<	/med + ik + æl/
	medicine	mɛdəsən	<	/med + ik + in/
	medicate	mɛdəket	<	/med + ik + ǣt/
c.	*allege*	əlɛdʒ	<	/ælege/
	allegation	æləgeʃən	<	/æleg + ǣt + iVn/
d.	*reduce*	rədus	<	/re + duke/
	reduction	rədʌkʃən	<	/re + duk + t + iVn/

The high degree of abstraction in this analysis renders it rather unpalatable to most modern phonologists. Surface-based theories like OT are especially loath to propose such entities as the /e/ at the end of *allege* and *reduce*, which apparently has no motivation beside providing an environment for velar softening to apply before being deleted. Apart from being overly abstract, this analysis has other problems as well. For one thing, the rule is awkward to state since /k/ and /g/ do not undergo parallel changes: /k/ becomes an alveolar fricative while /g/ becomes a palatoalveolar affricate.

Furthermore, the rule does not apply within morphemes (*king* [kɪŋ], *give* [gɪv]) or before Class 2 suffixes (in SPE terms, before a # boundary: *panicking* [pænɪkɪŋ], *dragging* [drægɪŋ]). This led lexical phonologists like Kiparsky (1982a) and Jensen (1993) to the conclusion that velar softening is a postcyclic lexical rule that applies before the addition of Class 2 morphology. However, even before Class 1 suffixes (SPE's + boundary) there are exceptions to velar softening, as shown in (5).

(5) Exceptions to velar softening before Class 1 suffixes

a.	*monarch*	[mɑnɚ**k**]	*monarchism*	[mɑnɚ**k**ɪzəm]
b.	*patriarch*	[petriɑr**k**]	*patriarchy*	[petriɑr**k**i]
c.	*zinc*	[zɪŋ**k**]	*zincify*	[zɪŋ**k**əfaɪ]
d.	*drug*	[drʌ**g**]	*druggist*	[drʌ**g**əst]

As we saw in chapter 3, many unpredictable alternations like this can profitably be analyzed by assuming multiple input allomorphs. Under such an analysis, the words in (2) and (4) have multiple inputs like {/krɪtɪk/, /krɪtɪs/}, etc., while the exceptions in (5) simply have no allomorphs like /mɑnɚs/, /petriɑrs/, /zins/, /drʌdʒ/, etc. But to account for the alternations in (2) and (4), one would need first to determine which of each pair [k, s] and [g, dʒ] is less marked in an absolute, context-free sense, and next to determine why the more marked member surfaces in the environments where it does.

It seems safe to say that stops less marked than fricatives and affricates: [k, g] are cross-linguistically much more common than [s, dʒ] and usually the presence of [s, dʒ] in a language's consonant inventory implies the presence of [k, g] (Maddieson 1984). Also, children usually acquire [k] and [g] earlier than [s] and [dʒ]. So we may suggest the universal constraint rankings *s ≫ *k and *dʒ ≫ *g. This ranking correctly predicts that stops will appear in unsuffixed forms like *critic* and *colleague*, as shown in the tableaux in (6).

(6) Velar stops correctly predicted word-finally

{krɪtɪk, krɪtəs}	*s	*k
☞ krɪtɪk		**
krɪtəs	* !	*

{kɑlig, kɑlidʒ}	*dʒ	*g
☞ kɑlig		*
kɑlidʒ	* !	

However, the wrong results are obtained in *practice* and *purge*, where the existence of velar stop allomorphs is proved by *practical* and *purgation*.

(7) Velar stops incorrectly predicted word-finally

{præktɪk, præktəs}	*s	*k
☹ præktɪk		*
præktəs	* !	

{pɝg, pɝdʒ}	*dʒ	*g
☹ pɝg		*
pɝdʒ	* !	

Also in suffixed forms it is not always possible to predict which alternative will appear where. For example, [e] patterns with the back vowels (e.g. [mɛdɪket] *medicate*) and [aɪ] with the nonlow front vowels (e.g. [krɪtəsaɪz] *criticize*), which is a bigger problem in a surface-based theory like OT that tries to avoid abstraction than it was in SPE, where the underlying vowels /ǣ/ and /ī/ were assumed. OT must be concerned with surface markedness, and it is unfortunately virtually inconceivable that the markedness rankings in (8) could obtain.

(8) Markedness rankings required for velar softening
a. *ki, *gi ≫ *si, *dʒi
b. *kɪ, *gɪ ≫ *sɪ, *dʒɪ
c. *se, *dʒe ≫ *ke, *ge
d. *kɛ, *gɛ ≫ *sɛ, *dʒɛ
e. *sæ, *dʒæ ≫ *kæ, *gæ
f. *kaɪ, *gaɪ ≫ *saɪ, *dʒaɪ

It is also unclear which sounds are to be expected before [ju] and its developments ([jə] in unstressed syllables; [u] after coronals for most North Americans). The pair *appendi*[s]*itis*~*appendi*[k]*ular* shows that the stem *appendic-* has both a velar stop and a sibilant allomorph; here, the velar stop is found before [jə]. On the other hand, the pair *pharma*[s]*eutical*~*pharma*[k]*ology* shows that the stem *pharmac-* also has both a velar stop and a sibilant allomorph, but in this case it is the sibilant that is found before [(j)u]. I know of no other stems that have both velar stop and sibilant allomorphs and also take [ju]-initial formatives.

Furthermore, although the stop allomorphs predominate before the suffixes *-al* and *-ous* (cf. (9)a–j and (10)a–e) there are also exceptions like *collegial* in (9)k and *litigious* in (10)f as well as ambiguous cases like *laryngal/laryngeal*, where both allomorphs are found in the standard language, and *analogous*, which has a common though nonstandard by-form with [dʒ] alongside the standard pronunciation with [g].

(9) [k, g] or [s, dʒ] before *-al* [əl]?

a.	*al*[g]*al*	(cf. *al*[dʒ]*ae*)
b.	*appendi*[k]*al*	(cf. *appendi*[s]*itis*)
c.	*centrifu*[g]*al*	(cf. *centrifu*[dʒ]*e*)
d.	*fe*[k]*al*	(cf. *fe*[s]*es*)
e.	*fo*[k]*al*	(cf. *fo*[s]*i*)
f.	*fun*[g]*al*	(cf. *fun*[dʒ]*i*)
g.	*medi*[k]*al*	(cf. *medi*[s]*ine*)
h.	*practi*[k]*al*	(cf. *practi*[s]*e*)
i.	*synago*[g]*al*	(cf. *synago*[dʒ]*ical*)

j. *vo*[k]*al* (cf. *vo*[s]*iferous*)
but k. *colle*[dʒ]*ial* (cf. *collea*[g]*ue*)
and l. *laryn*[g]*al* or *laryn*[dʒ]*eal* (cf. *laryn*[g]*oscope, laryn*[dʒ]*itis*)

(10) [k, g] or [s, dʒ] before *-ous* [əs]?
a. *al*[g]*ous* (cf. *al*[dʒ]*ae*)
b. *calcifu*[g]*ous* (cf. *calcifu*[dʒ]*e*)
c. *fun*[g]*ous* (cf. *fun*[dʒ]*i*)
d. *anthropopha*[g]*ous* (cf. *anthropopha*[dʒ]*y*)
e. *tautolo*[g]*ous* (cf. *tautolo*[dʒ]*y*)
but f. *liti*[dʒ]*ious* (cf. *liti*[g]*ate*)
and g. *analo*[g]*ous* sometimes *analo*[dʒ]*ous* (cf. *analo*[dʒ]*y*)

Ambiguity is also found in the word *longitude*. In America, the historical pronunciation with [-ndʒ-] is still retained, but in Britain a pronunciation with [-ŋg-], influenced by *long*, has come to predominate, while [-ndʒ-] is still preferred by only 15% of the population (Wells 1999).

In sum, it seems clear that an allomorphic analysis of the velar softening facts is just impossible. It is simply not the case that the distribution of the allomorphs is governed by principles of markedness, as it is in the Polish sibilant alternation case. Rather, there is a tendency for forms with velar stops to occur before some suffixes and for forms with sibilants to occur before other suffixes, but the quality of the initial segment of the suffix is not a determinant, and anyway there are a fair number of exceptions. In unsuffixed forms the velar stops are more frequent, but the sibilants are also common.

As mentioned in the context of laxing, the high degree of regularity suggests there is a generalization which must not be missed; therefore a morphological analysis must be careful not to be too parochial. Here again, an analysis using conjoined OO faithfulness constraints is conceivable, but the details must be left to future research.

5.3 Conclusion

Throughout this book we have seen examples of phonological phenomena that cannot be analyzed as a simple interaction of universal markedness constraints with faithfulness constraints. As the title of the book suggests, it is necessary to limit phonology to those processes that *can* be so analyzed. Processes that make crucial reference to morphological information, including reference to specific lexemes, are best analyzed using language-specific morphological constraints. This suggestion will improve OT in particular and phonological theory in general, because it will enable OT to provide analyses of phenomena like opacity that it was previously unable to explain without powerful mechanisms like sympathy theory, and because if phonological theory is powerful enough to explain all the idiosyncratic "morphophonological" processes in all the world's languages, the theory will greatly overgenerate possible patterns and will become unfalsifiable. Morphological theory, on the other hand, is by its very nature idiosyncratic, so it can accommodate patterns like the ones described in this book without decrement.

References

Abbreviations used in the references

BLS	Berkeley Linguistic Society
CJL	*Canadian Journal of Linguistics/Revue canadienne de linguistique*
CLS	Chicago Linguistic Society
CSLI	Center for the Study of Language and Information (Stanford Univ.)
GLSA	Graduate Linguistics Students Association (UMass)
JEAL	*Journal of East Asian Linguistics*
LI	*Linguistic Inquiry*
LR	*The Linguistic Review*
MIT	Massachusetts Institute of Technology
MITWPL	MIT Working Papers in Linguistics
NELS	*Proceedings of the North East Linguistic Society*
NLLT	*Natural Language & Linguistic Theory*
ROA	Rutgers Optimality Archive, http://roa.rutgers.edu/
RUCCS	Rutgers University Center for Cognitive Science
UCLA	University of California at Los Angeles
UCSC	University of California at Santa Cruz
UMass	University of Massachusetts, Amherst
WCCFL	*Proceedings of the West Coast Conference on Formal Linguistics*

Agbayani, B., and S.-W. Tang, eds. 1997. *WCCFL 15*. Stanford, Calif.: CSLI.

Alcántara, J. B. 1998. The architecture of the English lexicon. PhD dissertation, Cornell Univ. ROA-254.

Alegre, M., and P. Gordon. 1999. Frequency effects and the representational status of regular inflections. *Journal of Memory and Language* 40:41–61.

Archangeli, D., and D. T. Langendoen, eds. 1997. *Optimality theory: An overview*. Oxford: Blackwell.

Archangeli, D., and D. Pulleyblank. 2002. Kinande vowel harmony: domains, grounded conditions and one-sided alignment. *Phonology* 19:139–88.

Aronoff, M. 1983. Potential words, actual words, productivity and frequency. In *Proceedings of the thirteenth International Congress of Linguists*, ed. S. Hattori and K. Inoue, 163–71. Tokyo: Permanent International Committee on Linguistics.

Artstein, R. 1998. The incompatibility of underspecification and markedness in optimality theory. *RuLing Papers: Working Papers from Rutgers University* 1:7–13.

Awbery, G. M. 1984. Phonotactic constraints in Welsh. In Ball and Jones 1984, 65–104.

Baković, E. 2000. Harmony, dominance and control. PhD dissertation, Rutgers Univ. Available as ROA-360.

Ball, M. J. 1984. Phonetics for phonology. In Ball and Jones 1984, 5–39.

Ball, M. J., and G. E. Jones, eds. 1984. *Welsh phonology*. Cardiff: Univ. of Wales Press.

Ball, M. J., and N. Müller. 1992. *Mutation in Welsh.* London: Routledge.

Barbosa, P., D. Fox, P. Hagstrom, M. McGinnis, and D. Pesetsky, eds. 1998. *Is the best good enough? Optimality and competition in syntax*. Cambridge, Mass.: MIT Press.

Bauer, L. 2003. *Introducing linguistic morphology*. 2nd ed. Edinburgh: Edinburgh Univ. Press.

Beckman, J. N., L. Walsh Dickey, and S. Urbanczyk, eds. 1995. *Papers in optimality theory*. UMass Occasional Papers 18. Amherst: GLSA.

Benua, L. 1995. Identity effects in morphological truncation. In Beckman, Walsh Dickey, and Urbanczyk 1995, 77–136.

———. 1998. Transderivational identity: Phonological relations between words. PhD dissertation, UMass. Pub. as *Phonological relations between words*, New York: Garland, 2000.

Bermúdez-Otero, R. In preparation. *Stratal Optimality Theory*. Oxford Studies in Theoretical Linguistics. Oxford: Oxford University Press.

Bird, S. 1990. Constraint-based phonology. PhD dissertation, Univ. of Edinburgh.

Blevins, J. 1995. The syllable in phonological theory. In Goldsmith 1995, 206–44.

———. 2003. The independent nature of phonotactic constraints: An alternative to syllable-based approaches. In Féry and van de Vijver 2003, 375–403.

Bochner, H. 1993. *Simplicity in generative morphology*. Berlin: Mouton de Gruyter.

Boersma, P. 1998. *Functional phonology: Formalizing the interactions between articulatory and perceptual drives.* The Hague: Holland Academic Graphics.

———. 2000. Learning a grammar in functional phonology. In Dekkers, van der Leeuw, and van de Weijer 2000, 465–523.

Boersma, P., and J. A. Cutillas-Espinosa, eds. 2004. *Advances in optimality theory*. International Journal of English Studies 4 (2). Murcia: Servicio de Publicaciones, Universidad de Murcia.

Bonet, E. 2004. Morph insertion and allomorphy in optimality theory. In Boersma and Cutillas-Espinosa 2004, 73–104.

Booij, G. 1996. Lexical phonology and the derivational residue. In Durand and Laks 1996, 69–96.

———. 1997. Nonderivational phonology meets lexical phonology. In Roca 1997, 261–88.

Booij, G., and J. Rubach 1984. Morphological and prosodic domains in lexical phonology. *Phonology Yearbook* 1:1–27.

Borowsky, T. J. 1986. Topics in the lexical phonology of English. PhD dissertation, UMass.

———. 1989. Structure preservation and the syllable coda in English. *NLLT* 7:145–66.

Borsley, R. D. 1997. Mutation and Case in Welsh. *CJL* 42:31–56.

———. 1999. Mutation and constituent structure in Welsh. *Lingua* 109: 267–300.

Borsley, R. D., and M. Tallerman. 1996. Phrases and soft mutation in Welsh. *Journal of Celtic Linguistics* 5:1–49.

Bosch, A. R. K. 1996. Prominence at two levels: Stress versus pitch prominence in north Welsh. *Journal of Celtic Linguistics* 5:121–65.

Broderick, G. 1984–86. *A handbook of late spoken Manx*. 3 vols. Tübingen: Niemeyer.

Brown, F., S. R. Driver, and C. A. Briggs. 1906. *The new Brown-Driver-Briggs-Gesenius Hebrew and English lexicon*. Boston: Houghton, Mifflin. Repr. Peabody: Hendrickson, 1979.

Bruening, B. 1999. Morphological templates and phonological theory. Talk presented at the second Mediterranean Meeting on Morphology, Msida, Malta.

Buckley, E. 1999. Uniformity in extended paradigms. In Hermans and van Oostendorp 1999, 81–104.

Burzio, L. 1994. *Principles of English stress*. Cambridge: Cambridge Univ. Press.

———. 1996. Surface constraints versus Underlying Representation. In Durand and Laks 1996, 123–41.

———. 1997. Strength in numbers. In Miglio and Morén 1997, 27–52.

———. 1998. Multiple correspondence. *Lingua* 104:79–109.

———. 2000. Cycles, nonderived-environment blocking, and correspondence. In Dekkers, van der Leeuw, and van de Weijer 2000, 47–87.

———. 2002a. Segmental contrast meets output-to-output faithfulness. In *Resolving conflicts in grammars*, ed. G. Fanselow and C. Féry, 163–81. Hamburg: Buske.

———. 2002b. Surface-to-surface morphology: When your representations turn into constraints. In *Many morphologies*, ed. P. Boucher, 142–77. Somerville: Cascadilla Press.

Bybee, J. L. 1988. Morphology as lexical organization. In *Theoretical morphology: Approaches in modern linguistics*, ed. M. Hammond and M. Noonan, 119–41. San Diego: Academic Press.

———. 1995. Regular morphology and the lexicon. *Language and Cognitive Processes* 10:425–55.

———. 1996. Productivity, regularity and fusion: how language use affects the lexicon. In Singh 1996b, 247–69.

———. 1999. Usage-based phonology. In Darnell et al. 1999, 1:211–42.

———. 2002. Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language Variation and Change* 14:261–90.

———. 2003. Mechanisms of change in grammaticization: The role of frequency. In *The handbook of historical linguistics,* ed. B. D. Joseph and R. D. Janda, 602–23. Oxford: Blackwell.

Bye, P. 2003. Opacity, transparency and unification in the phonology of Tiberian Hebrew. In *NELS 33*, ed. M. Kadowaki and S. Kawahara, 475–94. Amherst: GLSA.

Calabrese, A. 1988. Towards a theory of phonological alphabets. PhD dissertation, MIT.

Chomsky, N. 1965. *Aspects of the theory of syntax*. Cambridge, Mass.: MIT Press.

———. 1995. *The minimalist program.* Cambridge, Mass.: MIT Press.

Chomsky, N., and M. Halle. 1968. *The sound pattern of English.* New York: Harper & Row. Repr. Cambridge, Mass.: MIT Press, 1991.

Christian Brothers 1960. *Graiméar Gaeilge na mBráithre Críostaí.* Dublin: An Gúm.

Churchyard, H. 1999. Topics in Tiberian Biblical Hebrew metrical phonology and phonetics. PhD dissertation, Univ. of Texas.

Clements, G. N., and E. V. Hume. 1995. The internal organization of speech sounds. In Goldsmith 1995, 245–306.

Clements, G. N., and S. J. Keyser. 1983. *CV phonology: A generative theory of the syllable*. Cambridge, Mass.: MIT Press.

Coetzee, A. W. 1999. *Tiberian Hebrew phonology: Focussing on consonant clusters.* Assen: Van Gorcum.

———. 2002. OO-correspondence as cumulativity. In *Papers in optimality theory II*, ed. A. Carpenter, A. W. Coetzee, and P. de Lacy, 27–57. UMass Occasional Papers 26. Amherst: GLSA.

Cohn, A. C., and J. J. McCarthy. 1998. Alignment and parallelism in Indonesian phonology. *Working Papers of the Cornell Phonetics Laboratory* 12:53–137.

Coleman, J. 1991. Phonological representations: Their names, forms and powers. PhD dissertation, Univ. of York. Pub. Cambridge: Cambridge Univ. Press, 1998.

Crosswhite, K. M. 1999. Vowel reduction in optimality theory. PhD dissertation, UCLA. Pub. 2001, New York: Routledge.

Darnell, M., E. Moravcsik, F. Newmeyer, M. Noonan, and K. Wheatley, eds. 1999. *Functionalism and formalism in linguistics.* 2 volumes. Amsterdam: John Benjamins.

Davidson, L., and R. Noyer. 1997. Loan phonology in Huave: Nativization and the ranking of faithfulness constraints. In Agbayani and Tang 1997, 65–79.

de Bhaldraithe, T. 1945/1975. *The Irish of Cois Fhairrge, Co. Galway*. Dublin: Dublin Institute for Advanced Studies.

———. 1953/1977. *Gaeilge Chois Fhairrge: An deilbhíocht.* Dublin: Dublin Institute for Advanced Studies.

Dekkers, J., F. van der Leeuw, and J. van de Weijer, eds. 2000. *Optimality theory: Phonology, syntax, and acquisition.* Oxford: Oxford Univ. Press.

Dolbey, A. 1997. Output optimization and cyclic allomorph selection. In Agbayani and Tang 1997, 97–112.

Downing, L. J., T. A. Hall, and R. Raffelsiefen, eds. 2005. *Paradigms in phonological theory*. Oxford: Oxford Univ. Press.

Dressler, W. 1985. On the predictiveness of natural morphology. *Journal of Linguistics* 21:321–37.

———. 1986. Explanation in natural morphology, illustrated with comparative and agent-noun formation. *Linguistics* 24:519–48.

———. 2000. Naturalness. In *Morphologie/Morphology I,* ed. G. Booij, C. Lehmann, and J. Mugdan, 288–96. Berlin: Mouton de Gruyter.

Dressler, W., W. Mayerthaler, O. Panagl, and W. Wurzel. 1987. *Leitmotifs in natural morphology*. Amsterdam: Benjamins.

Durand, J., and B. Laks, eds. 1996, *Current trends in phonology: Models and methods*. Salford: European Studies Research Institute, Univ. of Salford.

Eisner, J. 1997. FOOTFORM decomposed: Using primitive constraints in OT. In *Proceedings of the eighth Student Conference in Linguistics*, ed. B. Bruening, 115–43. MITWPL 31. Cambridge, Mass.: MIT.

Ellison, T. M. 2000. The universal constraint set: Convention, not fact. In Dekkers, van der Leeuw, and van de Weijer 2000, 524–53.

Elmedlaoui, M. 1993. Gemination and spirantization in Hebrew, Berber, and Tigrinya: A fortis-lenis module analysis. *Al-Tawāṣul al-Lisānī* (*Linguistica Communicatio*) 5:121–76.

Ferguson, C. A. 1972. "Short a" in Philadelphia English. In *Studies in linguistics in honor of George L. Trager*, ed. M. E. Smith, 259–74. The Hague: Mouton.

Féry, C. 1997. The mora as a measure of weight and a syllabic constituent. In *Certamen phonologicum III: Papers from the third Cortona Phonology Meeting, April 1996*, ed. P. M. Bertinetto, L. Gaeta, G. Jetchev, and D. Michaels, 91–110. Turin: Rosenberg & Sellier.

———. 2003a. Final devoicing and the stratification of the lexicon in German. In *The phonological spectrum*, ed. J. van de Weijer, V. J. van Heuven, and H. van der Hulst, 1:145–69. Amsterdam: John Benjamins.

———. 2003b. Markedness, faithfulness, vowel quality and syllable structure in French. *French Language Studies* 13:247–80.

Féry, C., and R. van de Vijver, eds. 2003. *The syllable in optimality theory*. Cambridge: Cambridge Univ. Press.

Finck, F. N. 1899. *Die araner Mundart: Ein Beitrag zur Erforschung des Westirischen*. Marburg: Elwert.

Ford, A., and R. Singh. 1983. On the status of morphophonology. In *CLS 19: Papers from the parasession on the interplay of phonology, morphology, and syntax*, ed. J. Richardson, M. Marks, and A. Chukerman, 63–78. Chicago: CLS.

———. 1985. Towards a non-paradigmatic morphology. In *Papers from BLS 11*, ed. M. Niepokuj, M. Van Clay, V. Nikiforidou, and D. Feder, 87–95. Berkeley: BLS.

———. 1996. Quelques avantages d'une linguistique débarrassée de la morpho(pho)nologie. In Singh 1996b, 119–39. Amsterdam: John Benjamins.

Ford, A., R. Singh, and G. Martohardjono. 1997. Pace *Pāṇini: Towards a word-based theory of morphology*. New York: Peter Lang.

Frampton, J. 2002. What kind of thing is a language faculty? A critical evaluation of OT phonology. *Glot International* 6:3–11.

Frisch, S. 1996. Similarity and frequency in phonology. PhD dissertation, Northwestern Univ.

Fukazawa, H., M. Kitahara, and M. Ota. 1998. Lexical stratification and ranking invariance in constraint-based grammars. In *CLS 34, Part 2: Papers from the panels*, ed. M. C. Gruber, D. Higgins, K. S. Olson, and T. Wysocki, 47–62. Chicago: CLS.

Gafos, A., and L. Lombardi. 1999. Consonant transparency and vowel echo. In *NELS 29*, ed. P. Tamanji, M. Hirotani, and N. Hall, 2:81–95. Amherst: GLSA.

Gesenius, F. H. W. 1910. *Gesenius' Hebrew grammar*. Edited and enlarged by E. Kautzsch; 2nd English ed. by A. E. Cowley. Oxford: Clarendon.

Gnanadesikan, A. E. 1997. Phonology with ternary scales. PhD dissertation, UMass.

Goldsmith, J. 1976. Autosegmental phonology. PhD dissertation, MIT. Pub. New York: Garland, 1979.

———, ed. 1995. *The handbook of phonological theory*. Oxford: Blackwell.

Golston, C. 1996. Direct optimality theory: Representation as pure markedness. *Language* 72:713–48.

Gordon, P., and M. Alegre. 1999. Is there a dual system for regular inflections? *Brain and Language* 68:212–17.

Green, A. D. 2000. The prosodic representation of clitics in Irish. In *Clitics in phonology, morphology and syntax*, ed. B. Gerlach and J. Grijzenhout, 181–218. Amsterdam: John Benjamins.

———. 2001. The tense-lax distinction in English vowels and the role of parochial and analogical constraints. In *Phonology in Potsdam*, 32–57. Linguistics in Potsdam 16. Potsdam: Univ. of Potsdam.

———. 2004a. Coronals and compounding in Irish. MS, Berlin. ROA-689. Under review for *Linguistics*.

———. 2004b. Opacity in Tiberian Hebrew: Morphology, not phonology. In *Papers in phonetics and phonology*, ed. S. Fuchs and S. Hamann, 37–70. ZAS Papers in Linguistics 37. Berlin: Zentrum für Allgemeine Sprachwissenschaft. Also available as ROA-703.

———. 2005. Word, foot, and syllable structure in Burmese. In *Studies in Burmese linguistics*, ed. Justin Watkins, 1–25. Canberra: Pacific Linguistics.

———. 2006. The independence of phonology and morphology: The Celtic mutations. *Lingua* 116:1946–85.

Grijzenhout, J. 1995. Irish consonant mutation and phonological theory. PhD dissertation, Univ. of Utrecht.

Guerssel, M. 1977. Constraints on phonological rules. *Linguistic Analysis* 3:267–305.

Gürel, A. 1999. Decomposition: to what extent? The case of Turkish. *Brain and Language* 68:218–24.

Hall, T. A. 1999. Phonotactics and the prosodic structure of German function words. In *Studies on the Phonological Word*, ed. T. A. Hall and U. Kleinhenz, 99–131. Amsterdam: Benjamins.

———. 2000. *Phonologie: Eine Einführung*. Berlin: Walter de Gruyter.

———. 2002. Review of Robinson 2001. *Phonology* 19:293–98.

Halle, M. 1977. Tenseness, vowel shift, and the phonology of the back vowels in Modern English. *LI* 8:611–25.

Halle, M., and K. P. Mohanan. 1985. Segmental phonology of Modern English. *LI* 16:57–116.

Hammond, M. 1999a. *The phonology of English: A prosodic optimality-theoretic approach*. Oxford: Oxford Univ. Press.

———. 1999b. Lexical frequency and rhythm. In Darnell et al. 1999, 1:329–58.

———. 2004. Gradience, phonotactics, and the lexicon in English phonology. In Boersma and Cutillas-Espinosa 2004, 1–24.

Hannahs, S. J. 1996. Phonological structure and soft mutation in Welsh. In Kleinhenz 1996, 46–59.

———. 2007. Constraining Welsh vowel mutation. *Journal of Linguistics* 43:341–63.

Harlow, S. 1989. The syntax of Welsh soft mutation. *NLLT* 7:289–316.

Harrison, K. D., and A. Kaun. 2000. Pattern-responsive lexicon optimization. In *NELS 30*, ed. M. Hirotani, A. Coetzee, N. Hall, and J.-Y. Kim, 327–39. Amherst: GLSA.

———. 2001. Patterns, pervasive patterns and feature specification. In *Distinctive feature theory*, ed. T. A. Hall, 211–36. Berlin: Mouton de Gruyter.

Hayes, B. 1986. Inalterability in CV phonology. *Language* 62:321–52.

———. 1995. *Metrical stress theory: Principles and case studies*. Chicago: Univ. of Chicago Press.

Hermans, B., and M. van Oostendorp, eds. 1999. *The derivational residue in phonological optimality theory*. Amsterdam: Benjamins.

Hetzron, R. 1987. Hebrew. In *The world's major languages*, ed. B. Comrie, 686–704. New York: Oxford Univ. Press.

Hughes, A. J. 1986. *The Gaelic of Tangaveane and Commeen, County Donegal*. PhD dissertation, Queen's Univ. of Belfast.

Hulst, H. van der. 1984. *Syllable structure and stress in Dutch.* Dordrecht: Foris.

Hulst, H. van der, and N. Smith, eds. 1982. *The structure of phonological representations*. 2 vols. Dordrecht: Foris.

Hume, E. V. 1992. Front vowels, coronal consonants and their interaction in nonlinear phonology. PhD dissertation, Cornell Univ.

Idsardi, W. J. 1997. Phonological derivations and historical changes in Hebrew spirantization. In Roca 1997, 367–92.

———. 1998. Tiberian Hebrew spirantization and phonological derivations. *LI* 29:37–73.

———. 2000. Clarifying opacity. *LR* 17:337–50.

Inkelas, S. 1995. The consequences of optimization for underspecification. In *NELS 25*, ed. J. N. Beckman, 287–302. Amherst: GLSA.

———. 1996. Archiphonemic underspecification: An optimization approach to the phonological description of morphemes. MS, UC Berkeley.

———. 1999. Exceptional stress-attracting suffixes in Turkish: Representations versus the grammar. In Kager, van der Hulst, and Zonneveld 1999, 134–87.

Inkelas, S., and Y. Y. Cho. 1993. Inalterability as prespecification. *Language* 69:529–74.

Inkelas, S., O. Orgun, and C. Zoll. 1997. The implications of lexical exceptions for the nature of grammar. In Roca 1997, 393–418.

Itô, J., and A. Mester. 1995. The core-periphery structure of the lexicon and constraints on reranking. In Beckman, Walsh Dickey, and Urbanczyk 1995, 181–209.

———. 1999. The phonological lexicon. In *The handbook of Japanese linguistics*, ed. N. Tsujimura, 62–100. Oxford: Blackwell.

———. 2003. On the sources of opacity in OT: Coda processes in German. In Féry and van de Vijver 2003, 271–303.

Itô, J., A. Mester, and J. Padgett. 1995. Licensing and underspecification in optimality theory. *LI* 26:571–613.

Iverson, G. K. 1995. Rule ordering. In Goldsmith 1995, 609–14.

Jackson, K. H. 1955. *Contributions to the study of Manx phonology*. Edinburgh: Nelson and Sons.

Janda, R. D. 1987. On the motivation for an evolutionary typology of sound-structural rules. Ph.D. dissertation, UCLA.

Jensen, J. T. 1993. *English phonology*. Amsterdam: John Benjamins.

Jones, G. E. 1984. The distinctive vowels and consonants of Welsh. In Ball and Jones 1984, 41–64.

Joseph, B. D. 1996. How general are our generalizations? What speakers actually know and what they actually do. In *ESCOL '96: Proceedings of the thirteenth Eastern States Conference on Linguistics*, ed. A. D. Green and V. Motapanyane, 148–60. Ithaca: CLC Publications.

Kager, R. 1989. *A metrical theory of stress and destressing in English and Dutch*. Dordrecht: Foris.

———. 1993. Alternatives to the iambic-trochaic law. *NLLT* 11:381–432.

———. 1996. On affix allomorphy and syllable counting. In Kleinhenz 1996, 155–71.

———. 1999a. *Optimality theory*. Cambridge: Cambridge Univ. Press.

———. Forthcoming. Lexical irregularity and the typology of contrast. In *The nature of the word: Essays in honor of Paul Kiparsky*, ed. K. Hanson and S. Inkelas, Cambridge, Mass.: MIT Press.

Kager, R., H. van der Hulst, and W. Zonneveld, eds. 1999. *The prosody-morphology interface*. Cambridge: Cambridge Univ. Press.

Kahn, D. 1976. Syllable-based generalizations in English phonology. PhD dissertation, UCLA. Reproduced by the Indiana Univ. Linguistics Club.

Kaye, A. S., ed. 1997. *Phonologies of Asia and Africa*. Winona Lake, Ind.: Eisenbrauns.

Keer, E. 1999. Geminates, the OCP and the nature of CON. PhD dissertation, Rutgers Univ. ROA-350.

Kenstowicz, M. 1982. Gemination and spirantization in Tigrinya. *Studies in the Linguistic Sciences* 12:103–22.

———. 1995. Cyclic vs. non-cyclic constraint evaluation. *Phonology* 12: 397–436.

———. 1996. Base-identity and uniform exponence: Alternatives to cyclicity. In Durand and Laks 1996, 363–93.

———. 1997. Uniform exponence: Exemplification and extension. In Miglio and Morén 1997, 139–54. MS also available as ROA-218. Revised version to appear in *Bollettino della Società Linguistica Italiana*.

Kenstowicz, M., and C. Kisseberth. 1971. Unmarked bleeding orders. *Studies in the Linguistic Sciences* 1:8–28. Repr. in *Studies in generative phonology*, ed. C. Kisseberth, 1–13. Edmonton: Linguistic Research, 1973.

———. 1977. *Topics in phonological theory*. New York: Academic Press.

Kenyon, J. S., and T. A. Knott. 1944. *A pronouncing dictionary of American English*. Springfield, Mass.: Merriam-Webster.

Khan, G. 1990. *Karaite Bible manuscripts from the Cairo Genizah*. Cambridge: Cambridge Univ. Press.

———. 1997. Tiberian Hebrew phonology. In Kaye 1997, 85–102.

Kibre, N. J. 1995. A model of mutation in Welsh. MA thesis, Univ. of California at Santa Barbara. 1997 revision dist. by Indiana Univ. Linguistics Club.

King, G. 1993. *Modern Welsh: A comprehensive grammar*. London: Routledge.

Kiparsky, P. 1968. Linguistic universals and linguistic change. In *Universals in linguistic theory*, ed. E. Bach and R. T. Harms, 171–202. New York: Holt, Rinehart & Winston. Repr. in Kiparsky 1982b, 13–43.

———. 1971. Historical linguistics. In *A survey of linguistic science*, ed. W. O. Dingwall. 1st ed., College Park: Univ. of Maryland, 576–649. 2nd ed., Stamford: Greylock, 33–62. Repr. in Kiparsky 1982b, 57–80.

———. 1973. Abstractness, opacity and global rules. In *Three dimensions of linguistic theory*, ed. O. Fujimora, 1–136. Tokyo: Taikusha.

———. 1982a. From cyclic phonology to lexical phonology. In van der Hulst and Smith 1982, 1:131–75.

———. 1982b. *Explanation in phonology*. Dordrecht: Foris.

———. 1985. Some consequences of lexical phonology. *Phonology Yearbook* 2:85–138.

———. 1993. Blocking in nonderived environments. In *Studies in lexical phonology*, ed. S. Hargus and E. M. Kaisse, 277–313. Phonetics and Phonology 4. San Diego: Academic Press.

———. 2003. Syllables and moras in Arabic. In Féry and van de Vijver 2003, 147–82.

Kirchner, R. 2000. Geminate inalterability and lenition. *Language* 76: 509 – 45.

Kleinhenz, U., ed. 1996. *Interfaces in phonology*. Studia Grammatica 41. Berlin: Akademie Verlag.

Klokeid, T. J. 1976. Topics in Lardil grammar. PhD dissertation, MIT.

Koontz-Garboden, A. 2001. Tiberian Hebrew spirantization and related phenomena in stratal OT. MS, Stanford University. ROA-607.

Krämer, M. 2001. Vowel harmony and correspondence theory. PhD dissertation, Heinrich-Heine-Universität Düsseldorf. Pub. 2003, Berlin: Mouton de Gruyter.

Kurath, H., and R. I. McDavid, Jr. 1961. *The pronunciation of English in the Atlantic states.* Ann Arbor: Univ. of Michigan Press.

Labov, W. 1966. *The social stratification of English in New York City*. Washington, D.C.: Center for Applied Linguistics.

———. 1972. *Sociolinguistic patterns*. Philadelphia: Univ. of Pennsylvania Press.

———. 1981. Resolving the Neogrammarian controversy. *Language* 57: 267–308.

———. 1994. *Principles of linguistic change: Internal factors*. Oxford: Blackwell.

Lamontagne, G. A. 1993. Syllabification and consonant cooccurrence conditions. PhD dissertation, UMass.

Lass, R. 1976. *English phonology and phonological theory: Synchronic and diachronic studies*. Cambridge: Cambridge Univ. Press.

Leben, W. 1973. Suprasegmental phonology. PhD dissertation, MIT.

Legendre, G., J. Grimshaw, and S. Vikner, eds. 2001. *Optimality theoretic syntax*. Cambridge, Mass.: MIT Press.

Lieber, R. 1987. *An integrated theory of autosegmental processes*. Albany: State Univ. of New York Press.

Lombardi, L. 2002. Coronal epenthesis and markedness. *Phonology* 19: 219–51.

Łubowicz, A. 2002. Derived environment effects in optimality theory. *Lingua* 112:243–80.

Maddieson, I. 1984. *Patterns of sounds*. Cambridge: Cambridge Univ. Press.

Malone, J. L. 1993. *Tiberian Hebrew phonology*. Winona Lake, Ind.: Eisenbrauns.

Mascaró, J. 1996a. External allomorphy and contractions in Romance. *Probus* 8:181–205.

———. 1996b. External allomorphy as emergence of the unmarked. In Durand and Laks 1996, 473–83.

Massam, D. 1983. The morphology of Irish mutation. *MITWPL* 5:10–29.

Mayerthaler, W. 1980. Ikonismus in der Morphologie. *Zeitschrift für Semiotik* 2:19–37.

———. 1981. *Morphologische Natürlichkeit*. Wiesbaden: Athenaion.

McCarthy, J. J. 1979. Formal problems in Semitic phonology and morphology. PhD dissertation, MIT. Pub. New York: Garland, 1985.

———. 1988. Feature geometry and dependency: A review. *Phonetica* 43:84–108.

———. 1999. Sympathy and phonological opacity. *Phonology* 16:331–99.

———. 2002. *A thematic guide to optimality theory*. Cambridge: Cambridge Univ. Press.

———. 2003. Sympathy, cumulativity, and the Duke-of-York gambit. In Féry and van de Vijver 2003, 23–76.

———, ed. 2004. *Optimality theory in phonology: A reader*. Oxford: Blackwell.

McCarthy, J. J., and A. S. Prince. 1993a. Generalized alignment. *Yearbook of Morphology* 1993:79–153.

———. 1993b. Prosodic morphology: Constraint interaction and satisfaction. RUCCS Technical Report #3. Revised version (2001) available as ROA-482.

———. 1994. The emergence of the unmarked: Optimality in prosodic morphology. In *NELS 24,* ed. M. Gonzàlez, 333–79. Amherst: GLSA.

———. 1999. Faithfulness and identity in prosodic morphology. In Kager, van der Hulst, and Zonneveld 1999, 218–309.

McMahon, A. 2000. *Change, chance, and optimality*. Oxford: Oxford Univ. Press.

Mhac an Fhailigh, É. 1968. *The Irish of Erris, Co. Mayo*. Dublin: Dublin Institute for Advanced Studies.

Miglio, V., and B. Morén, eds. 1997. *Selected phonology papers from H-O-T 97*. Univ. of Maryland Working Papers in Linguistics 5. College Park: Univ. of Maryland.

Mohanan, K. P. 1986. *The theory of lexical phonology*. Dordrecht: Reidel.

Morén, B. T. 1997. Markedness and faithfulness constraints on the association of moras. MA thesis, Univ. of Maryland.

Moulton, W. G. 1962. *The sounds of English and German*. Chicago: Univ. of Chicago Press.

Murray, R. W., and T. Vennemann 1983. Sound change and syllable structure in Germanic phonology. *Language* 59:514–28.

Myers, J. 1999. Lexical phonology and the lexicon. MS, National Chung Cheng Univ. ROA-330.

———. 2002. Exemplar-driven analogy in Optimality Theory. In *Analogical modeling: An exemplar-based approach to language*, ed. R. Skousen, D. Lonsdale, and D. B. Parkinson, 265–300. Amsterdam: John Benjamins.

Myers, S. 1987. Vowel shortening in English. *NLLT* 5:485–518.

Nespor, M., and I. Vogel. 1989. On clashes and lapses. *Phonology* 6:69–116.

Ní Chiosáin, M. 1991. Topics in the phonology of Irish. PhD dissertation, UMass.

Ní Chiosáin, M., and J. Padgett. 2001. Markedness, segment realization, and locality in spreading. In *Segmental phonology in optimality theory*, ed. L. Lombardi, 118–56. Cambridge: Cambridge Univ. Press.

Noske, M. 2000. [ATR] harmony in Turkana: A case of FaithSuffix ≫ FaithRoot. *NLLT* 18:771–812.

Noyer, R. 1997. Attic Greek accentuation and intermediate derivational representations. In Roca 1997, 501–27.

Odden, D. 1986. On the Obligatory Contour Principle. *Language* 62:353–83.

Ó Dónaill, N., ed. 1977. *Foclóir Gaeilge-Béarla*. Dublin: An Gúm.

Ó Duibhín, C. 2003. Tobar na Gaedhilge, version 1.1. Searchable database. Available online at http://www.smo.uhi.ac.uk/~oduibhin/tobar/.

Ó Searcaigh, S. 1925. *Foghraidheacht Ghaedhilge an tuaiscirt*. Belfast: Browne & Nolan.

Ó Siadhail, M. 1989. *Modern Irish: Grammatical structure and dialectal variation*. Cambridge: Cambridge Univ. Press.

Ó Siadhail, M., and A. Wigger 1975. *Córas fuaimeanna na Gaeilge*. Dublin: Dublin Institute for Advanced Studies.

Padgett, J. 1995. Feature classes. In Beckman, Walsh Dickey, and Urbanczyk 1995, 385–420.

Paradis, C. 1997. Non-transparent constraint effects in Gere: From cycles to derivations. In Roca 1997, 529–50.

Penke, M., U. Janssen, and M. Krause. 1999. The representation of inflectional morphology: evidence from Broca's aphasia. *Brain and Language* 68:225–32.

Perlmutter, D. M. 1998. Interfaces: Explanation of allomorphy and the architecture of grammars. In *Morphology and its relation to phonology and syntax*, ed. S. G. Lapointe, D. K. Brentari, and P. M. Farrell, 307–38. Stanford, Calif.: CSLI.

Phillips, B. S. 1999. The mental lexicon: Evidence from lexical diffusion. *Brain and Language* 68:104–9.

Prince, A. 1975. The phonology and morphology of Tiberian Hebrew. PhD dissertation, MIT.

———. 1983. Relating to the grid. *LI* 11:511–62.

———. 1990. Quantitative consequences of rhythmic organization. In *Papers from the 26th Regional Meeting of the CLS*, ed. M. Ziolkowski, M. Noske, and K. Deaton, 2:355–98. Chicago: CLS.

Prince, A., and P. Smolensky. 2004. *Optimality theory: Constraint interaction in generative grammar*. Oxford: Blackwell.

Pulleyblank, D. 1986. *Tone in lexical phonology*. Dordrecht: Reidel.

Pyatt, E. J. 1997. An integrated model of the syntax and phonology of Celtic mutation. PhD dissertation, Harvard Univ.

Quiggin, E. C. 1906. *A dialect of Donegal*. Cambridge: Cambridge Univ. Press.

Rappaport, M. 1984. Issues in the phonology of Tiberian Hebrew. PhD dissertation, MIT.

Rendsburg, G. A. 1997. Ancient Hebrew phonology. In Kaye 1997, 65–83.

Roberts, I. G. 1997. The syntax of direct object mutation in Welsh. *CJL* 42:141–68.

———. 2005. *Principles and parameters in a VSO language: A case study in Welsh*. Oxford: Oxford Univ. Press.

Robinson, O. W. 2001. *Whose German? The* ach/ich *alternation and related phenomena in "standard" and "colloquial."* Amsterdam: John Benjamins.

Roca, I., ed. 1997. *Derivations and constraints in phonology*. Oxford: Clarendon.

Rubach, J. 1997. Extrasyllabic consonants in Polish: Derivational optimality theory. In Roca 1997, 551–81.

Rubach, J., and G. Booij. 2001. Allomorphy in optimality theory: Polish iotation. *Language* 77:26–60.

Sagey, E. 1986. The representation of features and relations in nonlinear phonology. PhD dissertation, MIT. Pub. New York: Garland, 1991.

Sanders, R. N. 2003. Opacity and sound change in the Polish lexicon. PhD dissertation, Univ. of California at Santa Cruz. ROA-603.

Schein, B., and D. Steriade. 1986. On geminates. *LI* 17:691–744.

Scobbie, J. 1991. Attribute value phonology. PhD dissertation, Univ. of Edinburgh.

———. 1993. Constraint violation and conflict from the perspective of declarative phonology. *CJL* 38:155–67.

Selkirk, E. O. 1982. The syllable. In van der Hulst and Smith 1982, 2: 337 – 84.

Seuren, P. A. M. 1998. *Western linguistics: An historical introduction*. Oxford: Blackwell.

Singh, R. 1987. Well-formedness conditions and phonological theory. In *Phonologica 1984*, ed. W. U. Dressler, H. C. Luschützky, O. E. Pfeiffer, and J. R. Rennison, 273–85. Cambridge: Cambridge Univ. Press.

———. 1996a. Natural Phono(morpho)logy: A view from the outside. In *Natural phonology: The state of the art*, ed. B. Hurch and R. A. Rhodes, 1–38. Berlin: Mouton de Gruyter.

———, ed. 1996b. *Trubetzkoy's orphan: Proceedings of the Montréal roundtable "Morphonology: Contemporary responses."* Amsterdam: Benjamins.

Smolensky, P. 1993. Harmony, markedness, and phonological activity. Handout from Rutgers Optimality Workshop 1. ROA-87.

Sommerfelt, A. 1929. South Armagh Irish. *Norsk Tidsskrift for Sprogvidenskap* 2:107–91.

———. 1965. The phonemic structure of the dialect of Torr, Co. Donegal. *Lochlann* 3:237–54.

Spencer, A. 1996. *Phonology: Theory and description*. Oxford: Blackwell.

Stampe, D. 1973. A dissertation on natural phonology. PhD dissertation, Univ. of Chicago. Pub., New York: Garland, 1980.

Stanley, R. 1967. Redundancy rules in phonology. *Language* 43:393–436.

Steiner, R. C. 1997. Ancient Hebrew. In *The Semitic languages*, ed. R. Hetzron, 145–73. London: Routledge.

Stenson, N. 1990. Phrase structure congruence, government, and Irish-English code-switching. In *The syntax of the modern Celtic languages*, ed. R. Hendrick, 167–97. Syntax and Semantics 23. San Diego: Academic Press.

Steriade, D. 2000. Paradigm uniformity and the phonetics-phonology boundary. In *Acquisition and the lexicon*, ed. M. Broe and J. Pierrehumbert, 313–34. Papers in Laboratory Phonology 5. Cambridge: Cambridge Univ. Press.

Stewart, T. W., Jr. 2004. Mutation as morphology: Bases, stems, and shapes in Scottish Gaelic. PhD dissertation, The Ohio State Univ. Available online at http://www.ohiolink.edu/etd/send-pdf.cgi ?osu1086046888.

Stump, G. T. 1988. Non-local spirantization in Breton. *Journal of Linguistics* 24:457–81.

Sumner, M. 2002. The psycholinguistic reality of abstract representations. In *WCCFL 21 Proceedings*, ed. L. Mikkelsen and C. Potts, 429–42. Somerville: Cascadilla Press.

Swingle, K. 1993. The Irish and other mutations. In *WCCFL 11*, ed. J. Mead, 451–66. Stanford, Calif.: CSLI.

Tallerman, M. 1998. The uniform Case-licensing of subjects in Welsh. *LR* 15:69–133.

———. 1999. Welsh soft mutation and marked word order. In Darnell et al. 1999, 2:277–94.

———. 2006. The syntax of Welsh "direct object mutation" revisited. *Lingua* 116:1750–76.

Thomas, A. R. 1984. A lowering rule for vowels and its ramifications, in a dialect of North Welsh. In Ball and Jones 1984, 105–24.

Thorne, D. A. 1993. *A comprehensive Welsh grammar*. Oxford: Blackwell.

Trager, G. L. 1930. The pronunciation of "short *a*" in American Standard English. *American Speech* 5:396–400.

———. 1934. What conditions limit variants of a phoneme? *American Speech* 9:313–15.

———. 1940. One phonemic entity becomes two: The case of "short *a*." *American Speech* 15:255–58.

———. 1941. ə ˈnəwt on æ ənd æ˔ˑ in əˈmerikən ˈiŋgliʃ. *Maître Phonétique* 17–19.

Tranel, B. 1996. Exceptionality in optimality theory and final consonants in French. In *Grammatical theory and Romance languages*, ed. K. Zagona, 275–91. Amsterdam: John Benjamins.

———. 1998. Suppletion and OT: On the issue of the syntax/phonology interaction. In *WCCFL 16*, ed. E. Curtis, J. Lyle, and G. Webster, 415–29. Stanford, Calif.: CSLI.

Ulbrich, H. 1972. *Instrumentalphonetisch-auditive R-Untersuchungen im Deutschen*. Berlin: Akademie-Verlag.

Vennemann, T. 1988. *Preference laws for syllable structure and the explanation of sound change with special reference to German, Germanic, Italian, and Latin*. Berlin: Mouton de Gruyter.

Wells, J. C. 1982. *Accents of English*. 3 vols. Cambridge: Cambridge Univ. Press.

———. 1999. British English pronunciation preferences: A changing scene. *Journal of the International Phonetic Association* 29:33–50.

———. 2000. *Longman pronunciation dictionary*. 2nd ed. Harlow, England: Longman.

Wiese, R. 1996. *The phonology of German*. Oxford: Oxford Univ. Press.

Williams, B. 1983a. An approach to the Welsh vowel system. *Bulletin of the Board of Celtic Studies* 30:239–52.

———. 1983b. Stress in modern Welsh. PhD dissertation, Univ. of Cambridge. Printed and distributed 1989, Bloomington: Indiana Univ. Linguistics Club.

Wurzel, W. U. 1980. Some remarks on the relations between naturalness and typology. *Travaux du cercle linguistique de Copenhague* 20:103–13.

———. 1984. *Flexionsmorphologie und Natürlichkeit*. Berlin: Akademie-Verlag.

Yip, M. 1993. Cantonese loanword phonology and optimality theory. *JEAL* 2:261–91.

———. 2004. Phonological markedness and allomorph selection in Zahao. *Language and Linguistics* 5:969–1001.

Zwicky, A. 1984. Welsh soft mutation and the case of object NPs. In *Papers from the twentieth regional meeting of the CLS*, ed. J. Drogo, V. Mishra, and D. Testen, 387–402. Chicago: CLS.

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