2015

Phonologically Conditioned Allomorphy and UR Constraints

Brian W. Smith

PHONOLOGICALLY CONDITIONED ALLOMORPHY AND UR CONSTRAINTS

A Dissertation Presented

by

BRIAN W. SMITH

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

September 2015

Linguistics

PHONOLOGICALLY CONDITIONED ALLOMORPHY AND UR CONSTRAINTS

A Dissertation Presented

by

BRIAN W. SMITH

Approved as to style and content by:

____

Joe Pater, Chair

____

Lyn Frazier, Member

____

John J. McCarthy, Member

____

Lisa Sanders, Member

____

John Kingston, Department Chair
Linguistics

Dedicated to Greg Smith, Hazel Smith, and the rest of my family.

ACKNOWLEDGMENTS

Before anyone else, I have to thank my advisors. I looked forward to every meeting, and no matter how much I write in gratitude, it doesn't feel like enough. I'm realizing more and more that my own academic personality is constructed out of pieces of each of them, from the big things (the way I teach) to the incredibly small (the way I sign e-mails).

Joe Pater is one of the main reasons this dissertation was finished. Throughout my entire graduate career, Joe was simultaneously supportive of me and critical of my ideas. I appreciate both. For every good idea in this dissertation, there are two worse ideas that didn't survive our meetings. Without him, I doubt I would've ever considered the range of possibilities in linguistic theory: weighted constraints, variation, learnability, statistics. When I decided to become a linguist, I was certain I would never work on such things, and that's why I'm glad I found Joe.

John McCarthy's push towards explicitness made every idea clearer, exposing its shortcomings and advantages. He also knows pretty much everything. My only complaint about working with John is that he always knew my analysis before I did. My hard earned cleverness was always met with effortless foresight. I'm most grateful for how much John taught me beyond linguistics: clarity in writing and thought, and generosity and charity in approaching the ideas of others.

Lyn Frazier introduced me to entirely new literatures, especially in psycholinguistics and speech production. Lyn always found ways to connect these literatures to my questions about morphophonology. Perhaps most importantly, she taught me the difference between a hypothesis and a prediction, and I look forward to torturing my own students with questions such as "But what's your *hypothesis*?" and "But why do we *care*?"

Lisa Sanders served as an invaluable and insightful outside member of the committee. Her input made many sections of the dissertation much clearer, especially for non-specialists. She also asked some of the hardest questions at my defense, which have shaped a great deal of my post-dissertation research.

I'm lucky to know a wonderful group of people from South College, all of whom I look forward to bumping into at conferences in the coming years. My cohortmates – Kevin Mullin, Suzi Lima, and Clint Hartzell – were a constant source of support and friendship. The other phonology students made every seminar a joy, and the non-phonologists provided both a bit of perspective ("you should learn Distributed Morphology") and distraction from linguistics ("you should play more board games"). I'll thank just a few people here, because the complete list would fill pages. They are: Anisa Schardl, Bobby Amour, Claire Moore-Cantwell, Dat Nguyen, Dustin Ngo, Emily Elfner, Geordie Hine, Ivy Hauser, Karen Jesney, Kathryn Pruitt, Martin Walkow, Matthew Hine, Mike Clauss, Presley Pizzo, and Tom Maxfield. Finally, there were many other professors at UMass who I looked forward to passing in the halls and also learned a lot from, including Alice Harris, Ellen Woolford, John Kingston, Kyle Johnson, Kristine Yu, and Rajesh Bhatt.

Beyond UMass, many of the ideas here benefited from feedback at the 20th and 21st Manchester Phonology Meetings, and the 2014 Workshop on Allomorphy at the University of Jerusalem. Renate Raffelsiefen and Ricardo-Bermúdez Otero provided a lot of helpful feedback, especially regarding *-(a)licious*, and Stephanie Shih and Kie Zuraw provided countless invaluable discussions about morphology, phonology, and statistics. A paper version of the *-(a)licious* chapter also benefited from the feedback of three anonymous reviewers.

I should also thank the linguistics professors at Rutgers University, my undergrad alma mater, especially Alan Prince, Jane Grimshaw, Paul de Lacy, and Viviane Deprez. They pushed me towards pursuing linguistics as a career and showed me how beautiful it all can be. Alan in particular was a real mentor, teaching me about much more than

phonology: logic, philosophy of science, how to be a good academic, what it means to be a member of a scientific field, and what a theory is. All of these things remain with me today.

ABSTRACT

PHONOLOGICALLY CONDITIONED ALLOMORPHY AND UR CONSTRAINTS

SEPTEMBER 2015

BRIAN W. SMITH

B.A., RUTGERS UNIVERSITY, NEW BRUNSWICK

Ph.D., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Joe Pater

This dissertation provides a new model of the phonology-morphology interface, focusing on Phonologically Conditioned Allomorphy (PCA). In this model, UR selection occurs during the phonological component, and mappings between meanings and URs are encoded as violable constraints, called UR constraints (Boersma 2001; Pater et al. 2012).

Ranking UR constraints captures many empirical generalizations about PCA, such as similarities between PCA and phonological alternations, the existence of defaults, and the interaction of PCA and phonological repairs (epenthesis, deletion, etc.). Since PCA follows from the ranking or weighting of constraints, patterns of PCA can be learned using existing learning algorithms, and modeling variation in PCA is straightforward.

The main empirical conclusion is that some cases of PCA are driven by the general phonological grammar, and are not the result of subcategorization. This conclusion follows from three case studies: English *a* and *an*, French liaison, and English suffixes

-*(a)licious* and -*(a)thon*. For each of these cases, PCA is closely integrated into the phonology of the language. The same ranking of constraints can be used to capture both alternations and PCA, and phonological repairs like epenthesis and deletion conspire with PCA to avoid marked structures.

Each of these cases comes with novel data and analyses. For English *a* and *an*, the selection of the article interacts with h-deletion and ʔ-epenthesis, conspiring with both to avoid hiatus. In French liaison, the default allomorph is often unpredictable, and liaison in some words conspires with n-epenthesis to avoid hiatus. For English -*(a)licious* and -*(a)thon*, PCA avoids hiatus and stress clash, and the suffix -*(a)licious* conspires with the Rhythm Rule to avoid stress clashes. For each case study, I also present variable data, analyzed with UR constraints in Maximum Entropy Harmonic Grammar (Goldwater and Johnson 2003).

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 PCA: lexicon or grammar?

This dissertation examines the division of labor between morphology and phonology, especially as it relates to Phonologically Conditioned Allomorphy (PCA: Carstairs 1988 and subsequent work). The longstanding question is whether PCA is a product of the lexicon, the grammar, or some combination of the two. I argue that some cases of PCA are best analyzed as a product of the phonological grammar, obeying phonological constraints and interacting with phonological repairs. To account for these facts, I provide a constraint-based model in which the selection of underlying representations follows from the ranking of phonological and morphological constraints. I outline this model after a brief discussion of PCA.

PCA describes a situation in which there are multiple allomorphs, each with a different Underlying Representation (UR), and the choice of UR is phonologically conditioned. A well-known example is the subject marker in Korean. It has two allomorphs: *-i* occurs after consonants, and *-ga* occurs after vowels. Though the distribution is phonologically conditioned, the two allomorphs cannot be derived from a single UR.

(1) PCA in Korean subject marker

a.	Listed URs:	/-i/ and /-ka/
b.	Conditioning:	*-i* after consonants
		-ga after vowels
c.	Examples:	chib-i ‘house-subject’
		cha-ga ‘car-subject’

In the PCA analysis of Korean, the choice between the URs /-i/ and /-ga/ is determined by phonological context. The question for any account is where this conditioning comes from.

(2) Phonological conditioning

When UR selection is phonologically-conditioned, how is phonological conditioning encoded?

A closely related question is the extent to which UR selection considers its phonological consequences.

(3) Lookahead to repairs

If the choice of a UR creates a phonological context that conditions the application of some process or "repair" (like epenthesis or deletion), does UR selection take these repairs into account?

The answers to these two questions are closely related. Most previous work addressing them fits into one of the two approaches below.

(4) The lexical approach

The lexical entry of /-i/ says: use /-i/ after a UR that ends in a consonant.

No access to phonological repairs.

(5) The grammatical approach

Use the UR that results in the least marked output, e.g. minimizes the number of codas.

Full access to phonological repairs.

The lexical approach is taken in most of the literature surrounding Distributed Morphology (DM: Halle and Marantz 1993), among others (Paster 2005, 2006; Bye 2008). These accounts argue that phonological requirements are listed for every affix, usually as subcategorization frames (see Embick 2010 and references within). Under some of these accounts, UR selection occurs before the phonology, and as a result, PCA is indifferent to repairs.

On the other hand, the grammatical approach is taken in constraint-based frameworks, especially Optimality Theory (OT: Prince and Smolensky 1993/2004). OT accounts of PCA argue that phonological conditioning emerges from the phonological grammar, which has the power to decide between listed URs (Mester 1994; Kager 1996; Mascaró 1996; Wolf 2008). Since UR selection occurs during the phonology, PCA can and should take advantage of phonological repairs.

So far, a lot of work has established that the grammatical approach is insufficient. Many cases of PCA contradict the general phonology of their host language, and many cases of PCA ignore repairs. Based on these data, Embick (2010) and Paster (2006) argue that the lexical approach necessary, making the grammatical approach redundant.

In this dissertation, I take a different stance. I provide a set of case studies showing the benefits and necessity of the grammatical approach. In my analysis of these cases, the phonological grammar chooses between listed URs on the basis of a constraint-based grammar. The grammar used for PCA is the same one used in the regular phonology of the language, accounting for the fact that the constraints on PCA resemble those elsewhere in the language: in phonotactics, in repairs, and across other cases of PCA. Moreover, in each of these case studies, UR selection takes phonological repairs into account: UR selection and repairs work together to actively avoid the same marked structures.

Although I focus on the evidence showing the necessity of the grammatical approach, the ultimate conclusion is that some combination of the lexical and grammatical approaches is necessary. Although this alternative has received less attention, it seems to be the only one that's consistent with the data, as argued in Dolbey (1997); Lapointe and Sells (1997); Booij (1998); Bonet, Lloret, and Mascaró (2003); Nevins (2011).

(6) The mixed approach

Analyze a pattern with the grammatical approach if it works, otherwise use the lexical approach.

The mixed approach is necessary due to the contradictory nature of the data: some cases necessitate the grammatical approach, as I show here, and some cases necessitate the lexical one, as shown by Paster (2006) and Embick (2010). The idea is to use lexical listing as a last resort, since listing misses many of the generalizations and insights of the grammatical approach.

The three case studies come from English and French. The first is the English indefinite article. I use the unreduced forms /ej/ and /æn/ as the URs, rather than [ə] and [ən], which I justify in Chapter 3.

(7) PCA in English indefinite article, *a* and *an*

a.	Listed URs:	/ej/ and /æn/
b.	Conditioning:	*a* before consonants
		an before vowels
c.	Examples:	a pear
		an apple

The second is French liaison, a final consonant alternation occurring with many words. The adjective *petit* is just one example.

(8) PCA in French liaison, e.g. *petit*

a.	Listed URs:	/pœti/ and /pœtit/
b.	Conditioning:	[pœti] before consonants
		[pœtit] before vowels
c.	Examples:	[pœti gaʁsɔ̃] 'small boy'
		[pœtit ɔm] 'small man'

The third is English -*(a)licious* and related neologistic suffixes, such as -*(a)thon* and -*(a)holic*. All of these suffixes follow a distribution like the one below.

(9) PCA in English neologistic suffixes, e.g. -*(a)licious*

a. Listed URs: /-lɪʃəs/ and /-əlɪʃəs/

b. Conditioning: [-lɪʃəs] after vowels
[-əlɪʃəs] after consonants

c. Examples: snow-licious
rain-alicious

These case studies are supported by new data collected both experimentally and from corpora such as COCA (Davies 2008-), Buckeye (Pitt et al. 2005), and GlOWbE (Davies 2013).

Unlike the Korean subject marker, the differences between allomorphs in these cases is small – only one or two segments. As a result, we might imagine an alternative analysis with a single UR and epenthesis or deletion. Throughout the dissertation, I show that a single UR analysis doesn't work out for these cases, either due to ranking paradoxes or contradictory data.

The next sections outline a few issues in PCA, which make up the full explanatory target of the dissertation. The goal is a model that captures these properties. I outline this model – called URC – at the end of the introduction.

1.2 Lookahead to repairs

Patterns of PCA can often be stated in two ways: either in terms of the input to suffixation, or in terms of the output of suffixation. The lexical and grammatical approaches are typically input- and output-oriented, respectively.

(10) The lexical approach

The lexical entry of /-i/ says: use /-i/ after a UR that ends in a consonant.

Refers to the input of suffixation, i.e. the stem

(11) The grammatical approach

Use the UR that minimizes the number of codas.

Refers to the output of suffixation

If we find that PCA is output-oriented, we might further consider the *extent* to which it is output-oriented. Does PCA consider the output of phonological repairs like epenthesis and deletion?

In this dissertation, I argue that UR selection considers not only the output of suffixation, but also the output of repairs. For example, *a* and *an* interact with glottal stop epenthesis and h-deletion, always choosing the appropriate UR for the phonological repair. When h-deletion is used, *an* occurs.

As mentioned earlier, lookahead to repairs goes hand-in-hand with the grammatical approach. Since UR selection is governed by the phonological grammar, it has access to phonological processes.

1.3 Defaults

Cases of PCA often have a default allomorph, which occurs in the elsewhere context. In fact, every case of PCA can be rewritten with a default by replacing one of the phonological environments with "elsewhere". The Korean case is restated below with *-ga* as the default.

(12) PCA in Korean

a. *-i* after consonants

b. *-ga* elsewhere

In Korean, both analyses, with and without a default, are compatible with the data.

In other cases, however, defaulthood is necessary, because one allomorph's distribution can't be defined with any sort of natural class. For example, English *a* not only occurs before consonants, but also before parentheticals and disfluencies like *um*.

(13) PCA in English *a* and *an*

a.	Listed URs:	/ej/ and /æn/	
b.	Conditioning:	*an* before vowels	
		a elsewhere	before consonants
			before parentheticals
			before disfluencies
c.	Examples:	an apple	
		a pear	
		a – in my opinion – ideal guy	
		a um apple	

In previous accounts, defaulthood hasn't received a lot of attention, and models of defaulthood often rely on the lexicon to list the default form. For example, Mascaró (2007)'s OT analysis uses the constraint PRIORITY (see also Bonet, Lloret, and Mascaró 2007).

(14) PRIORITY

Respect lexical priority (ordering) of allomorphs.

Analyses that list the default don't address why one form is the default over the other, or how a learner determines which form is the default allomorph.

Under a theory with UR constraints, the identity of the default follows from the constraint ranking, and isn't externally listed. Since the default follows from the constraint ranking, it's easily learnable using pre-existing learning algorithms.

1.4 Variation

Sometimes allomorphs occur in free variation, with both allomorphs being possible for a given stem. If this variation is phonologically conditioned, an allomorph is more likely with stems of a certain shape. For example, an allomorph might occur 60% of the time in the elsewhere context, but 90% of the time after a vowel.

An example of variation in PCA is described for Latin in Mester (1994). There are two allomorphs *-ia* and *-iēs*, which are identical in meaning. For some stems, both allomorphs are possible; however, for stems that end in heavy syllable, *-iēs* is avoided, and *-ia* is much more likely.

The big question for cases of variable PCA is how to model them. Ideally, generalizations like the Latin ones should follow from the grammar.

Under URC, the strength of the default and phonological conditioning follows from the constraint ranking. By using a constraint-based theory of variation, it's straightforward to model and learn variable patterns like the ones above.

1.5 Preview of the model

The goal of this dissertation is a model that can account for the properties above. This model, called URC, builds on earlier OT analyses of PCA but differs in one crucial way: mappings between meanings and URs are encoded as rankable UR constraints.

UR constraints evaluate the phonological exponence of morphological features (Boersma 2001; Pater et al. 2012). Under this account, the input to phonology contains no phonological material whatsoever. Instead, the input contains morphosyntactic features, and UR selection is regulated by UR constraints. UR selection occurs in parallel with phonological repairs, giving UR selection full lookahead to phonological outputs.

For example, the constraints below, which encode the phonological content of *-i* and *-ga*, require the morphosyntactic features of the subject marker to be realized by the

URs /i/ and /ka/. The actual features of the subject marker aren't straightforward or phonologically relevant, so the morphosyntactic features below are placeholders.

(15) {NOM} → /i/

Assign one violation for every set of morphosyntactic features {NOM} that is not realized by /i/

(16) {NOM} → /ka/

Assign one violation for every set of morphosyntactic features {NOM} that is not realized by /ka/

Ranking or weighting UR constraints with respect to markedness, faithfulness, and other UR constraints is enough to model phonological conditioning, repair-PCA interactions, and defaults.

(17) Phonological conditioning

a UR constraint can be ranked/weighted below a markedness constraint to capture conditioning

(18) Repair-PCA interactions

a UR constraint can be ranked/weighted above or below a faithfulness constraint to encode preferences between repairs and PCA

(19) Defaults

the UR constraint for the default can be ranked/weighted above other UR constraints to encode a baseline preference for the default

The benefit of treating UR selection as the result of a constraint-based grammar is that all of these properties are learnable using pre-existing learning algorithms, and adding variation is as straightforward as switching to one of the many constraint-based models of variation.

1.6 Outline of dissertation

The dissertation is outlined as follows. In Chapter 2, I present URC and illustrate it using the well-known case of English *a* and *an*. The chapter also lays out the three main results of URC. First, URC predicts that the constraints conditioning PCA play a greater role in the language, in alternations and phonotactics. Second, URC predicts that defaulthood in allomorphy is phonologically arbitrary, and defaulthood is consistent across contexts. Third, URC predicts that PCA is output-oriented, and UR selection has lookahead to phonological repairs. Chapters 3 through 5 show that these predictions are borne out in English and French.

In Chapter 3, I expand the URC analysis to provide a complete account of *a* and *an*, focusing on the interaction of PCA and repairs. This chapter presents arguments for *a(n)* being driven by the constraint ∗ə.V, arguments for *a* as an arbitrary default, and arguments that *a(n)* allomorphy conspires with phonological repairs such as h-deletion and ʔ-epenthesis. I also show how URC can account for cases of variation with weighted constraints.

In Chapter 4, I present a URC account of French liaison, a pattern in which final consonants are variably realized depending on the following phonological context. The account focuses on two difficult cases of liaison: cardinal numbers and Ṽ-final words. Cardinal numbers are difficult for most analyses because they behave inconsistently with respect to the realization of their liaison consonant. Some numbers realize their consonants phrase-finally, while others do not. This difference follows naturally from the ranking of UR constraints. Ṽ-final words are difficult because they present an interaction of PCA with a phonological repair – n-epenthesis. PCA and n-epenthesis conspire to avoid hiatus, but the preferred strategy differs on a word-by-word basis. In the URC account, these differences follow from the weighting of UR constraints and faithfulness constraints.

In Chapter 5, I present new data about two derivational suffixes in English – *-(a)thon* and *-(a)licious*. These suffixes are subject to phonologically-conditioned variation, and tend to avoid both hiatus and stress clash. They provide a strong argument for the grammatical approach: the constraints conditioning *-(a)licious* are observable throughout English, and the distribution of *-(a)licious* can't be learned given sparse data. The fact that the suffix *-(a)licious* avoids stress clash finds further support in its interaction with the Rhythm Rule (RR), a clash-avoiding phonological repair. UR selection and the RR work together to avoid stress clash, and this interaction can be modeled with UR constraints.

Each of these case studies has a lot in common. For each of the case studies, the same constraints that condition PCA also condition repairs and phonotactics in the language. This fact follows under an account like URC, in which UR selection is driven by language-wide constraints. For many of these cases, I show that both PCA and repairs can be captured under a single ranking or weighting of constraints.

Throughout these chapters, there are also four cases of PCA-repair conspiracies. In each of these cases, it seems that PCA considers the output of repairs, supporting a model in which UR selection considers its phonological consequences.

Finally, in each case study, there is at least one instance of variable PCA. Using weighted constraints in URC provides a means to capture these patterns of variation.

CHAPTER 2

MODEL AND RESULTS

2.1 Overview of Chapter 2

This chapter outlines URC, a model of PCA using UR constraints. In this model, UR selection occurs during phonology, and mappings between meanings and URs are encoded by UR constraints.

The model has three main results, listed below. The rest of the dissertation supports these results using data from English and French.

- PCA is conditioned by the same constraints that condition phonological repairs.
- UR selection is sensitive to the output of phonological repairs.
- Defaulthood comes from constraint ranking.
  - URC predicts categorical preferences between URs (defaults).
  - URC predicts non-categorical preferences between URs (preferred allomorphs).
  - URC allows for a straightforward model of the learning of default and preferred allomorphs.

To illustrate URC and its results, I use the example of the indefinite article, *a* and *an*. I provide a URC analysis of *a* and *an* in §2.3, and a discussion of the results above in §2.4.

2.2 The URC model

This section goes through the mechanics of URC: what the input to evaluation is, how the candidate set is constructed, how UR constraints are evaluated, and some possible extensions.

URC builds on previous work, and in many ways, URC resembles the classic OT model of PCA. Consequently, many of the results of URC are shared by other OT accounts, and I note these similarities throughout the section.

2.2.1 The input

In URC, the input to phonological evaluation does not contain any phonological material at all. Instead, the input contains something like *meaning* or *intent*. In this way, URC resembles a production model. The speaker has some intent, encoded here as morphosyntactic features, and the grammar's goal is to realize it.

The idea that the input to phonology contains no phonological material has been pursued extensively in earlier work, such as Russell (1995), Zuraw (2000), Boersma (2001), and Wolf (2008) (among others, see Wolf 2014 for a recent summary).

To encode meaning, I use morphosyntactic features. There are many other ways to do this, and I think nothing crucial hinges on this particular formalization. For the theory to work out, the only important thing is that every morpheme has something in the input that distinguishes it from the others. That is, a speaker's input encodes that she wants to say *dog* and not *cat* or *canine* or *pug*.

The input consists pairs of category labels and bundles of morphosyntactic features. These pairs are in a fixed order, determined before phonology. As a result, the phonological grammar has no power over linearization. The example below contains the phonological input for *the sheep (plural)*, assuming terminal nodes for the determiner (D), root (n), and suffix (#).

(1) <D, {+DEF}> + <n, {$\sqrt{\text{SHEEP}}$}> + <#, {PLURAL}>

In the example above, morphosyntactic features are written in small caps between curly brackets (to avoid confusion with SRs in square brackets). Roots are indicated with a square-root symbol, e.g. $\{\sqrt{\textsc{sheep}}\}$. For convenience, I usually omit category labels.

Like earlier accounts, I don't have much to say about where this input comes from or how features are bundled. These questions have been taken up in work in Distributed Morphology (DM: Halle and Marantz 1993, 1994), which has proposed a number of morphological operations that manipulate morphosyntactic features. With the exception of the mechanics of UR selection, URC is largely compatible with DM. In DM, URs are inserted late, after syntactic operations, and in many DM accounts, UR selection occurs after linearization (Embick and Noyer 2001; Pak 2008).

URC pushes back UR selection even further, from morphology to phonology. Since URs aren't selected ahead of time, the phonological grammar is free to select URs while taking into consideration phonological constraints, like markedness and faithfulness.

2.2.2 Representations

Candidates in URC have a three-level representation. This representation contains the input, the underlying representations of morphemes, and the surface representation. The grammar evaluates all three of these levels at the same time.

Input (meaning)	<D, $\{-\textsc{det}\}$> + <n, $\{\sqrt{\textsc{cat}}\}$>
|	|
Underlying Representation (URs for each morpheme)	/ej/+/kæt/
|	|
Output (Surface Representation)	[ə kæt]

Figure 2.1: Structure of representations: three levels for every candidate

Between these levels are correspondence relations. Each set of features in the input is in correspondence with a UR. This meaning-UR correspondence is what UR constraints evaluate. Segments in URs and segments in SRs are also in correspondence. This correspondence is evaluated by UR-SR faithfulness constraints, traditionally called input-output faithfulness constraints (McCarthy and Prince 1995).

<D, {−DET}>^{a} + <n, {$\sqrt{\text{CAT}}$}>^{b}

⇕ meaning-UR correspondence (superscript letters)

/ej_1/^{a} + /$k_2æ_3t_4$/^{b}

⇕ UR-SR correspondence (subscript numbers)

[$ə_1k_2æ_3t_4$]

Figure 2.2: Structure of representations: correspondences between levels

It's important to note that all three levels are evaluated at once. They do *not* represent a derivation, but are parts of a single candidate. Also, there is no meaning-SR correspondence, since such a relation is unecessary in URC.

Candidates like the ones above, which assess inputs, URs and SRs at the same time, are used in many other accounts in which the phonology governs UR selection, namely Zuraw (2000), Boersma (2001), and Wolf (2008).

2.2.3 UR constraints

Given that the phonology governs UR selection, there needs to be some way for the phonology to know the set of possible meaning-UR mappings. In URC, these mappings are encoded as UR constraints. The formulation for UR constraints here closely follows Pater et al. (2012), and a number of other similar proposals are discussed at the end of the section.

A UR constraint requires a particular input to be realized by a particular UR.

(2) INPUT → /UR/

Assign one violation for every INPUT that does not correspond to /UR/.

In URC, the INPUT is a set of features, and /UR/ consists of any string of phonological segments, including the empty string. Three examples are below. The last constraint encodes the zero plural, as in *ten sheep*.

(3) <D, {−DEF}> → /ej/

Assign one violation for every set of features <D, {−DET}> that does not correspond to UR /ej/.

(4) <D, {−DEF}> → /æn/

Assign one violation for every set of features <D, {−DET}> that does not correspond to UR /æn/.

(5) <#, {+PL}> → /Ø/

Assign one violation for every set of features <#, {+PL}> that does not correspond to UR /Ø/ (the empty string).

UR constraints are language-specific. The constraints above don't exist in French or Chinese. If an English speaker never uses the UR /æn/, she simply doesn't have the corresponding UR constraint in her grammar.

I abbreviate UR constraints, especially in tableau, using "UR = X". For example, the above constraints are abbreviated UR = /æn/, UR = /ej/, and UR = /Ø/.

2.2.4 The candidate set

For an input, the candidate set consists of all of the possible URs for that input, and all of the possible SRs for each UR.

One thing that sets URC apart from other theories is that the set of possible URs for an input is determined by looking at the set of UR constraints. If there's a constraint, {X} → /Y/, /Y/ will always be in the candidate set for the input {X}. The inclusion of a candidate is completely independent of the constraint ranking. As long as the relevant UR constraint exists, the UR will be included in candidate set.[1]

After the set of possible URs for an input is determined, each of the URs is paired with all possible surface representations (SRs), producing a candidate set of (meaning, UR, SR) triplets with correspondences between them. Due to the candidate generation algorithm, the input (and its morphosyntactic features) is always the same across candidates in the set. No two candidates have different features.[2]

	Input	UR	SR
a.	<D, {−DEF}> + <n, {$\sqrt{\text{CAT}}$}>	/ej/+/kæt/	[ej kæt]
b.	<D, {−DEF}> + <n, {$\sqrt{\text{CAT}}$}>	/ej/+/kæt/	[ə kæt]
c.	<D, {−DEF}> + <n, {$\sqrt{\text{CAT}}$}>	/æn/+/kæt/	[æn kæt]
d.	<D, {−DEF}> + <n, {$\sqrt{\text{CAT}}$}>	/æn/+/kæt/	[ən kæt]

Table 2.1: A sample candidate set in URC

Since the candidate set contains (meaning, UR, SR) triplets, URs are chosen with full consideration of their SRs. This means that UR selection has access to phonological repairs like reduction, epenthesis, and deletion, at least in fully parallel OT. For example, in the last candidate above, the UR /æn/ is chosen at the same time as vowel reduction. As a result, the grammar can choose a UR specifically because it will undergo or trigger a repair.

The formulation of the candidate set in URC is a point of departure from previous work. For accounts without phonology in the input, such as Boersma (2001) and Wolf

[1]If UR constraints are used for candidate generation, in what sense are they constraints? As I show, UR constraints can be ranked, and their ranking matters.

[2]There have been cases claimed to require competition between URs with different features. One such case, French pre-nominal liaison, is discussed at length in Chapter 4. See especially §4.8.

(2008), the full set of URs is considered for every input.[3] In other OT accounts of PCA (e.g., Mester 1994, Kager 1996) competition between URs is limited as it here. However, these other accounts limit competing URs by stipulating that the input to phonology is a set of URs. For the indefinite article, for example, the input to phonology is the set {/ej/, /æn/}. Presumably, these sets are generated by consulting meaning-UR mappings in the lexicon, much like the candidate set in URC is generated by consulting the set of UR constraints.

2.2.5 Ranking UR constraints

Ranking UR constraints in the grammar can capture phonological conditioning, repair-PCA interactions, and defaults. I illustrate each of these basic rankings below with a toy example. In the rest of the dissertation, each of these types of ranking is used to capture real world data, and similar effects are captured in cases of variation with weighted constraints.

Defaulthood comes from the ranking of UR constraints alone. When there are two conflicting UR constraints for the same input, the UR of the higher-ranked UR constraint will be used whenever possible. This is shown in the tableau below. The UR /xy/ is used instead of the UR /ab/, because UR =/xy/ dominates UR =/ab/.

	UR = /xy/	UR = /ab/
☛ /xy/ [xy]		*
/ab/ [ab]	*	

Table 2.2: Illustration of ranking two UR constraints

[3]But Wolf (p. 447) notes that this model is not psychologically plausible, and suggests that the set of URs available in the candidate set should actually be a subset of the URs in the language, as is done here.

Since UR selection occurs during phonology, markedness constraints can help decide between URs. If a markedness constraint is ranked high enough, it can even force the grammar to deviate from an otherwise preferred UR. I show this below, where the default /xy/ is *not* used before [z], and the non-default /ab/ is used instead.

	∗xyz	UR = /xy/	UR = /ab/
/xy/+/z/ [xyz]	∗		∗
☛ /ab/+/z/ [abz]		∗	

Table 2.3: Illustration of ranking markedness and UR constraints

If a non-default UR and a repair avoid the same marked structure, the choice between them comes the ranking of UR constraints and faithfulness constraints. Imagine, for example, that y-deletion is a possible repair in this language. The ranking of MAX, which opposes y-deletion, and UR =/ab/ determines whether the repair is used to satisfy ∗xyz or the non-default /ab/ is used instead.

When the constraint against deletion is ranked lower, y-deletion is used.

	∗xyz	UR = /xy/	UR = /ab/	MAX
/xy/+/z/ [xyz]	∗		∗	
☛ /xy/+/z/ [xz]			∗	∗
/ab/+/z/ [abz]		∗		

Table 2.4: Illustration of ranking faithfulness and UR constraints (1)

When the constraint against deletion is ranked higher, deletion is avoided, and the non-default is used instead.

		*xyz	Max	UR = /xy/	UR = /ab/
	/xy/+/z/ [xyz]	*			*
	/xy/+/z/ [xz]		*		*
☛	/ab/+/z/ [abz]			*	

Table 2.5: Illustration of ranking faithfulness and UR constraints (2)

I return to these three types of rankings in the analysis of *a(n)* in §2.3. Before that, I consider a few more implications and extensions of UR constraints.

2.2.6 Previous work with exponence constraints

UR constraints are just one possible formulation for constraints that oversee the phonological realization of morphosyntactic features. This class of constraints is named *exponence constraints* in Nevins (2011).

I divide exponence constraints into three categories, based on the identity of FORM in the template below: FORM can be a UR, a SR, or omitted entirely.

(6) INPUT → FORM

a. **UR realization**: INPUT → /UR/

Assign one violation for every INPUT that does not correspond to /UR/.

b. **SR realization**: INPUT → [SR]

Assign one violation for every INPUT that does not correspond to [SR].

c. **General realization**: INPUT →

Assign one violation for every INPUT that does not have some correspondent in the /UR/ or [SR].

UR realization. Constraints on meaning-UR mappings are proposed in Boersma (2001), called Lexical Constraints. Boersma uses these to model UR learning. By ranking Lexical constraints, a learner can find a set of URs that's consistent with the observed data.

Lexical constraints are very similar to UR constraints, but they assess violations differently. Apoussidou (2007) uses Lexical Constraints for UR learning, and implements them as follows.

(7) Do not connect the meaning 'XY' to an underlying form /xy/

In practice, there are Lexical Constraints for every UR that a meaning *doesn't* map to.

(8) Do not connect the meaning 'dog' to the form /kæt/

(9) Do not connect the meaning 'dog' to the form /maʊs/

As mentioned above, Lexical Constraints have been used primarily for UR learning, and haven't been used to model PCA.

In general, exponence constraints have been used for PCA only in limited ways. In Kager (1996), an exponence constraint GEN=-n is used to capture the preference for the Djabugay genitive to be realized as *-n*, rather than *-ŋun*, but such constraints aren't used in Kager's analysis beyond capturing this preference. Kager's constraint is discussed again in the next section.

SR realization. There are also proposals for constraints that require the input to be realized by particular *output* exponents rather than particular URs. Yip (1998)'s constraint PLURAL (PL =s) is an example. It requires English plurals to be realized in the output with a stem plus a *-s* suffix.

In Russell (1995), the entire lexicon is replaced by a set of SR realization constraints, doing away with URs altogether. The dissolution of URs is challenged by Bonet (2004), who argues that URs are necessary to capture alternations. In particular, URs are necessary for cases that require positional faithfulness.

In URC, of course, URs and faithfulness play a prominent role. Alternations and phonological repairs exist alongside PCA.

General realization. These constraints require an input to be realized, but are indifferent as to how. For example, the spell-out constraints of Wolf (2008) require the realization of input features, but don't specify the phonological form that should be used. A similar system is found in Zuraw (2000), who uses general constraints on UR selection like Meaning (select UR(s) with the correct meaning) and UseListed (select a single UR). In both models, the set of meaning-UR mappings is stored in an external list, separate from the phonological grammar.

In URC, UR constraints specify the particular UR that should be used to realize a set of input features. As a result, no external list of meaning-UR mappings is needed, as discussed in the next section.

2.2.7 UR constraints as a replacement for the Vocabulary

Every meaning-UR mapping in a language has a UR constrain. Even a non-alternating morpheme like *cat*, with just one UR (/kæt/), has the UR constraint below.

(10) <n, $\{\sqrt{\text{CAT}}\}$> → /kæt/

Assign one violation for every set of features <n, $\{\sqrt{\text{CAT}}\}$> that does not correspond to UR /kæt/

For an idealized English speaker with a complete vocabulary, the set of UR constraints might looks like the one below. The ellipses can be replaced with every English word between *Aaron* and *zydeco*. Some of these words will have multiple UR constraints, like the indefinite article does.

UR = *Aalborg*	UR = *aapa*
UR = *aardvark*	UR = *aardwolf*
…	…
UR = /ej/	UR = /æn/
…	…
UR = *zygote*	UR = *Zyklon B*
UR = *zymogen*	UR = *Zyrian*

Figure 2.3: The complete set of UR constraints for an English speaker.

Since every meaning-UR mapping in a language has a UR constraint, there's no need for an external list of meaning-UR correspondences. All of this information is available in the constraint set.

To make this clearer, consider the structure of the lexicon in DM. In DM, information that is traditionally stored in the lexicon is distributed across different lists. There's the Vocabulary, which contains Vocabulary Items. Vocabulary Items encode meaning-UR correspondences, just like UR constraints do. The Vocabulary Item for *cat* is below.

(11) <n, {$\sqrt{\text{CAT}}$}> ↔ /kæt/

In addition to the Vocabulary, there's the Encyclopedia. The Encyclopedia contains non-linguistic knowledge about words, such as their referents and special meanings. The encyclopedia entry for *cat* might contain the information below (from Siddiqi 2010).

(12) <n, {$\sqrt{\text{CAT}}$}> = *Little furry thing, likes to sleep on my face.*

In URC, we don't need an external Vocabulary at all, nor do we need Vocabulary Items. For meanings, we still need something like the Encyclopedia.

The abandonment of the Vocabulary in favor of UR constraints answers a common objection to exponence constraints: having a UR constraint in the phonology duplicates the UR in the lexicon. This sort of criticism is found in Nevins (2011). As mentioned in the last section, Kager (1996) uses a UR constraint, Gen=-n, to capture the fact that *-n* is the default UR for the genitive in Djabugay. Nevins (2011), in a discussion of Kager's analysis, says:

> These constraints [like Gen=-n] demand a particular exponent for a particular morphological category and are thus one way of encoding the notion of a certain exponent being the default, but it might strike some as brute force to include and rank a violable constraint dedicated to every exponent in the grammar.

Under the assumption that there is both a Vocabulary and set of UR constraints, it *is* brute force to rank a UR constraint for every word in the grammar. However, once we abandon an external Vocabulary, UR constraints for every word are necessary in order to encode meaning-UR mappings. Once a UR constraint for every word exists, it follows that every UR constraint can be ranked, and as I show, these ranking can capture a variety of phenomena.

2.2.8 Possible extensions

The description of UR constraints above is sufficient for the cases in this dissertation, but insufficient for the range of allomorphic possibilities. Here are a few possible extensions, which I think can be implemented without much trouble.

There could be multiple set of features on the left side of the arrow, requiring a many-to-one mapping between features and URs. This could be used to model portmanteau morphs, cases where a single UR spans multiple syntactic terminal nodes, expressing multiple sets of features. An example is the realization of French *de*+*le* (‘of’+’the’): it’s *du* before consonants but *de l’* before vowels. A possible UR constraint to account for the pattern is below.[4]

(13) <P, {+REL}> + <D, {+DET, +MASC}> → /du/
Assign one violation for every sequence of feature sets <P, {+REL}> + <D, {+DET, +MASC}> that does not correspond to the UR /du/

Many-to-one UR constraints can also model lexicalization, cases in which multi-morphemic phrases are accessed as a single UR. Examples can be found in English, e.g. *oxen*, multi-morphemic words in Tagalog in Zuraw (2000), and French *est un* (“is a”) in Bybee (2001).

(14) <n, {$\sqrt{\text{ox}}$}> + <#, {+PL}> → /ɑksn̩/
Assign one violation for every sequence of feature sets <n, {$\sqrt{\text{ox}}$}> + <#, {+PL}> that does not correspond to UR /ɑksn̩/

Moving to the right side of the arrow in the UR constraint, strings of segments are likely insufficient. They could be augmented with floating features (e.g. voicing, a high tone) and templates, e.g. RED for reduplication. Essentially, anything that’s analyzable as a concatenative morpheme can be on the right side of the arrow in a UR constraint.

Finally, there are cases in which PCA is not driven by markedness constraints, and phonological conditioning is arbitrary. Capturing phonological conditioning in these cases requires some extra mechanism.

2.2.9 Extending to non-optimizing and opaque cases

In URC, UR selection always occurs during phonology, and it’s determined by the constraint ranking alone. A major problem for this view is the existence of cases of

[4] For a similar account in DM, see (Svenonius 2012)’s analysis with spanning. In his model, vocabulary items can spell out multiple terminal nodes, although this requires some architectural additions to DM.

PCA that seem to ignore the phonological grammar. These examples have been used to argue for lexically-specific subcategorization (Paster 2006; Bye 2008; Embick 2010).

In this section, I give two cases where subcategorization has been argued to be necessary, non-optimizing and opaque PCA, and sketch a few ways they could be captured with UR constraints alongside optimizing cases. In each of the solutions, I add constraints that encode lexically-specific, idiosyncratic phonological conditioning. In URC, these constraints for idiosyncratic PCA are evaluated at the same time as other constraints, and all PCA occurs in the same grammar.

The solutions here are similar in spirit to Bonet, Lloret, and Mascaró (2003)'s constraint Respect, which is a universal faithfulness constraint enforcing subcategorization requirements. In their model, PCA is either driven by markedness constraints, resulting in optimization, or subcategorization requirements, resulting in non-optimizing PCA. Like the account here, both sorts of PCA occur in the same grammatical component.

As discussed at the end of this section, such constraints are only posited as a last resort, when a cases of PCA can't be captured with independently attested markedness and faithfulness constraints. In URC, if a case can be analyzed as a result of pre-existing markedness constraints, there's little reason not to.

Non-optimizing PCA. PCA is non-optimizing when the conditioning environment is inconsistent with independently motivated phonological constraints.

The canonical example of this is from Haitian Creole, in which PCA creates onsetless and codaful syllables, contrary to cross-linguistic tendencies in syllable structure (Klein 2003). There are two suffixes, *-la* and *-a*: *la* occurs with C-final roots, while *-a* occurs with V-final roots.

(15) Haitian Creole definite suffix *la/a*

a.	C-final roots	liv-la	"book"
b.	V-final roots	tu-a	"hole"

Some non-optimizing cases have been reanalyzed as a result of well-motivated constraints (Klein 2003 has an account for Haitian Creole), but there are just as many that likely can't be reanalyzed. In a survey of syllable-counting allomorphy by Paster (2005), for example, the non-optimizing cases outnumber the optimizing ones.

In URC, or any constraint-based framework, there are two straightforward solutions for non-optimizing cases. The first is to use alignment constraints to encode subcategorization requirements (McCarthy and Prince 1993). McCarthy and Prince propose such a constraint to account for a suffix in Dyirbal (*-ŋgu*) that only occurs after a metrical foot. I give a similar alignment constraint for *la* below.

(16) Align(*la*, L, *consonant*, R}

Assign one violation for every morpheme *la* that does not have a consonant directly to its left

Under this sort of analysis, UR constraints can still be used to capture and learn defaults, even in cases of non-optimizing PCA. Alignment constraints refer to the output, so an account with them predicts that even non-optimizing PCA will be output-oriented.

A second possibility is to add subcategorization requirements to the definition of some UR constraints.

(17) <D, {+Def}> → /la/ / V ___

Assign one violation for every set of features <D, {+Def}>: if <D, {+Def}> does not correspond to the UR /la/, and the UR /la/ is not preceded by a vowel in the underlying representation

The constraint above requires the definite suffix to be realized by *la*, and furthermore, *la* must follow a vowel. If either condition isn't met, it assigns a violation mark. Under this sort of analysis, phonological conditioning is stated in terms of the underlying representation, and input-oriented as a result.

Opaque PCA. In cases of opaque allomorphy, the conditioning environment that selects between allomorphs isn't available in the output. For example, in Polish, the allomorph /e/ occurs after coronals, while /u/ occurs after prepalatals. The choice of allomorph completely ignores a process of palatalization, and the resulting pattern can't be stated in terms of the output (Łubowicz 2006).

(18) Opaque allomorphy in Lubowicz 2006

a.	o lis/t/	o lis[t]	letter.nom
b.	o lis/c/	o lis[c]	leaf.nom
c.	o lis/t/+e	o lis[c]+e	letter.loc
d.	o lis/c/+u	o lis[c]+u	leaf.loc

It's still possible to account for opaque allomorphy without subcategorization, but only with some additional mechanisms. Łubowicz (2006), for instance, analyzes the data above as the result of contrast preservation: allomorphy prevents neutralization between "letter" and "leaf" in the locative. While possible for Polish, this analysis may not be available for other cases of opaque allomorphy.

Under URC, opaque PCA is a problem because phonological conditioning comes solely from markedness constraints, which refer to outputs.

There are two possible solutions. The first is to limit the amount of lookahead of UR selection. By forcing UR selection to occur earlier, before repairs, UR selection can still use markedness constraints, even though they won't be relevant on the surface. This is similar to the approach taken in Wolf (2008).

The problem with this solution is that there are cases of PCA that require UR selection and repairs to happen in parallel. An answer may be found in a framework like Stratal OT (Kiparsky 2000), in which some repairs occur in parallel (within a level), while others are ordered (level 1 before level 2). In a framework with multiple strata, it's possible to develop a model in which some repairs happen in parallel with UR selection, while others only occur after UR selection.

A second solution is a contextual UR constraint, which adds subcategorization information. This sort of constraint was sketched for *la* above, and one for Polish is below.

(19) <{+Loc}> → /e/ / t ___

Assign one violation for every set of features <{+Loc}>: if <{+Loc}> does not correspond to the UR /e/, and the UR /e/ is not preceded by a /t/ in the underlying representation.

This constraint requires the locative to be realized by *-e*, and it also requires its UR to be preceded by a /t/ in the underlying representation. If either condition isn't met, the constraint is violated. Since it refers to the underlying representation, this sort of constraint can model opaque PCA. Using a constraint like the one above for non-optimizing cases predicts that these cases will always be input-oriented, and sometimes opaque.

I don't know which solution is better for Haitian Creole or Polish. The point here is that non-optimizing and opaque PCA *are* compatible with a theory in which PCA follows solely from the ranking of constraints.

Diagnosing a case as optimizing. If we add morpheme-specific constraints to capture cases like the ones above, we might ask why we shouldn't analyze every case of PCA this way. The argument goes that such a theory – where all PCA is modeled the same way – is simpler and thus preferred.

Paster (2006) presents an argument similar to the one above. She argues against a mixed approach, in which different cases of PCA are the product of different mechanisms. She notes that determining whether a case should be analyzed as a product of general markedness or subcategorization is arbitrary and analysis-dependent (Paster 2006: pp. 264–268).

URC provides an answer to these objections. I adopt a simple heuristic: the best grammar is the one that accounts for the data – both PCA and repairs – with the smallest set of constraints. Under this heuristic, subcategorization-like constraints will only be used as a last resort, since they only apply to single morphemes and duplicate markedness constraints. Since we already need markedness and faithfulness constraints to account for repairs, why shouldn't we use them for PCA?

2.3 URC account of a(n)

In this section, I provide a URC account of *a* and *an*. This account is used to illustrate the results of URC in §2.4.

2.3.1 Basic pattern

The indefinite article has two forms, *a* and *an*, whose distribution is conditioned by phonology. This is illustrated below with breeds of sheep. For many speakers, these are effectively nonce words, demonstrating the pattern's productivity.

(20) a / ___ C

a Zwartble	a Llanwenog	a Lleyn	a Värmland
a Soay	a Cheviot	a Lonk	a Helsinge
a Swaledale	a Rambouillet	a Svärdsjö	a Gestrike

an / ___ V

an Arcott	an Outaouais Arcott	an Île-de-France	an Elliottdale
an Oxford	an East Friesian	an American Tunis	an Arapawa Island
an Icelandic	an Exmoor Horn	an English Lester	an Old Norwegian
an Åsen	an Est à laine		

The same distribution is found before adjectives and adverbs.

(21) a careful sheep, a carefully groomed sheep

(22) an eerie sheep, an eerily quiet sheep

The phonological conditioning of the article is nearly exceptionless. In the Switchboard corpus (Godfrey, Holliman, and McDaniel 1992), *a* occurs before consonants 99.9% of the time (out of 51791 tokens), and *an* occurs before vowels 95% of the time (out of 4310 tokens). Full results are presented in §3.2.

The phonological conditioning of *a* and *an* is so robust that it accommodates speech errors. As shown in Fromkin (1973), *an* occurs before vowels resulting from transposition errors, and likewise for *a* before transposed consonants.

(23) Examples of accommodation from (Fromkin 1973 p. 231)

a. a current argument → an arrent curgument

b. a history of idealogy → an istory of hideology

c. an eating marathon → a meeting arathon

d. an ice cream cone → a kice ream cone

Moreover, these examples show that the choice between *a* and *an* is independent of an item's lexical identity. The same word can occur with either *a* or *an*, depending on its surface pronunciation.

There are a few well-known exceptions to the generalization above, such as *an historic*, but these are marginal at best. Most usage grammars treat *an historic* as incorrect, since it doesn't obey the surface pattern (e.g., the Chicago Manual of Style, 16th ed.). For speakers who productively use *an* before /h/, the choice may be the result of h-deletion, discussed at length in the next chapter (§3.2).

Allomorphy in the indefinite article is often analyzed as PCA. This is because there's no general rule of n-epenthesis or n-deletion in English, as shown by the examples below, which fail to either undergo n-epenthesis (a–b) or n-deletion (c–d).

(24) No n-epenthesis or n-deletion

a. my exmoor [mɑɪ ɛksmɔɹ]

b. to a lonk [tu ə lɔŋk]

c. nine lonks [nɑɪn lɔŋks]

d. in lonks [ɪn lɔŋks]

The rest of Chapter 2 gives a URC account of these data. The data are largely incomplete, glossing over many interesting issues, such as the alternation between the article's strong and weak forms ([ej] and [ə]), the relationship between the article and the rest of English phonology, and whether the basic argument for a PCA analysis holds (why not morpheme-specific epenthesis?). These issues are taken up in Chapter 3, which presents a complete analysis of *a(n)*, along with repairs such as reduction and epenthesis.

2.3.2 Account overview

The URC account of *a(n)* aims to capture three generalizations:

- *a* occurs before consonants.
- *an* occurs before vowels.
- Suppletion is restricted to *a* and *an*.

The basic URC account is that *a* is generally preferred to *an* (*a* is the default), and *an* is used to avoid a marked hiatus. Suppletion is restricted due to URC's algorithm for candidate set construction. Each piece of the analysis is justified in Chapter 3, using corpus evidence and data from descriptions of English.

2.3.3 Constraints

The account of *a(n)* uses four constraints: two UR constraints, a markedness constraint ∗ə.V, and a faithfulness constraint Dep.

The UR constraints require the set of features corresponding to *a(n)* to be realized by one of the URs.

(25) <D, {−DEF}> → /æn/ (abbreviated UR = /æn/)

Assign one violation for every set of features <D, {−DET}> that does not correspond to the UR /æn/.

(26) <D, {−DEF}> → /ej/ (abbreviated UR = /ej/)

Assign one violation for every set of features <D, {−DET}> that does not correspond to the UR /ej/.

In URC, phonological conditioning in PCA is the result of markedness constraints ranked over particular UR constraints. In the analysis of *a(n)*, the markedness constraint driving PCA is ∗ə.V.

(27) ∗ə.V

Assign one violation for every lax-vowel–vowel sequence.

e.g., ∗ assigned to [ɪ.ɑ], [ɛ.i], [ə.aɪ], [ɪ.ə]

In Chapter 3, I show that this constraint is attested in English phonotactics, derivational morphology, and phonological repairs.

When a non-default UR and a repair can satisfy the same markedness constraint, the choice between them comes from ranking a UR constraint with respect to faithfulness. I consider epenthesis here, and the constraint militating against it is Dep.

(28) Dep

Assign one violation for every segment in the SR without a corresponding segment in the UR.

2.3.4 Ranking

In the URC account of *a* and *an*, I proceed generalization-by-generalization.

2.3.4.1 a before consonants

The use of *a* before consonants comes from a general preference for *a* over *an*, which follows from the ranking of UR = /ej/ ≫ UR = /æn/ .

In the tableau below, since there are no ranking arguments to rank the constraints ∗ə.V and Dep with respect to UR = /ej/ or UR = /æn/ , these constraints are set apart with a thick gray line. The W's and L's show whether each constraint favors the desired winning candidate or a losing candidate (Prince 2002). For the desired winner to be optimal, every row must have at least one W to the left of all L's.

Ranking arguments: UR = /ej/ ≫ UR = /æn/; Unranked: ∗ə.V, Dep

			∗ə.V	Dep	UR = /ej/	UR = /æn/
☛	/ej/+/lɑŋk/	[ə lɑŋk]	0	0	0	−1
	/æn/+/lɑŋk/	[ən lɑŋk]	0	0	−1 W	0 L

Table 2.6: *a* before consonants

In this analysis, the use of *a* before consonants follows from the general preference for *a* over *an*. It has nothing to do with the phonological ill-formedness of [ən lɑŋk], such as its violations of NoCoda. Rather, *a* is the default, the form used in the elsewhere context. I present independent evidence for treating *a* as the default in the next chapter (§3.3).

In tableaux, I don't include UR constraints for non-alternating words like *lonk* or *arcott*. The candidate set only contains multiple URs for alternating morphemes, like *a(n)*. UR constraints for non-alternating morphemes are never violated, and as a result, they can be ranked anywhere.

2.3.4.2 an before vowels

The fact that *an* occurs before vowels comes from the ranking ∗ə.V ≫ UR = /ej/ . When ∗ə.V is ranked above UR = /ej/ , the grammar is willing to deviate from the default UR *a* to avoid a hiatus.

Ranking arguments: ∗ə.V ≫ UR = /ej/; Unranked: Dep

			Dep	∗ə.V	UR = /ej/	UR = /æn/
☛	/æn/+/ɛksmoɹ/	[ən ɛksmoɹ]	0	0	−1	0
	/ej/+/ɛksmoɹ/	[ə ɛksmoɹ]	0	−1 W	0 L	−1 W

Table 2.7: *an* before vowels

The basic pattern of *a* and *an*, then, follows from the ranking ∗ə.V ≫ UR = /ej/ ≫ UR = /æn/ . This ranking ensures that *a* is preferred to *an*, unless *an* can avoid a violation of ∗ə.V.

2.3.4.3 Ruling out repairs

Given that UR selection competes alongside phonological processes in URC, we need to rule out repairs that can be used to avoid violations of ∗ə.V.

In English, glottal stop epenthesis provides another hiatus-avoidance stategy, as seen in examples like the ones below.

(29) Contexts with nearly obligatory ʔ-epenthesis

a. salsa-ing [sɔlsəʔɨŋ]

b. samba-ing [sɑmbəʔɨŋ]

c. soda-y [sodəʔi]

d. zoomba-ist [zumbəʔɨst]

Supporting these intuitions, Keating et al. (1994) find that ʔ-epenthesis always occurs between [ðə] and following vowel-initial words in the TIMIT corpus.

The challenge for the URC analysis is candidates like [ə ʔ ɛksmoɹ], which satisfy both ∗ə.V *and* the higher ranked UR constraint, UR = /ej/. Given that ʔ-epenthesis can be used to avoid hiatus, why isn't it used instead of *an*?

To rule out these candidates, the constraint Dep, which militates against epenthesis, must be ranked above UR = /ej/. As a result of this ranking, the candidate with ʔ-epenthesis will lose to the candidate with *an*.

(30) Dep

Assign one violation for every segment in the SR without a corresponding segment in the UR.

Ranking arguments: ∗ə.V, Dep ≫ UR = /ej/

			∗ə.V	Dep	UR = /ej/	UR = /æn/
☛	/æn/+/ɛksmoɹ/	[ən ɛksmoɹ]	0	0	−1	0
	/ej/+/ɛksmoɹ/	[ə ɛksmoɹ]	−1 W	0	0 L	−1 W
	/ej/+/ɛksmoɹ/	[ə ʔ ɛksmoɹ]	0	−1 W	0 L	−1 W

Table 2.8: Tableau: No glottal stop epenthesis with *a*

As shown in the tableau above, URC can capture preferences between non-default URs and repairs by ranking faithfulness and UR constraints. In this case, the non-default UR is used instead of ʔ-epenthesis.

Although we've ruled out epenthesis in *an exmoor*, we still need to make sure that epenthesis is available to resolve hiatus in general. This follows from the ranking ∗ə.V ≫ Dep. This ranking is consistent with the ranking already established.

Ranking arguments: ∗ə.V ≫ Dep

			UR = /sodə/	∗ə.V	Dep
☛	/sodə/+/i/	[sodə ʔ i]	0	0	−1
	/sodə/+/i/	[sodə i]	0	−1 W	0 L

Table 2.9: Tableau: [ʔ]-epenthesis to resolve hiatus

In URC, both ʔ-epenthesis in *soda-y* and suppletion in *an exmoor* are driven by the same constraint, ∗ə.V. The difference is that for *a(n)*, multiple URs are available, while for *soda-y*, the only UR ends in a vowel, so epenthesis is required. This raises the question, why isn't suppletion available for *soda*?

2.3.4.4 Suppletion is limited to a and an

One of the goals of the analysis is to account for the fact that suppletion occurs with *a* and *an* but not other words, like *my* or *soda*. In URC, this difference is a consequence of the way the candidate set is constructed.

Recall that the candidate set's URs are determined by consulting the list of UR constraints. Since the only UR constraint that references the set of features <n, {$\sqrt{\text{SODA}}$}> is UR = /sodə/, the only UR that can compete in its candidate set is /sodə/. If there were a UR constraint such as UR = /sodən/, then we'd expect suppletion between *soda* and *sodan*, given the right ranking of the markedness and UR constraints.

2.3.4.5 Summary

The final ranking for *a* and *an* is below.

(31) ∗ə.V ≫ Dep ≫ UR = /ej/ ≫ UR = /æn/

Under this ranking, *a* is generally preferred to *an*, except when using *an* can avoid a violation of ∗ə.V. Both epenthesis and *an* are used to avoid hiatus, but *an* is always preferred to epenthesis, when the option is available. The tableau below contains all of the candidates from the chapter.

Ranking arguments: ∗ə.V ≫ DEP ≫ UR = /ej/ ≫ UR = /æn/

			∗ə.V	DEP	UR = /ej/	UR = /æn/
☛	/ej/+/laŋk/	[ə laŋk]	0	0	0	−1
	/æn/+/laŋk/	[ən laŋk]	0	0	−1 W	0 L
	/ej/+/laŋk/	[ə ʔ laŋk]	−1 W	0	0	−1
☛	/æn/+/ɛksmoɹ/	[ən ɛksmoɹ]	0	0	−1	0
	/ej/+/ɛksmoɹ/	[ə ɛksmoɹ]	−1 W	0	0 L	−1 W
	/ej/+/ɛksmoɹ/	[ə ʔ ɛksmoɹ]	0	−1 W	0 L	−1 W
☛	/sodə/+/i/	[sodə ʔ i]	0	−1	0	0
	/sodə/+/i/	[sodə i]	−1 W	0 L	0	0

Table 2.10: Summary tableau for *a* and *an*

2.4 Results of URC

In this section, I use the analysis of *a* and *an* to illustrate some predictions of URC, which are supported in the chapters that follow.

2.4.1 Language-wide constraints condition PCA

Under URC, phonological conditioning in PCA results from ranking a UR constraint below a phonological constraint. For example, in the account of *a(n)*, UR = /ej/ is ranked below ∗ə.V. ∗ə.V isn't a constraint that's specific to PCA: it's a general, language-wide constraint that's active elsewhere in English.

I call this idea – that PCA is conditioned by language-wide constraints – the Language-Wide Constraint Hypothesis (the LWC Hypothesis).

(32) The Language-Wide Constraint Hypothesis

PCA follows from the ranking of phonological constraints in the grammar, and these constraints are active across the language.

The LWC Hypothesis has been pursued in many other OT accounts of PCA, such as Mester (1994), Kager (1996), and Mascaró (1996). It's also been called P ≫ M (Paster 2006), since it's often modeled by ranking phonological constraints above morphological ones, and TETU (Mascaró 1996).

Under the strongest form of this hypothesis, there is one ranking of constraints conditioning all PCA, all phonological repairs, phonotactics, phonologically-conditioned syntactic variation, and so on. That is, wherever there is phonological conditioning, there is a markedness or faithfulness constraint conditioning it. As a slogan, we might say: One Phonology to Rule Them All.

A weaker form of this hypothesis, and the one I argue for here, is that some cases of PCA are the result of language-wide constraints, while others may require additional constraints specific to PCA (see §2.2.9). At the very least, I argue that language-wide constraints are responsible for the three case studies here: English *a(n)*, French liaison, and English *licious*-type suffixes.

As mentioned above, the LWC Hypothesis finds support when the constraints used for PCA are attested elsewhere in the language.

(33) The LWC Hypothesis is supported when PCA-conditioning constraints are active elsewhere in the same language.

a. They condition repairs.

b. They condition phonotactics.

c. They condition other cases of PCA.

I use each of these to support of LWC Hypothesis. In Chapter 3, I show that ∗ə.V, the constraint conditioning *a* and *an* is active across English in all three domains. In

Chapters 4 and 5, I show the same for *Hiatus in French liaison and *Clash in -*(a)licious*-type suffixes in English.

Single ranking required. The LWC Hypothesis imposes a strong requirement on any analysis that assumes it. For the LWC Hypothesis to hold, the distribution of every morpheme and alternation should follow from the same ranking of constraints.

(34) A requirement of the LWC Hypothesis

There is a consistent constraint ranking for PCA and repairs.

If two words require different rankings, either additional constraints are necessary, or the LWC Hypothesis is wrong.

This requirement is met for the dissertation's cases. In every analysis, the ranking of markedness and faithfulness constraints is consistent across different morphemes and alternations, and in every analysis, PCA coexists with repairs.

Opting out. Although the LWC Hypothesis predicts that PCA can be conditioned by language-wide markedness constraints, it doesn't predict that every morpheme will be. Markedness-conditioned PCA doesn't occur under the conditions below.

(35) A morpheme won't be conditioned by a markedness constraint M:

a. if it only has one UR.

b. if all of the morpheme's URs incur equal violations of M (if it has more than one UR).

c. if the UR constraints for all of the morpheme's URs are ranked above M.

The first exception is why *my* and *sofa* do not undergo suppletion with *mine* or *sofan* to avoid a violation of *ə.V. Only a morpheme with multiple URs is subject to PCA.

The second exception means that only relevant markedness constraints have an effect on the selection between two URs. For example, if a morpheme has two URs with the same stress pattern, a constraint on stress won't ever favor one over the other.

The third exception is a consequence of the fact that UR constraints can be freely ranked on a UR-by-UR basis. Recall that phonological conditioning results from ranking a UR constraint below a markedness constraint. If a morpheme has two URs, and both UR constraints are ranked above a markedness constraint, then that markedness constraint will play no role in the choice between the URs. URC predicts, then, that cases of PCA can be sensitive to some markedness constraints (the ones ranked above the relevant UR constraints) but not others (the ones ranked below), and that individual cases of PCA can differ.

The alternative: subcategorization. The major alternative to LWC Hypothesis is subcategorization: PCA is the result of selectional restrictions encoded on a morpheme-by-morpheme basis. Unlike the LWC Hypothesis, subcategorization holds that phonological conditioning in PCA is unrelated to the phonological constraints of the language and their ranking, and predicts that phonological conditioning can be completely arbitrary.

As shown in §2.2.9, the LWC Hypothesis is compatible with subcategorization, and both can follow under a single model.

For a case of PCA, choosing between the two approaches can be difficult. As noted above, the LWC Hypothesis is supported when PCA-conditioning constraints are attested elsewhere, but such data aren't incompatible with subcategorization. It could be that subcategorization frames and repairs coincidentally avoid the same structures, or that similarities between them are the result of historical change.

There are two ways to definitively diagnose a case as the result of language-wide constraints. A case of PCA can't be the result of subcategorization if there aren't enough data to learn the morpheme-specific selectional restrictions, or if there's no explanation for similarities between PCA and the rest of the language.

(36) The LWC Hypothesis is also supported when:

a. There's insufficient data to learn the affix's distribution.

b. There's no historical explanation for the affix's distribution.

Subcategorization requires language learners to discover that different affixes have different requirements, and similarities between affixes and repairs need some sort of historical explanation. On the other hand, the LWC Hypothesis requires neither. Similarities between PCA and repairs follow from the fact that they obey the same constraints, and phonological conditioning doesn't need to be learned, since it's the result of extending the existing phonological grammar.

I use these arguments in Chapter 5, where I show that the conditioning of *-(a)licious* cannot be learned given sparse input data, and lacks any sort of historical explanation.

2.4.2 Defaults emerge from ranking

In URC, UR constraints are ranked with respect to other UR constraints to model defaults. In the analysis of *a* and *an*, UR = /ej/ is ranked above UR = /æn/. As a result, *a* occurs when there are no higher-ranked phonological constraints.

URC makes two predictions about defaulthood.

(37) Predictions about defaulthood

a. Defaults are phonologically and syntactically arbitrary.

b. Ddefaulthoodefaulthood emerges in unmarked contexts (the elsewhere context).

The first prediction straightforwardly follows from the fact that defaulthood is the result of ranking phonologically- and syntactically-arbitrary UR constraints. If UR = /æn/ were ranked above UR = /ej/, for example, the default would be *an* instead of *a*. In some other accounts, defaulthood follows from morphosyntactic or phonological markedness, with the default either expressing syntactic features better (Tranel 1996b), being less phonologically marked, e.g. shorter or containing less-marked segments (Rubach and Booij 2001), or some combination of both (Wolf 2008).

The second prediction follows from the fact that defaulthood is the result of constraint ranking. Since a ranking of two UR constraints won't change across contexts, the default will always remain the same. Whenever markedness constraints aren't relevant, the default will be used. The URC account of *a(n)* predicts that *a* should be used in *all* unmarked contexts, whenever ∗ə.V isn't relevant. I show that this is the case in §3.3.

There are a number of other accounts that assume the default is preferred for phonologically and syntactically arbitrary reasons. In accounts like Kager (1996) and Bonet, Lloret, and Mascaró (2007), defaulthood is obtained by constraints tailored to the task. For Kager, a UR constraint is used for defaulthood, and for Bonet et al, the constraint Priority enforces the lexicon's arbitrary preferences. In DM, the default is the allomorph that has the fewest requirements for its insertion. The operation of Vocabulary Insertion proceeds from the most phonologically-specific to the most phonologically-general vocabulary items, following the elsewhere principle (Kiparsky 1973). Vocabulary items with specific contexts for insertion are tried first, and if there is no phonologically-specific vocabulary item for a given context, a general one is used instead.

These accounts are similar to URC in that defaults are arbitrary, although the account here doesn't have any special mechanism devoted to defaulthood, such as Priority constraints or the elsewhere principle. Rather, defaulthood emerges from the ranking of UR constraints, which are independently necessary to encode meaning-UR mappings.

The use of ranking alone to capture defaulthood has two results, which aren't shared by the other accounts discussed above.

Preferred allomorphs. URC predicts non-categorical preferences between URs (preferred allomorphs). As soon as we allow variation into the grammar, UR constraints can be ranked or weighted to capture different distributions over URs in the elsewhere context. For example, instead of *always* using *a* when ∗ə.V isn't relevant, *a* is used 75% of the time.

In Pater et al. (2012), we use this property of UR constraints to model lexical variation in French. In French, words differ in their likelihood of being pronounced with a schwa, independent of frequency of phonology. Some words favor schwa in the elsewhere context more than others.

UR constraints provide a straightforward analysis. Each word with a schwa has two URs – one with a schwa and one without – and each UR has a UR constraint. In words that favor schwa more, the difference between UR constraints is greater.

Learning. In URC, it's straightforward to model the learning of defaulthood using pre-existing learning algorithms. In each of the case studies and analyses here, the ranking of UR constraints is learnable.

Since defaulthood comes solely from the ranking of constraints, learning the default is as simple as learning the ranking. There are many learning algorithms available for this task – assuming either ranked or weighted constraints. These learning algorithms determine the optimal ranking or set of weights to capture a set of data.

In these models, the learner is provided with:

(38) The input to the learner

a. A set of constraint violations

b. A set of desired winners (or set of probabilities)

c. A set of violation profiles for every candidates

d. URs and SRs of every candidate

Using this information, the learner finds a ranking or weighting of constraints that captures the desired winners. In URC, the learner will do this by ranking UR constraints, discovering defaults along the way.

2.4.3 UR selection considers the output

In URC, UR selection and phonology happen at the same time, and as a result, the grammar is able to choose between different combinations of URs and repairs. In the example candidate set below, the repairs are h-deletion and vowel reduction, and the URs are /ej/ and /æn/.

	Set of features	UR	SR	Notes
a.	<D, {−DEF}> + {√HAT}	/ej/+/hæt/	[ej hæt]	*a*
b.	<D, {−DEF}> + {√HAT}	/ej/+/hæt/	[ə hæt]	*a* + reduction
c.	<D, {−DEF}> + {√HAT}	/ej/+/hæt/	[ej æt]	*a* + h-deletion
d.	<D, {−DEF}> + {√HAT}	/ej/+/hæt/	[ə æt]	*a* + reduction + h-deletion
e.	<D, {−DEF}> + {√HAT}	/æn/+/hæt/	[æn hæt]	*an*
f.	<D, {−DEF}> + {√HAT}	/æn/+/hæt/	[ən hæt]	*an* + reduction
g.	<D, {−DEF}> + {√HAT}	/æn/+/hæt/	[æn æt]	*an* + h-deletion
h.	<D, {−DEF}> + {√HAT}	/æn/+/hæt/	[ən æt]	*an* + reduction + h-deletion

Table 2.11: A possible candidate set under URC

As a consequence of this, there are often multiple ways to satisfy the same markedness constraint. For example, the grammar can satisfy ∗ə.V by choosing the candidate with the UR /æn/ and h-deletion, or choosing the candidate with the UR /ej/ and no h-deletion. Either way, a violation of the markedness constraint is avoided.

The preferred solution depends on the ranking of constraints. In the analysis of *a* and *an*, for example, a candidate with glottal stop epenthesis was ruled out by ranking a faithfulness constraint above the UR constraint. However, if this ranking were reversed, the epenthesis candidate would win.

Ranking constraints to capture preferences between repairs and URs is used throughout the dissertation. In Chapter 3, I show that preferences between epenthesis and *an* differ across speakers of English, and these differences follow from UR constraints. In Chapter 4, I show the same for n-epenthesis and UR selection in French, and in Chapter 5 for the Rhythm Rule and *-(a)licious*.

URC also predicts cross-feeding between UR selection and repairs. Since UR selection and repairs are evaluated at once, a selected UR can trigger a repair while simultaneously being licensed by the repair it triggers. McCarthy (2002) calls this sort of interaction the chicken-egg effect.

(39) The chicken-egg effect, a consequence of parallelism (McCarthy 2002)

The application of process A depends on knowing the output of process B, and the application of process B depends on knowing the output of process A.

In a model with an ordering between UR selection and repairs, the situation above results in a paradox. Process A must apply both before and after process B.

Throughout the dissertation, I present a number cases that can be taken as examples the chicken-egg effect. In Chapter 3, I argue that h-deletion feeds and is fed by *a(n)* allomorphy, and the same for ʔ-epenthesis. In Chapter 4, I argue that liaison feeds and is fed by n-epenthesis, and in Chapter 4, I argue that PCA with *-(a)licious* feeds and is fed by the Rhythm Rule.

The chicken-egg effect is shared by many other parallel models of PCA, such as the classic model of PCA in OT (Mester 1994; Kager 1996; Mascaró 1996). As long as UR selection is evaluated at the same time as repairs, we expect the chicken-egg effect.

Alternatives. The predicted interaction of UR selection and repairs isn't shared by feedforward models, in which UR selection must occur *before* phonology. Returning to *a(n)*, if UR selection occurs before reduction and h-deletion, these repairs are simply irrelevant to UR selection. In a feedforward OT model, which is otherwise the same as URC, this is what the candidate set looks like at the point of UR selection. Given this candidate set, there's no reason to select the candidate with *an* over *a*.

	set of features	UR	SR	
a.	<D, {−DEF}> + {$\sqrt{\text{HAT}}$}	/ej/+/hæt/	[ej hæt]	*a*
b.	<D, {−DEF}> + {$\sqrt{\text{HAT}}$}	/æn/+/hæt/	[æn hæt]	*an*

Table 2.12: A candidate set under a feedforward model (at UR selection)

In other derivational models, such as Wolf (2008), UR selection can be interleaved with phonological repairs: repairs can apply between the selection of URs, either before or after. Since ordering is necessary in this sort of model, cross-feeding interactions are still impossible.

CHAPTER 3

ENGLISH A AND AN

3.1 Overview of Chapter 3

Chapter 3 addresses the interaction of PCA and repairs, focusing on the case of English *a* and *an*. The chapter does three things. First, it provides more empirical support for the analysis of *a(n)* from Chapter 2, using data from spoken corpora. Second, it extends the model to ʔ-epenthesis and reduction. Finally, it considers *a* and *an* in acquisition, history, and other dialects of English. These varieties of English are subject to variation and demonstrate complicated interactions between PCA and repairs. I argue that all of these data are best analyzed with UR constraints in a parallel model.

The chapter is outlined as follows. The first part (§3.2-§3.4) provides empirical support for the analysis of *a(n)* presented in Chapter 2, using data mainly from corpora of spoken English. In support of the analysis, I show that the constraint conditioning *a(n)* s active throughout English, conditioning repairs such as ʔ-epenthesis and vowel reduction. In §3.3, I show that *a* is the default allomorph using evidence from the Switchboard Corpus (Godfrey, Holliman, and McDaniel 1992). In §3.4, I give new data from the Buckeye Corpus (Pitt et al. 2005) that further support the claims in §3.2 and §3.3.

The next part (§3.5-§3.6) extends the URC analysis to include ʔ-epenthesis and vowel reduction. In §3.5, I show that *a(n)* allomorphy and repairs can be captured in URC under a single ranking of constraints. In §3.6, I discuss some alternatives to the URC account, including morpheme-specific epenthesis and subcategorization. While these alternatives are able to model the basic pattern of *a(n)*, they run into difficulty modeling *a(n)* alongside the other repairs.

The last part (§3.7) addresses speakers with variable *a(n)*, focusing on the interaction of ʔ-epenthesis and *a(n)* allomorphy. Across dialects of English, speakers differ in their preferences between ʔ-epenthesis and *a(n)* allomorphy, and these differences can be captured with UR constraints in Maximum Entropy Harmonic Grammar (Goldwater and Johnson 2003). Supporting the predictions of parallel model, I also show that *a(n)* allomorphy feeds and is fed by ʔ-epenthesis.

The bullet points below summarize how each result of URC is supported in the chapter.

- **Language-wide constraints condition PCA**: Hiatus is independently avoided in English (§3.2, §3.4). There is a consistent ranking for repairs and PCA (§3.5).
- **Defaults emerge from ranking**: *a* is used in the elsewhere context (§3.3, §3.4). Sometimes *a* is a preferred allomorph, instead of a categorical default (§3.7). Default-hood is learnable with UR constraints (§3.5.7, §3.7).
- **UR Selection considers the output**: ʔ-epenthesis feeds and is fed by *a(n)* allomorphy (§3.7). H-deletion feeds *a(n)* allomorphy (§3.2.5). Parallelism provides solutions to some problems in the analysis of *a(n)* (§3.5.5).

In addition to the results above, this chapter also shows the benefits of using UR constraints to model PCA. It compares the it to the alternatives outlined below.

- Priority **constraints**: Learning defaults and UR preferences is straightforward with UR constraints (§3.6) and UR constraints can model variation (§3.9).
- **Morpheme-specific phonology**: Morpheme-specific phonology faces difficulty in modeling the PCA pattern together with other repairs (§3.6).

- **Subcategorization**: Subcategorization misses conspiracies between repairs and PCA (§3.6).

Like the rest of the dissertation, Chapter 3's conclusion is that PCA is sometimes the result of the phonological grammar. In these cases, it's best modeled in a parallel architecture, in which UR selection: (i) is regulated by UR constraints; and (ii) considers the output of phonology.

3.2 a(n) avoids hiatus

In this section, I present empirical arguments that *a(n)* is driven by ∗ə.V, supporting the analysis from Chapter 2.

In URC, phonological conditioning comes from the phonological grammar. As a result, URC is supported when a PCA-conditioning constraint shows effects elsewhere – in repairs, phonotactics, and other cases of PCA. I call this the Language-wide Constraint Hypothesis (the LWC Hypothesis), and its support is repeated below from Chapter 2.

(1) The LWC Hypothesis is supported when:

a. PCA-conditioning constraints are active elsewhere in the same language.

(i) They condition phonotactics.

(ii) They condition repairs.

(iii) They condition other cases of PCA.

As I show, each of these holds for ∗ə.V in English. While the LWC Hypothesis is part of URC, it also holds in other OT-based approaches to PCA, in which PCA comes from markedness constraints. Similar arguments have been used in Tranel (1996), Kager (1996), Mascaró (1996), and Wolf (2008), among others.

3.2.1 The formulation of hiatus

Hiatus avoidance in English is robust, with a long history of description. In the dedication of 1693's *Examen poeticum*, John Dryden describes a sequence of two vowels as "the most horrible ill-sounding gap", that is "to be avoided at all costs" (Gillespie et al. 2008). More recently, many authors (Stene and Tillotson 1954; Plag 1999; Britain and Fox 2009) have described a conspiracy of processes that all avoid hiatus.

A common thread in this research is that hiatus is sensitive to the quality of the first vowel, which I write as V_1. Hiatus is categorically avoided when V_1 is lax, but tolerated to some degree when V_1 is tense. For the purposes of hiatus, the lax vowels are [ɪ, ʊ, ɔ, ɛ, ə, æ, ɑ], and the tense vowels are [ej, i, ow, u]. Although [ɑ] and [ɔ] are arguably tense (appearing in open monosyllabic words like *spa* and *law*), they mostly pattern with [ə] and the other lax vowels with respect to hiatus.

Why can't V_1 be lax? Under my analysis, the fact that V_1 cannot be lax is part of the definition of ∗ə.V. The same constraint has been proposed to account for other cases of PCA (like *-ize*) in Plag (1999).

(2) ∗ə.V

Assign one violation for every lax-vowel.vowel sequence.

e.g., ∗ assigned to [ɪ.ɑ], [ɛ.i], [ə.aj], [ɪ.ə]

A common alternative is that a tense V_1 provides a glide, which avoids the hiatus. This is the position taken in Stene and Tillotson (1954), and a similar argument is made even earlier in Conway's 1878 *Treatise on Versification* (Conway 1878 p. 72). Conway challenges readers to consult a mirror if they doubt the presence of a glide: "let the objector try if he can sound, naturally, in measured recitation, any of these words [which end in tense vowels], before an initial vowel, without some contact of the vocal organs."

It’s true that a glide percept is present in the examples below, which are my own.

(3) V_1 is tense, so glide insertion can occur

a. Narnia [naɹniʲə]

b. radio [rejdiʲo]

c. boa [boʷə]

d. arduous [aɹdʒuʷəs]

Glides like the ones above are analyzed as the result of glide insertion or “intrusive [j]” (McCarthy 1993; Gimson and Cruttenden 2001) or low-level articulatory transitions (Heselwood 2006). For an overview, see Davidson and Erker (2014) and Britain and Fox (2009).

Again, this isn’t the position I take here. Under my analysis, ∗ə.V alone is responsible for the tense-lax distinction. The use of ∗ə.V instead of glide epenthesis is supported by Davidson and Erker (2014), who argue against glide epenthesis in words like *radio*. In a production experiment, they find ʔ-epenthesis in the same contexts as the putative intervocalic glide, in addition to phonetic differences between underlying glide+vowel sequences (e.g. *see yacht*) and underlying vowel+vowel sequences (e.g. *see otter*). Their conclusion is that glides in this context are the result of a perceptual illusion, and a full glide isn’t present.

The next sections show the role of ∗ə.V in *a(n)*, phonotactics, repairs, and other cases of PCA. For nearly all of the cases, hiatus avoidance is particularly severe when V_1 is lax, suggesting that the same constraint is at work throughout.

3.2.2 Phonotactics

Within English morphemes, we never find a hiatus where V_1 is lax. Some examples of attested words and unattested words are below.

(4) Attested words (V_1 is tense)

a. Narnia e. various

b. radio f. arduous

c. boa g. archaism

d. rodeo h. Hebraism

(5) Unattested words (V_1 is lax)

a. *[nɑɹ.nə.i] (cf. Narnia)

b. *[rej.dɪ.o] (cf. radio)

c. *[bɔ.o] (cf. boa)

d. *[ro.dɛ.o] (cf. rodeo)

This generalization is implicit in SPE, in which a rule of pre-vocalic tensing ensures these sequences never occur (Chomsky and Halle 1968).

Chomsky and Halle's generalization finds support in the CMU pronouncing dictionary (Weide 1993). I searched the CMU dictionary for words that are at least three syllables long (see §5.8.3 for discussion), excluding any low-frequency words that didn't occur at least once in SUBTLEX-US, a corpus of English subtitles (Brysbaert and New 2009). There are only 16 words with lax-V.V sequences, including words in which V_1 is [ɔ] or [ɑ]. On the other hand, there are over 2,500 that contain a hiatus where V_1 is tense.

Words containing	Count (% of total words)
Hiatus where V_1 is lax	16 (<1%)
Hiatus where V_1 is tense	1,597 (8%)

Table 3.1: Number of 3+ syllable words with different types of hiatus from CMU pronouncing dictionary, out of 20,988 words

All 16 words with lax V_1 are below. Only two of these sixteen words are convincing counterexamples. The majority are mistranscriptions, multi-morphemic, or pronounced without a hiatus. Both counterexamples include [ɔ] as V_1, which makes sense given the intermediate status of [ɔ] as tense or lax. I present my own impressions of the CMU transcriptions below, based on my pronunciations, although other speakers may differ. The hiatus is in boldface, with the CMU transcription to the right.

(6) All words with lax-tense sequences in CMU

a. True counterexamples

(i) withdr**awa**l [ɔ.ə]

(ii) withdr**awa**ls [ɔ.ə]

b. Mistranscriptions

(i) evac**ua**te [ə.ej]

(ii) pyren**ee**s [ə.i]

(iii) s**yna**pses [ɪ.æ]

c. Actually pronounced with a single vowel

(i) extr**ao**rdinaire [ə.ɔ]

(ii) extr**ao**rdinary [ə.ɔ]

(iii) sak**ai** [ɑ.ɪ]

(iv) n**ai**vely [ɑ.i]

(v) n**ai**vete [ɑ.i]

(vi) mas**ai** [ɑ.i]

d. Morpheme boundaries

(i) intr**ao**cular [ə.ɑ]

(ii) outl**awi**ng [ɔ.ə]

(iii) redr**awi**ng [ɔ.ɪ]

(iv) subpoen**ai**ng [ə.ɪ]

(v) withdr**awi**ng [ɔ.ə.]

In summary, ∗ə.V is strictly obeyed in English phonotactics. The next section shows that the same constraint conditions phonological repairs.

3.2.3 Repairs

There are four hiatus-conditioned repairs across varieties of English: ʔ-epenthesis, intrusive r, intrusive L, and vowel reduction. Under the analysis here, all of these repairs are conditioned by ∗ə.V.

The idea that diverse phonological repairs conspire to avoid a constraint like ∗ə.V is found in earlier work, such as in Stene and Tillotson (1954) and Plag (1999). Both authors note the connection between *a* and *an*, and the forms of *the* ([ði, ðə]). Stene and Tillotson (1954) also claim that hiatus avoidance drives intrusive r and the forms of *to* ([tu, tə]), while Plag (1999) uses hiatus avoidance to account for ʔ-epenthesis.

ʔ-epenthesis. As noted in the last section, there are no lax-V.V sequences within morphemes in English; however, such sequences do arise at morpheme boundaries, e.g. *samba-ing*, *dada-ist*, *banana-y*. In these cases, hiatus is avoided through ʔ-epenthesis.

Words like *mora-ize* are obligatorily pronounced with a glottal stop, according to Plag (1999). Plag's claim is supported by my own examples below, which tend to be pronounced with a glottal stop between the schwa and following suffix.

(7) Contexts with nearly obligatory ʔ-epenthesis

a. salsa-ing [sɔlsəʔɨŋ]

b. samba-ing [sɑmbəʔɨŋ]

c. soda-y [sodəʔi]

d. zumba-ist [zumbəʔɨst]

In a study of the spoken corpus TIMIT (Garofolo et al. 1986), Keating et al. (1994) find nearly categorical ʔ-epenthesis in *the*+V sequences when *the* is pronounced with a schwa. As shown in the graph, the rate of epenthesis is dependent on the quality of the vowel in *the*.

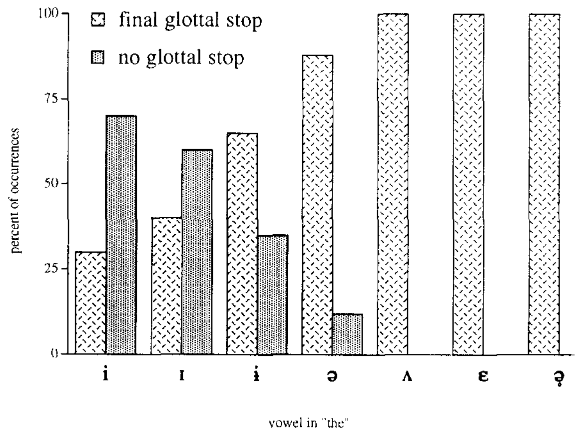

Figure 3.1: Figure from Keating et al. 1994: ʔ-epenthesis depends on the vowel in *the*

ʔ-epenthesis also depends on prosodic boundaries, as shown by the examples below. Across prosodic words, there is less of a tendency to epenthesize glottal stop, at least based on my own judgments.

(8) Contexts with optional ʔ-epenthesis

a. salsa all day ?[sɔlsə ʔ ɔl]

b. samba all day ?[sɑmbə ʔ ɔl]

c. zumba all day ?[zumba ʔ ɔl]

It's worth noting that ʔ-epenthesis occurs in other contexts, and it's unclear how these other types of ʔ-epenthesis are related to the ones described above. Garellek (2012) finds ʔ-epenthesis at the beginning of phrases before vowels, especially when the vowel is prominent. Pak (2014) notes that this kind of emphatic ʔ-epenthesis does *not* respect the phonological conditioning of *a(n)*.

(9) Examples of non-hiatus ʔ-epenthesis from Pak (2014)

a. That's an ʔéxcellent idea.

b. What an ʔídiot.

Davidson and Erker (2014) find a similar kind of stress-conditioned ʔ-epenthesis, which occurs 45% in tense-V.V sequences. Like emphatic glottal stop, this epenthesis is more likely before prominent vowels.

(10) Sample contexts for ʔ-epenthesis from Davidson and Erker (2014)

a. [ej + o]

gourmet oatmeal, sauté okra

b. [i + ɑ]

see otters, he objected

Emphatic ʔ-epenthesis doesn't necessarily contradict the ∗ə.V analysis. It may be that there are two types of ʔ-epenthesis: ∗ə.V-enforcing ʔ-epenthesis that only occurs within prosodic words, and variable stress-conditioned ʔ-epenthesis that occurs before or after any vowel. If the latter is a phonetic process, or a very late phonological one, we expect that it won't interact with PCA. Emphatic ʔ-epenthesis does mean, though, that URC cannot be a fully parallel, monostratal model: only some repairs are able to interact with PCA (see §2.4.3).

I return to ʔ-epenthesis at two points later in the chapter. In §3.5, I add it to the URC model for *a* and *an*, and in §3.7, I argue that ʔ-epenthesis conspires with *a(n)* allomorphy to avoid hiatus in both child language and some varieties of London English.

Intrusive r. Intrusive r provides another example of V_1-sensitive hiatus avoidance. In many non-rhotic dialects, intrusive r occurs between vowels, but only after [ɑ/ə/ɔ]. The set of vowels that trigger intrusive R – [ɑ/ə/ɔ] – are the lax vowels that can occur word-finally in English.[1] In the examples from McCarthy (1999) below, intrusive r is underlined.

[1]Although see McCarthy 1999 for arguments against the hiatus analysis.

(11) Examples from McCarthy (1999)

a. [ɑ]: The spar̲ is broken.

b. [ə]: He put the tunar̲ away.

c. [ɔ]: The boat'll yawr̲ a little.

Intrusive r also occurs after [ɛ] and [æ] in dialects where these vowels occur word-finally, such as the East Anglican Fens. The example below is from Britain and Fox (2009)

(12) now and then

[nɛː ɹ ən ðɛn]

Britain and Fox (2009) show that intrusive r is being replaced by ʔ-epenthesis in some varieties of English, especially in central London. This has interesting consequences for the use of *a* and *an*, discussed in §3.7.

Intrusive L. Intrusive L follows a similar pattern, breaking up a hiatus where V_1 is lax (Gick 2002). For speaker with intrusive L, [l] is epenthesized in the in the context [ɔ] ___ V, resulting in homophonous pairs like *drawing* and *drawling*.

Function word reduction. A final example is function word reduction. Reduction is nearly obligatory before consonants, but blocked before vowels, where it would violate ∗ə.V.

English function words have strong and weak forms. Strong forms typically contain unreduced, tense vowels and/or final consonants, while weak forms are typically vowel-final with reduced vowels. The table below lists some of the most frequently occurring forms of English function words from the Switchboard corpus, adapted from Jurafsky et al. (1998).

	Word	Strong form	Weak form
a.	a	[ej]	[ə]
b.	the	[ði]	[ðə]
c.	in	[ɪn]	[ɨn]
d.	of	[ʌv]/[ʌ]	[əv]/[ə]
e.	to	[tu]	[tə]
f.	and	[æn]/[ænd]	[ɨn]
g.	that	[ðæ]/[ðæt]	[ðɨ]/[ðɨt]
h.	I	[ɑɪ]	[ə]
i.	it	[ɪ]/[ɪt]	[ɨ]/[ə]
j.	you	[ju]	[jɨ]

Table 3.2: Reduction across English function words, adapted from Jurafsky et al. (1998)

When followed by another word, a function words appears in its weak form. For example, *to* is realized as [tə] before a consonant. The reduction rate in spoken English is actually very high. In the corpus data presented in §3.4, *to* reduces more than 80% of the time before consonants.

The effect of ∗ə.V can be seen before vowels, where reduction is blocked. The most well-known example is *the*, which has two forms: [ði] and [ðə]. The allomorph [ði] occurs before vowels, while [ðə] occurs before consonants (Conway 1878; Stene and Tillotson 1954; Quirk et al. 1972; Keating et al. 1994). Like the cases above, this avoids a violation of ∗ə.V.

(13) [ði] / ___ V

a. [ði] exmoor

b. [ði] arcott

(14) [ðə] / ___ V

a. [ðə] lonk

b. [ðə] swaledale

Contrary to the description above, many speakers reduce function words before vowels. In Keating et al. (1994), younger speakers only use pre-vocalic [ði] about two-thirds of the time. Crucially, these speakers are still sensitive to hiatus. In the Buckeye corpus data (§3.4), I show that nearly every speaker reduces less often before vowels, regardless of their baseline rate in reduction.

Although I focus on synchronic evidence, it's worth noting that hiatus-conditioned reduction has a long history in English. This is most evident in discussions on poetic translation. Conway (1878) writes "to me so offensive is hiatus, that nothing short of necessity can render it endurable." However, unlike his predecessors, Conway finds that sometimes hiatus (e.g. *the answer, to answer*) is preferable to syncope (e.g. *th'answer', t'answer*) in translation. He hypothesizes that the reason these hiatuses are tolerable is the quality of the initial vowel. For *the*, he notes that the vowel quality changes depending on the following word: before a vowel, *the* is like Italian *gli* ([i]), and before a consonant, it's like French *le* ([ə]).

3.2.4 Other cases of PCA

Moving to morphophonology, we find a number of cases of suffix selection and stem suppletion that are sensitive to hiatus. Unlike phonotactics and repairs, some cases of PCA don't discriminate on the basis of V_1, although most cases do.

An example that's discussed at length in Chapter 5 is the derivation of new words with suffixes like *-(a)licious* and *-(a)thon*. Each of these suffixes has a V-initial form (e.g. *-alicious, -athon*) and a C-initial form (e.g., *-licious, -thon*). For both suffixes, the preferred form avoids a hiatus: V-final stems take *-licious* and C-final take *-alicious*.

...C+alicious	...V+licious
curve alicious	tree licious
hunk alicious	jew licious
low carb alicious	ruby licious

Table 3.3: Examples from Corpus of Contemporary American English

Additionally, allomorphy with these suffixes is sensitive to vowel quality. The allomorphs *-alicious* and *-athon* are more likely with to occur with tense-vowel-final roots (e.g. *hero*) than schwa-final roots (e.g. *Alaska*), mirroring the tense-lax distinction in the other cases.

The suffix *-ese*, which derives a nationality from a country's name, follows a similar distribution. The form of the root avoids hiatus: V-final stems either add a consonant or drop a vowel.

(15) Distribution of *-ese* with V-final stems

a.	Canara	Canar-ese
b.	Java	Javan-ese
c.	Paama	Paam-ese
d.	Malta	Malt-ese
e.	Congo	Congol-ese
f.	Togo	Togol-ese
g.	Alghero	Algher-ese
h.	Shanghai	Shanghain-ese
i.	Faroe	Faro-ese (exception)

There are numerous cases of stem suppletion like *-ese* that have been argued to be conditioned by hiatus. Raffelsiefen (2004) uses a general constraint against hiatus to account for the distribution of the suffixes *-ize* and *-er*, among others. These tend to select for C-final stems, as shown below. The crucial example below is *Israelize*, which contrary to the general pattern, takes the country name rather than the adjectival nationality.

(16) Examples from Raffelsiefen (2004)

a.	Africa, **African**	African-ize
b.	ltaly, **Italian**	Italian-ize
c.	Canada, **Canadian**	Canadian-ize
d.	Germany, **German**	German-ize
e.	Saxony, **Saxon**	Saxon-ize
f.	**Israel**, Israeli	Israel-ize

Raffelsiefen (2004) also uses the constraint to account for *-er*, which selects for C-final stems.

(17) Examples from Raffelsiefen (2004)

a.	philosoph-er	philosophy
b.	geograph-er	geography
c.	astronom-er	astronomy

A final example of stem suppletion comes from Rubach and Booij (2001). Certain stems have a suppletive form that only appears with a V-initial suffix (although not every stem has a suppletive form, as shown by *heroic*).

(18) Examples from Rubach & Booij (2001)

a.	Plato	platon-ic, platon-ism
b.	drama	dramat-ic, dramat-ize
c.	Pluto	pluton-ic, pluton-ian
d.	hero	hero-ic, hero-ism (exception)

In the examples for *-ic* and *-ese*, the exceptions to the general patterns (*heroic* and *Faroese*) can be explained with the usual tense-lax distinction. Hiatus-sensitive suffixes exhibit a very strong tendency to avoid hiatus where V_1 is lax, but only a weaker tendency to avoid hiatus when V_1 is tense. As a result, most exceptions have a tense V_1. When a suffix does create a hiatus with a lax V_1 (e.g. *mora-ize*), it's repaired with categorical ʔ-epenthesis, as discussed in the previous section.

3.2.5 Alternations: speech errors and h-deletion

So far, I've presented evidence showing that ∗ə.V is independently motivated in English, but we can directly observe the effects of ∗ə.V on *a(n)* in alternations. If a process creates a vowel-initial word, *an* is used, and likewise for *a*. There are two cases that I review here: speech errors and h-deletion. In both cases, the same nouns occur with both *a* and *an*, depending on their surface pronunciation.

These cases show that *a(n)* is subject to active phonological conditioning, and challenge any theory that lists the words that occur with *a* or *an*. Under a model with listing, each noun in English is specified as [+a] or [+an], depending on its preferred determiner.

This view has been used for English comparatives in Bobaljik (2012), who argues that adjectives contain a phonologically-arbitrary [±M] feature that permits combination with *-er*. A similar account has also been used to model French liaison, with a [±sandhi] feature on nouns, which triggers liaison (Gaatone 1978b). More recently, Gouskova and Newlin-Łukowicz (2013) propose a model in which allomorphs are associated with sub-lexicons, the boundaries of which are (mostly) based on phonological features. Under this account, the nouns of English are divided into those that take *a* and those that take *an*.

The data here provide a real challenge for listing. The same word can occur with both *a* and *an*, depending on its pronunciation. As a result, a word like *historical* needs to have both features [+a] and [+an], or needs to be part of two sub-lexicons, with its ultimate behavior must be sensitive to its surface form.

The data in this section also show that UR selection can't occur before speech errors and repairs, consistent with the parallel model. At the end of the section, I show that h-deletion is a case of a chicken-egg effect. Not only does h-deletion feed *a(n)* allomorphy, but *a(n)* allomorphy feeds h-deletion. This type of interaction is possible with parallelism, but difficult to capture under a derivational model.

Speech errors. The phonological conditioning of *a* and *an* accommodates speech errors. As shown in Fromkin (1973), *an* occurs before vowels resulting from transposition errors, and likewise for *a* before transposed consonants.

(19) Examples of accommodation from (Fromkin 1973 231)

a. a current argument → an arrent curgument

b. a history of ideology → an istory of hideology

c. an eating marathon → a meeting arathon

d. an ice cream cone → a kice ream cone

These examples show the same word can occur with either *a* or *an*, depending on its surface pronunciation.

H-deletion. Optional h-deletion provides a similar argument. When an /h/ is deleted, *an* is used, but if the /h/ is pronounced, *a* is used instead.

In American English and British English, a regular process of h-deletion occurs in unstressed syllables, such as the initial syllable *horrendous*. The examples below are from Zwicky (1970), who claims that deletion in these cases is restricted to fast speech.

(20) H-deletion in Zwicky (1970)

a. horrendous → 'orrendous

b. humanity → 'umanity (cf. inhumane)

c. hispanic → 'ispanic

Here are a few more words that appear with an optional initial [h].

(21) h-initial words with unstressed initial syllables

a. historian

b. historical

c. historic

d. hysterical

e. hereditary

f. habitual

Although he doesn't provide examples, Rotenberg (1978) argues that optional h-deletion feeds the choice between *a* and *an*, resulting in *an* whenever an initial [h] is deleted. He further notes that dialects that always drop word-initial [h], such as Cockney English (Sivertsen 1960), always use *an* before typically [h]-initial words.

Reference grammars for both British and American English explicitly address h-initial words and *a(n)*. The Gregg Reference Manual (Sabin 2005), a style guide for American English says:

> In speech, both 'a historic occasion' and 'an historic occasion' are okay. It depends on whether the 'his' is sounded or left silent. In writing, 'a historic occasion' is the form more often used.

Fowler (1994), writing about British English, says the same. Speakers should avoid pronouncing ("aspirating") an initial [h] when they use *an*.

> …*an* was formerly used before an unaccented syllable beginning with *h* and is still often seen and heard (*an historian, an hotel, an hysterical scene, an hereditary title, an habitual offender*). But now that the *h* in such words is pronounced, the distinction has become anomalous and will no doubt disappear in time. Meantime, speakers who like to say *an* should not try to have it both ways by aspirating the *h*.

Schlüter (2003) tests the claim that h-deletion interacts with *a(n)* using data from the British newspaper *The Guardian* and the American *Detroit Free Press*. She finds that h-deletion feeds *a(n)*, as described above.

Schlüter divides h-initial words according to the prominence of their initial syllables. She assumes that less prominent syllables are more likely to undergo deletion, and finds that h-initial words with less prominent initial syllables are more likely to take *an*. Words with the least prominent initial syllables, those with the shortest vowels and least stress (e.g. *historic*), are the most likely to take *an*, relative to words with initial secondary stress (e.g. *histrionic*) and words with initial unstressed long vowels (e.g. *hypothesis*).

Schlüter also finds that *an* is used before *h* more often in British English than American English, 24% vs. 4% overall. This difference holds across all contexts, and is in line with the observation that h-deletion is more common in British English. The fact that Schlüter examines written sources most likely results in an underreporting of h-deletion. In British English h-deletion is sociolinguistically marked, described by Wells (1982 p. 254) as "the single most powerful pronunciation shibboleth in England." In addition, as noted in Gregg Reference Manual above, there's a greater tendency to use *a* before *h* in writing.

In addition to unstressed h-deletion discussed above, some varieties of British English are also subject to a well-known process of initial h-deletion, which occurs in initial stressed syllables, e.g. *'ouse*, *'ome*, *'orse* (Wells 1982). This process of h-deletion also feeds *a(n)* allomorphy, as shown below. These judgments come from three native speakers of English from Manchester.

(22) H-deletion and *a(n)*

a. a house

b. an 'ouse

c. *an house

d. *a 'ouse

e. a horse

f. an 'orse

g. *an horse

h. *a ’orse

As can be seen in these examples, the selection of *a* or *an* depends on the application of h-deletion.

In summary, there is no shortage of evidence showing that h-deletion feeds *a(n)* selection, supporting the view that *a(n)* actively avoids hiatus. While these cases are consistent with the parallel model, they don’t actually support it over a derivational one. A simple model in which h-deletion occurs before UR selection can model h-deletion and *a(n)*. In what follows, I present an argument that UR selection and h-deletion actually need to be assessed at the same time.

H-deletion and the chicken-egg effect. In URC, UR selection and repairs are evaluated in parallel. As a result, UR selection can feed repairs, and vice versa (§2.4.3).

The consequence is that UR selection and repairs can exist in a cross-feeding relationship, creating an ordering paradox. The repair provides the environment for the chosen UR, and at the same time, the UR that’s chosen triggers the repair. McCarthy (2002) calls this the chicken-egg effect.

(23) The chicken-egg effect, a consequence of parallelism (McCarthy 2002)

The application of process A depends on knowing the output of process B, and the application of process B depends on knowing the output of process A.

In a study of the historical development of h-deletion in English, Crisma (2007) argues that h-deletion feeds *a(n)* allomorphy, like above, and crucially, h-deletion depends on the function word. Words that can cliticize, like *a(n)*, trigger h-deletion, while words that cannot cliticize, like *my*/*mine*, do not. This presents a paradox.

(24) The chicken-egg effect in English (1420–1500)

a. h-deletion must precede UR selection: *an* occurs before a deleted *h*

b. UR selection must precede h-deletion: h-deletion occurs with *a(n)* but not *my*

Crisma's argument goes like this. In Middle English, *an* and *myn* occur before vowels. The word *myn* is the suppletive n-final form of *my*, which alternated at the time like *a(n)*.

(25) Before vowels

a.	an ile	*a ile
b.	myn ile	*my ile

Before *h*, we find that *an* and *myn* behave differently. While *an* is preferred before *h*, *myn* is not.

(26) Before h

a.	an hors	* a hors
b.	my hors	* myn hors

Crisma accounts for these facts with h-deletion. The phrase *an hors* is actually pronounced [anors] with a deleted *h*, while *hors* doesn't undergo deletion with *my* or *myn*.

(27) Before h

a.	an 'ors	* a hors
b.	my hors	* myn 'ors

Crisma argues that *a(n)* can trigger h-deletion due to its prosody: *a(n)* is always cliticized to the following word, while *my(n)* is not. Crisma's analysis finds support in meter, in which *my(n)* often bears stress, but *a(n)* never does.

Crisma reports that this pattern can also be observed in contemporary English. H-deletion in *historical* occurs after a clitic like *an*, but not after a number like *ten*.

(28) Contemporary English data from Crisma (2007)

a. an ’istorical question

b. three historical questions

c. ten historical questions

The account for contemporary English is the same. After the clitic *an*, *historical* is able to undergo h-deletion. After the non-clitic *ten*, the *h* remains. Prosodic differences between *ten* and *an* are found in function word reduction. As Shih (2014) shows using corpus data, cardinal numbers are less likely to be reduced than determiners like *a(n)*.

The ordering paradox rests on the claim that knowing a function word’s UR is required for determining whether it will cliticize. Another possibility is that *ten* and *a(n)* are subject to syntactic differences, and UR selection isn’t necessary to determine their their prosodic structure. However, phonological characteristics are relevant for cliticization: monosyllabic function words are much more likely to cliticize than disyllabic ones (Inkelas and Zec 1993; Shih 2014).

If UR selection requires h-deletion, and h-deletion requires UR selection, doing them simultaneously is the only way to satisfy both. This is exactly what happens in a parallel model like URC, in which the candidate set contains both URs and the outputs of different repairs.

3.2.6 Conclusion

This section has shown that ∗ə.V is a robust constraint in English. Later, I show that the patterns of repairs and *a(n)* follow under a single ranking of constraints in URC, and alternative analyses fail at capturing the conspiracy between PCA, phonotactics, and repairs.

Before that, I consider another aspect of the URC analysis of *a* and *an* – that *a* is the default.

3.3 a(n) and defaulthood

In this section, I provide arguments for the default status of *a*, supporting the URC analysis from Chapter 2. Default allomorphs are the natural consequence of ranking UR constraints, and URC makes two predictions about them.

(29) Predictions about defaulthood

- a. Defaults are phonologically and syntactically arbitrary.
- b. Defaulthood emerges in unmarked contexts (the elsewhere context).

Both of these predictions hold for *a(n)*.

3.3.1 Defaulthood and a

The analysis of *a* as the default is the traditional one, also found in Nevins (2011), Hayes (1990), Paster (2006), Zwicky (1986), among others. For instance, in Nevins (2011)'s overview of PCA, *a* and *an* are used to exemplify *Optimizer* and *Default*, with *an* as the optimizer and *a* as the default.

(30) Default and Optimizer in Nevins (2011)

- a. **Optimizer**: The allomorph chosen in order to satisfy a particular phonotactic [constraint], e.g. to provide an onset, in a particular set of environments (e.g. before vowel-initial words)
- b. **Default**: The allomorph chosen otherwise

Given the fact that the analysis with *a* as default is standard, why is this section necessary? In all of this work, little evidence is presented to support *a* as default.

Given the idealized distribution of *a* and *an*, it could be the other way around, with the *an* as the default, and *a* used to avoid codas.

(31) An alternative default and optimizer

a. **Optimizer**: *a* is chosen to avoid a coda (before consonant-initial words)

b. **Default**: *an* is the allomorph chosen otherwise

The rest of this section presents evidence that supports the traditional analysis: *a* occurs before hesitations, disfluencies, and parentheticals. In these environments, the following phonological context isn't available, so the default *a* is used.

3.3.2 Evidence for defaulthood

In this section, I present results from my own search of the Switchboard corpus of spoken English (Godfrey, Holliman, and McDaniel 1992), along with a review of some previous work.

The first argument for treating *a* as the default is that it occurs phrase-finally, where hiatus is not at issue. Examples of phrase-final *a* come from Rotenberg (1978), who shows that *an* is less acceptable than *a* before a parenthetical. This holds regardless of the initial segment of the parenthetical, or the initial segment of the word after the parenthetical.

(32) Examples from Rotenberg (1978: 29)

a. a – although I hate to admit it – absurd idea

b. ?an – although I hate to admit it – absurd idea

c. a – although I hate to admit it – silly idea

d. ?an – although I hate to admit it – silly idea

The second argument for the default status of *a* comes from disfluencies. Before disfluencies, like *uh* or *um*, *a* is used the vast majority of the time (Clark and Fox Tree 2002).

(33) Example of *a* before disfluencies from Clark and Fox Tree (2002)

we-um have **a-uh** pyro-techniques team that's-uh on the round or in the water!

Pak (2014) reports similar findings for adult speech in the CHILDES corpus (MacWhinney 1995).

(34) Examples of *a* before disfluencies from Pak (2014)

a. I'd like /ej/ um… a large coffee and a croissant.

b. This is /ej/ uh… part of a trailer truck

In the table below, I show that the preference for *a* before disfluencies holds for the Switchboard corpus. The counts are from the English orthography transcriptions, which were were automatically annotated used the phonetic transcriptions from CMU pronouncing dictionary (Weide 1993), and the dominant part of speech tags for each word from SUBTLEX-US (Brysbaert, New, and Keuleers 2012).[2]

	uh	um	V-initial N/ADJ
a	799	147	230
an	17	5	4080
%a	98%	97%	5%

Table 3.4: *a* and *an* before disfluencies

Under the assumption that *uh* or *um* indicate difficulty in lexical retrieval, these data show that speakers prefer *a* when they don't know the upcoming word. Under the analysis here, the reason they use *a* is that it's the default.

Another possibility is that speakers are simply matching the overall distribution of *a* and *an*. If this is what they're doing, the likelihood of using *a* before a disfluency

[2] In the written transcriptions of Switchboard, *uh* is used to transcribe any non-nasal disfluency, including *eh*, and *um* is used to transcribe any nasal disfluencies, including *hm* and the *nuh* of *nuh-uh*.

should match the likelihood of using *a* in general. The data here are unclear. The rate of *a* before disfluencies (97%) is higher than the overall rate of *a* before nouns and adjectives (92%). Whether they are probability matching or not, it's clear that *a* is preferred, and not *an*.

The preference for *a* holds regardless of the initial segment of the post-*um* word. The two tables below show that *a* is preferred across all contexts. The first table contains counts for all post-disfluency words, and the second table contains counts only for post-disfluency nouns and adjectives.

	C-initial word	V-initial word
a	481	386
an	7	13
%a	99%	97%

Table 3.5: Counts for *a/an uh/um X*

	C-initial N/ADJ	V-initial N/ADJ
a	250	19
an	2	2
%a	99%	90%

Table 3.6: Counts for *a/an uh/um ADJ/N*

It would be surprising if article selection could see across disfluencies, given the large literature suggesting that *uh* and *um* reflect production difficulty. *Uh* and *um* are used when lexical retrieval stalls, and in these cases, speakers don't have access to the following noun (Fox Tree and Clark 1997; Clark and Fox Tree 2002).

The data for disfluencies presented here are in disagreement with observations by Rotenberg (1978), who claims that disfluencies are invisible to article selection. He reports the judgments below, in which *a(n)* agrees with the post-*uh* noun.

(35) Disfluencies from Rotenberg (1978)

a. an – uh, uh – Eskimo

b. a – uh – snorkel

Rotenberg admits that metalinguistic factors may be influencing in his judgments. He writes: "My feeling about [the examples] is that sheer pedantry is responsible for the temptation to make the long distance alternation."

Zuraw (2006) finds similar long-distance agreement for parentheticals in a web corpus study, and cross-parenthetical dependencies have also been reported for French liaison (Schlenker 2010).

(36) An attested example from Zuraw (2006)

In the car on the way back to London, we had an – to me – even more peculiar exchange about my niece and her boyfriend.

In judgments and writing, it seems that speakers can exhibit phonological conditioning across a parenthetical or disfluency, but this dependency disappears in spoken corpora.

The third argument for treating *a* as the default comes from asymmetries in speech errors. In the Switchboard data, there are errors for both *a* and *an*, with *a* before vowels and *an* before consonants. The number of each type of error is reported in the table below. Overall, we find an error rate of 0.4%. Out of these errors, 95% are *an* → *a*, consistent with the default status of *a*.

	___ C	___ V	Total
a	51778	230	52008
an	13	4080	4093
Total	51791	4310	
%a	>99%	5%	

Table 3.7: *a* and *an* before adjectives and nouns

Since *a* is generally preferred to *an*, speech errors are more likely to result in *a* than *an*. Of course, it may be that errors favor the more frequent form, independently of defaulthood. Since frequency and defaulthood overlap so closely for *a* and *an*, teasing these two apart is difficult.

In the examples below, I list some of the *a* → *an* errors. A few extra notes on the corpus search. In annotating nouns and adjectives, I adhered to the IPA transcriptions in the CMU pronouncing dictionary, resulting in some potentially contentious transcriptions, e.g. *hors d'oeuvres* with an initial [h]. It should also be noted that in Switchboard *an* is used to transcribe both the indefinite article and *an'*, the reduced form of the word *and*. This explains examples like *an things like that* below. These cases, while few, do inflate the count of *an* errors.

(37) Some *a* → *an* errors from Switchboard

a. an current event
b. an high school education
c. an hors d'oeuvres
d. an house in our neighborhood
e. an meeting a meeting
f. an misuse of what we
g. an pollen attack

h. an soap opera

i. an things like that

j. an unanimous verdict

Below, I list some of *an* → *a* errors. English speakers, if they are sensitive to the asymmetry in the corpus, will judge the phrases below as more acceptable than the ones above.

(38) *an* → *a* errors from Switchboard

a. a absolute fact

b. a abundance of iron

c. a air conditioning unit

d. a american made truck

e. a ice cream parlor

f. a italian restaurant

For completeness, below is a breakdown of *an* → *a* errors, sorted by the initial vowel of the nouns and adjectives. There is no clear pattern for the errors. "Total" reports the total number of adjectives and nouns in the construction *a(n) ADJ/N* that begin with the specified vowel.

	[ɑ]	[æ]	[ə]	[ɔ]	[ɑw]	[aj]	[ɛ]
Errors	15	24	30	10	12	8	48
Total	398	379	643	171	331	160	655
%error	3.8%	6.3%	4.7%	5.8%	3.6%	5.0%	7.3%

	[ɚ]	[ej]	[ɪ]	[i]	[ow]	[ɔj]
Errors	2	2	58	5	14	2
Total	27	49	1189	73	219	16
%error	7.4%	4.1%	4.9%	6.8%	6.4%	12.5%

Table 3.8: *an* → *a* errors by initial vowel

The final argument for the default status of *a* comes from language change. Overall, there's a movement away from *an* and towards *a*. In some varieties of British English, the system is in transition, with pre-vocalic *an* being replaced by [əʔ], as discussed in §3.7 (Britain and Fox 2009).

In summary, the Switchboard data clearly indicate a preference for *a* over *an*. This preference emerges when phonological context is irrelevant, such as before parentheticals and disfluencies. The preference can also be observed in speech errors and historical change, both of which demonstrate a tendency for *an* to be replaced by *a*.

3.4 Buckeye search

This section presents new data from the Buckeye corpus (Pitt et al. 2005), focusing on *a(n)*, *the*, *to*, and *of*. The goal of the corpus search is to further test the claims in the last two sections about reduction and defaults. Unlike the Switchboard search, which used IPA transcriptions from the CMU pronouncing dictionary, the Buckeye search uses actual IPA transcriptions, and provides a large set of data for individual speakers.

Regarding reduction, the main finding is that nearly every speaker in the Buckeye corpus is sensitive to hiatus. This holds for all four function words, and regardless of a speaker's baseline rate of reduction. Regarding defaulthood, the main finding is that the contexts that favor strong forms also favor the default. This supports the analysis in which both the strong form and the default occur in contexts where following phonological material is unavailable or irrelevant.

3.4.1 Methods

The Buckeye corpus contains 300,000 words of conversational speech from 40 native central Ohio speakers, transcribed and annotated (Pitt et al. 2005).

The following function words were included in the search: *the*, *to*, *of*, *a*, and *an*. Function words are often subject to co-articulation, resulting in a diverse set of phonetic realizations. For each function word, any transcription used fewer than 25 times was excluded. Some function words – especially *a* – were occasionally transcribed as single consonant (e.g. *a lamp* as [l laemp]). These single-consonant transcriptions were also excluded.

Function words were annotated as strong or weak and V-final or C-final. Strong forms contain the vowels [i, ej, u, ow, aj, aw] (in Buckeye: iy, ey, uw, ow, ay, aw). The vowel [æ] was annotated as strong, since it occurs in the strong form of *an*. With respect to final segment, function words ending in a rhotic schwa ([ɚ]/*er*) were treated as vowel-final.

The table below shows the annotated transcriptions of *to* from Buckeye. This table illustrates the variation present in Buckeye transcriptions.

IPA	Buckeye notation	Final C/V	Strong/Weak	Count
[tə]	t ah	V	W	1182
[tɪ]	t ih	V	W	1018
[tu]	t uw	V	S	844
[ə]	ah	V	W	470
[dɪ]	d ih	V	W	356
[də]	d ah	V	W	349
[ɾə]	dx ah	V	W	334
[ɾɪ]	dx ih	V	W	268
[ɪ]	ih	V	W	192
[tʊ]	t uh	V	W	175
[nə]	n ah	V	W	95
[tɛ]	t eh	V	W	73
[du]	d uw	V	S	49
[ɾu]	dx uw	V	S	47
[nɪ]	n ih	V	W	39
[ɛ]	eh	V	W	38
[ti]	t iy	V	S	35
[ɾɛ]	dx eh	V	W	30
[ɾʊ]	dx uh	V	W	29
[dɛ]	d eh	V	W	27
[dʊ]	d uh	V	W	27
[ɾ̃ə]	nx ah	V	W	27

Table 3.9: Realizations of *to* in Buckeye

After the exclusions above, there were 24,013 tokens, distributed across function words as below.

a	an	of	the	to
5956	365	4161	7827	5704

Table 3.10: Distribution of function words in Buckeye, after exclusions

The next two sections first address *a(n)* and *of* and then *the* and *to*.

3.4.2 Results for *a(n)* and *of*

The table below presents the percent of final consonant realizations for *a(n)* across phonological contexts. These contexts include disfluencies, silence, and non-speech noises, all of which are transcribed in Buckeye. *UM* is the context before the disfluencies *uh* and *um*. Disfluencies are not included in *VOWEL* counts. *SIL* is silence (transcribed as SIL in Buckeye). *NOISE* are cut-off words, laughs, and vocal noises. The total number of tokens is in parenthesis. For example, *a(n)* occurs before consonants 5240 times, and of these, less than 1% are C-final *an*.

CONS	VOWEL	SIL	UM	NOISE
<1% (5240)	73% (379)	7% (202)	4% (57)	4% (379)

Table 3.11: *a(n)*: percent final consonant by phonological context

Like the Switchboard results, the Buckeye results show an asymmetry between errors for *a* and *an*. While *an* practically never occurs before consonants (only 9 out of 5240 times), *a* occurs quite often before vowels. In fact, the results for Buckeye show a relatively weak preference for *an* before vowels – only 73%, compared to the 95% found in the Switchboard search.

This low count follows from the lack of syntactic context in the table above. After sorting by part of speech, *an* is nearly categorically preferred before V-initial adjectives and nouns.

	Adj	Noun	Det	Prep	Verb	Other
C-initial	<1% (1340)	<1% (3535)	8% (13)	12% (17)	3% (32)	1% (301)
V-initial	89% (102)	90% (231)	22% (50)	0% (19)	25% (8)	36% (33)

Table 3.12: *a(n)*: percent final consonant by following segment and syntactic context

As noted in the section on defaults, *a* is overrepresented before parentheticals, speech errors, and false starts – cases where phonological conditioning doesn't play a role. These are the cases where *a(n)* is followed by a determiner, verb, preposition in the table above, and all of these contexts disfavor *an*, even when it's followed by a vowel.

We find similar results for *of*. Like *a(n)*, *of* has two forms – [əv] and [ə] – and the presence of the final consonant is conditioned by the following segment. Unlike *a(n)*, the default for *of* is the C-final form. The C-final form is preferred in all contexts except before a consonant.

	CONS	VOWEL	SIL	UM	NOISE
of	41% (2722)	80% (986)	81% (138)	98% (60)	70% (224)

Table 3.13: *of*: percent final consonant by phonological context

When *of* is followed by another preposition or verb, cases which are likely false starts or parentheticals, the C-final default should be used. These two contexts (excluding *Other*) favor *of* most overall, but the syntactic differences in *of* are less clear than they are in *a(n)*.

	Adj	Noun	Det	Prep	Verb	Other
C-initial	43% (180)	34% (801)	40% (1087)	47% (269)	43% (182)	58% (232)
V-initial	74% (51)	71% (308)	82 (149)	87% (411)	80% (20)	83% (47)

Table 3.14: *of*: percent final consonant by following segment and syntactic context

Since Buckeye contains a large set of data for 40 speakers, it's possible to look at variation within speakers. The graph below shows the proportion of final consonants for *a(n)* and *of* for each speaker in the corpus. The data used for this graph don't include silence (SIL), disfluencies (UM), or noise (NOISE). To reduce noise from syntactic context, the graph excludes cases where *a*/*an* is followed by a determiner, and cases where *of* is followed by a preposition. The syntactic categories marked *Other* in the tables above are also excluded.

The main finding of this graph is that speakers display an asymmetry between vowels and consonants, regardless of their baseline rate for final consonants. For 37 out of the 40 speakers, *an* is more likely than *a* before vowels, and for all speakers, *of* is more likely than *o'* before vowels. Note that some speakers in Buckeye do use quite a bit of pre-vocalic *a* – especially speakers 17, 19 and 4.

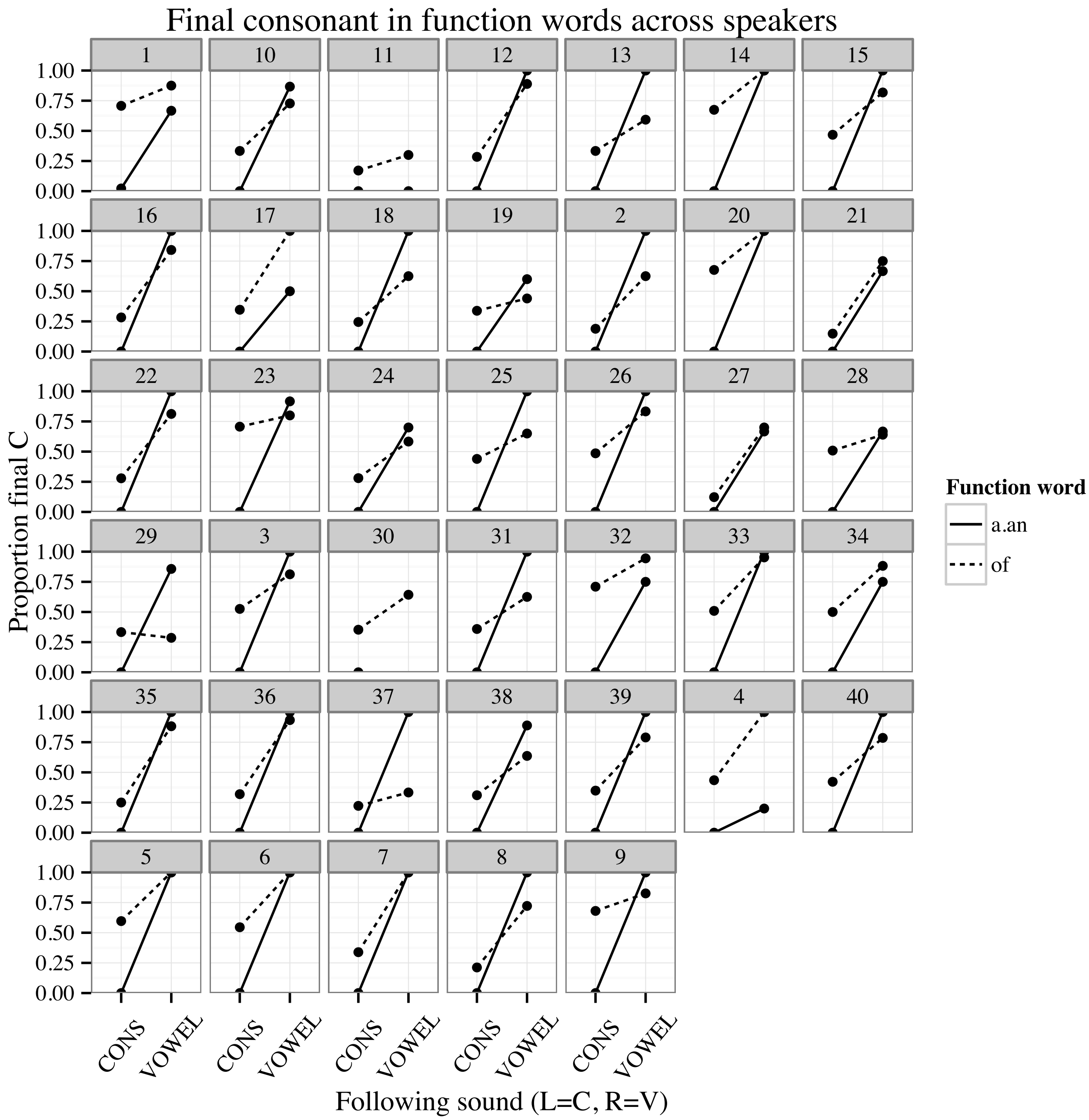

Figure 3.2: Final consonant realization for *a(n)* and *of* across speakers

The three exceptions to the general pattern are speakers 11, 29, and 30. Speaker 11 surprisingly only uses *an* once in the entire data set, preferring *a* before vowels, and speaker 30 never uses a V-initial word after *a* or *an*. The rest of the speakers show phonological conditioning, although some exhibit a high tolerance for pre-vocalic *a*.

For *a(n)*, we can consider the interaction of reduction and final consonant realization. The proportion of strong (unreduced) forms is presented in the table below. The strong form of *a* is most likely before disfluencies and vowels. In speech errors – when speakers erroneously use *a* before vowels – reduction of *a* is less likely than it is before consonants. This suggests that speakers tend to respect ∗ə.V even in speech errors.

	CONS	VOWEL	SIL	UM	NOISE
a	5% (5231)	28% (119)	9% (188)	73% (55)	9% (363)
an	44% (9)	34% (324)	21% (14)	0% (2)	19% (16)

Table 3.15: *a(n)*: percent strong forms by following phonological context

The use of [ej] before disfluencies (*UM* above) is well documented, and has been used to argue that disfluencies are part of speech planning (Fox Tree and Clark 1997; Clark and Fox Tree 2002). A speaker plans ahead of time whether she will use *uh/um*. Anticipating the disfluency and lack of following noun, she chooses the strong form, since the weak form requires a following noun.

In the table above, speakers do *not* use the strong forms of *a* and *an* before silence or noise. Under the production story, silence or vocal noises (like coughs) are unplanned interruptions, and as a result, speakers don't anticipate a break. They use the cliticized form in these contexts, expecting a following noun or adjective, which ultimately doesn't occur.

3.4.3 Results for the and to

In this section, I show that *the* and *to* are also conditioned by the following context, obeying ∗ə.V. The results here are consistent with previous descriptions in the literature, cited in §3.2.3.

The table below shows the basic phonological conditioning. The function words are more likely to be strong before vowels than consonants, and they are also more likely to be strong before disfluencies like *um*.

	CONS	VOWEL	SIL	UM	NOISE
the	6% (6031)	66% (914)	15% (272)	85% (103)	11% (507)
to	10% (4442)	42% (605)	40% (255)	91% (46)	33% (356)

Table 3.16: *the* and *to*: percent strong forms by following phonological context

Reduction occurs before silence and noise, just like it does for *a(n)* in the previous section, and the same explanation applies here: speakers use strong forms before planned prosodic breaks, but weak forms before unplanned ones.

For *the*, the effect of following vowel is strongest when *the* is followed by an adjective or noun. When *the* is followed by another determiner, preposition, or verb – cases which represent false starts or parentheticals – the effect of phonology is weakest, shown by the smaller difference between C-initial and V-initial contexts.

	Adj	Det	Noun	Prep	Verb	Other
C-initial	4% (1185)	14% (110)	6% (4504)	21% (28)	7% (28)	1% (172)
V-initial	66% (355)	38% (8)	68% (497)	38% (16)	33% (6)	55% (31)

Table 3.17: *the*: percent strong form by following syntactic category

For *to*, the role of syntactic category is much less evident, although the difference between following C-initial and V-initial contexts holds across all parts of speech.

	Adj	Det	Noun	Prep	Verb	Other
C-initial	13% (68)	15% (342)	7% (443)	18% (391)	8% (3022)	31% (176)
V-initial	98% (13)	53% (146)	17% (75)	67% (145)	24% (175)	57% (51)

Table 3.18: *to*: percent strong form by following syntactic category

As with *of* and *a(n)*, we can also consider reduction within individual speakers. All speakers reduce *the* and *to* more often before consonants than vowels.

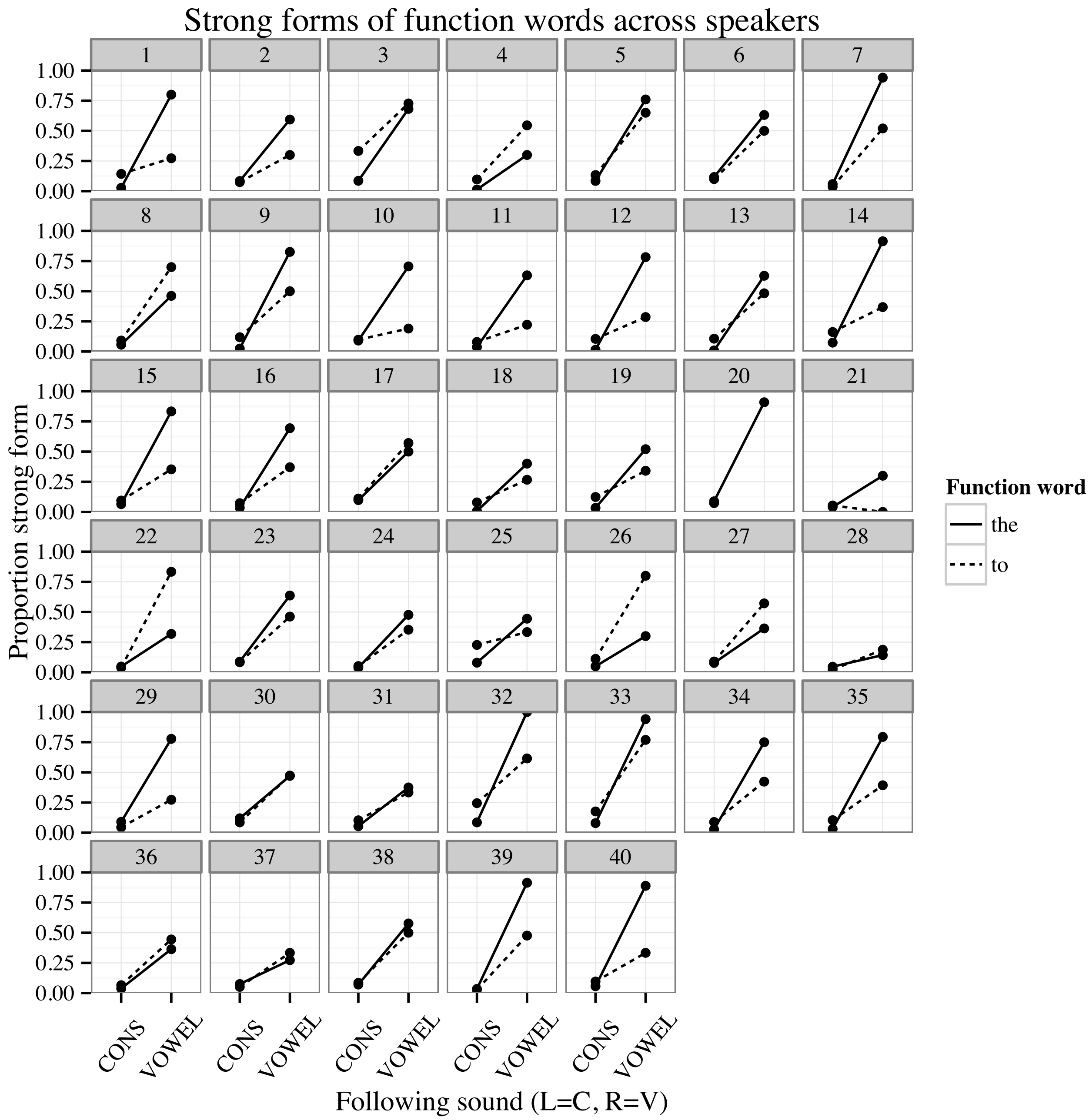

Figure 3.3: Strong forms for *the* and *to* across speakers

Most speakers use [ði] 50–75% of the time before vowels, with a few speakers employing nearly categorical pre-vocalic [ði] and some speakers employing it less. Some (e.g. 28) reduce *the* before vowels as much as 80% of the time. Every speaker avoids [ði] before consonants, even those who use pre-vocalic [ði] often.

3.4.4 Summary

The Buckeye results show that every speaker is sensitive to hiatus, regardless of her baseline rate of reduction or final consonant realization. This holds for all four function words. The results also show that the default and strong form are more likely before disfluencies and syntactic categories that represent parentheticals and false starts.

The individual differences from the Buckeye search are analyzed in the following sections, which provide a URC analysis of two basic patterns: speakers who reduce before vowels, and speakers who don't.

3.5 Extending the account to epenthesis and reduction

This section reviews and extends the URC account of *a(n)* to include *the*, vowel reduction, and ʔ-epenthesis. All of these data are captured under a single ranking of constraints.

The goal of the analysis is to account for the two types of speakers below. Both can be seen in Buckeye search from the previous section.

(39) **Thee users**: [ðə] before consonants; [ði] elsewhere

(40) **Reducers**: [ðə] before consonants and vowels; pre-vocalic [ðə] is always accompanied by ʔ-epenthesis

Based on the Buckeye data, I assume that both groups use [ði] before *uh* and *um*, and both use pre-vocalic *an*.

The analysis in this section assumes categorical data for reduction and UR selection. As seen in the corpus, the actual data are subject to a great deal of variation. In §3.7, I show similar data can be modeled in MaxEnt, focusing on speakers with variable pre-vocalic *a*.

3.5.1 The basic analysis and epenthesis

The analysis from Chapter 2 captures *a* and *an* with the ranking below.

(41) ∗ə.V ≫ Dep ≫ UR = /ej/ ≫ UR = /æn/

Under this ranking, ∗ə.V drives both PCA and epenthesis. When a violation of ∗ə.V isn't at stake, *a* is preferred to *an*. The ranking above permits epenthesis in words like *soda-y*, but blocks epenthesis with *a*. Because Dep dominates UR = /ej/, epenthesis is only used when *a(n)* allomorphy is unavailable.

The tableau below contains all of the candidates from Chapter 2. It shows how *an* is used before vowels, *a* is used elsewhere, and epenthesis is only used as a last resort.

Ranking arguments: ∗ə.V ≫ Dep ≫ UR = /ej/ ≫ UR = /æn/

			∗ə.V	Dep	UR = /ej/	UR = /æn/
☛	/ej/+/laŋk/	[ə laŋk]	0	0	0	−1
	/æn/+/laŋk/	[ən laŋk]	0	0	−1 W	0 L
	/ej/+/laŋk/	[ə ʔ laŋk]	−1 W	0	0	−1
☛	/æn/+/ɛksmoɹ/	[ən ɛksmoɹ]	0	0	−1	0
	/ej/+/ɛksmoɹ/	[ə ɛksmoɹ]	−1 W	0	0 L	−1 W
	/ej/+/ɛksmoɹ/	[ə ʔ ɛksmoɹ]	0	−1 W	0 L	−1 W
☛	/sodə/+/i/	[sodə ʔ i]	0	−1	0	0
	/sodə/+/i/	[sodə i]	−1 W	0 L	0	0

Table 3.19: Summary tableau for *a* and *an*, repeated from Chapter 2

In the tableau above, PCA and repairs coexist under a single ranking of constraints, and both are driven by the same constraint. The existence of a single consistent ranking is a requirement for any theory in which both PCA and repairs are the result of the same constraint-based phonology.

The next sections take this analysis and extend it to reduction. As with epenthesis, reduction is conditioned by ∗ə.V, and a single ranking can capture both reduction and PCA.

3.5.2 Obtaining reduction

Strong and weak function words are analyzed here as the result of a phonological process of reduction. Each function word has a single UR, which can appear in a strong or weak form.

(42) The single UR account of reduction

a. /ej/ → $\begin{bmatrix}\text{ə}\\ \text{ej}\end{bmatrix}$

b. /æn/ → $\begin{bmatrix}\text{ən}\\ \text{æn}\end{bmatrix}$

c. /ði/ → $\begin{bmatrix}\text{ðə}\\ \text{ði}\end{bmatrix}$

The use of a single UR captures the fact that function word reduction in English is highly systematic and productive. As described in Selkirk (1972) and subsequent work, every monosyllabic function word in English undergoes reduction.

I follow the basic analysis in Selkirk (1972): the weak form of a function word occurs when it's prosodically cliticized onto the following phrase, and the strong form occurs when the function word is forced to stand alone, before a prosodic boundary. To simplify the analysis, I assume that monosyllabic function words cliticize whenever possible.

Reduction is modeled with the two constraints below. Reduce enforces the requirement for a function word to be reduced when it's cliticized. This constraint is rather ad hoc, but sufficient for the discussion here. The faithfulness constraint Ident(V) militates against reduction.

(43) Reduce

Assign one violation for every unreduced vowel in a cliticized function word.

(44) IDENT(V)

Assign one violation for every output vowel that differs from its corresponding input vowel.

Reduction before consonants follows from the ranking REDUCE ≫ IDENT(V). This ranking correctly predicts that all function words that can cliticize should have reduced forms, as shown for *a lonk* and *the lonk* in the two tableaux below. The ranking here is consistent with the basic ranking established for *a* and *an* in Chapter 2.

				*ə.V	DEP	REDUCE	IDENT(V)	UR = /ej/	UR = /æn/
a.	☛	/ej/+/lɔŋk/	[ə lɔŋk]	0	0	0	−1	0	−1
b.		/ej/+/lɔŋk/	[ej lɔŋk]	0	0	−1 W	0 L	0	−1
c.		/ej/+/lɔŋk/	[ə ʔ lɔŋk]	0	−1 W	0	−1	0	−1
d.		/æn/+/lɔŋk/	[ən lɔŋk]	0	0	0	−1	−1 W	0 L
e.		/æn/+/lɔŋk/	[æn lɔŋk]	0	0	−1 W	0 L	−1 W	0 L
f.		/æn/+/lɔŋk/	[ən ʔ lɔŋk]	0	−1 W	0	−1	−1 W	0 L

Table 3.20: Reduce *a* before consonants

				*ə.V	DEP	REDUCE	IDENT(V)	UR = /ej/	UR = /æn/
b.	☛	/ði/+/lɔŋk/	[ðə lɔŋk]	0	0	0	−1	0	0
d.		/ði/+/lɔŋk/	[ði lɔŋk]	0	0	−1 W	0 L	0	0
f.		/ði/+/lɔŋk/	[ðə ʔ lɔŋk]	0	−1 W	0	−1	0	0

Table 3.21: Reduce *the* before consonants

The constraints also predict that a strong form will be used when cliticization is impossible – as in *a um lonk* and *the um lonk*. This follows from the definition of REDUCE, which only requires reduction in cliticized function words. The ϕ below marks a prosodic boundary, which prevents cliticization.

				*ə.V	REDUCE	DEP	IDENT(V)	UR = /ej/	UR = /æn/
a.	☛	/ði/+/ʌm/	[ði] ϕ [ʌm]	0	0	0	0	0	0
b.		/ði/+/ʌm/	[ðə] ϕ [ʌm]	0	0	0	−1 W	0	0
c.		/ði/+/ʌm/	[ðə ʔ] ϕ [ʌm]	0	0	−1 W	−1 W	0	0

Table 3.22: Reduction is blocked before disfluencies

Recall that this is exactly what we find in Buckeye and the literature on disfluencies (see especially Fox Tree and Clark 1997).

The generalizations above follow regardless of the ranking between DEP and REDUCE. In the following sections, I show that ranking these two constraints accounts for the difference between Thee Users and Reducers.

3.5.3 Thee Users

Thee Users use [ðə] before consonants, but [ði] before vowels.

Given the assumption that *the* is cliticized whenever possible, there are two possible explanations for this generalization. The first, which I use here, is that pre-vocalic [ði] avoids a [ə.V] sequence, which is especially marked in English (Plag 1999). The second is that use of the pre-vocalic [ði] conditions glide-insertion, and thus avoids hiatus (Britain and Fox 2009). See §3.2.1 for discussion.

The use of [ði] before vowels follows straightforwardly from the ranking ∗ə.V, Dep ≫ Reduce. The ranking in the tableau below is consistent with the one already established for *a* and *an* and reduction.

				∗ə.V	Dep	Reduce	Ident(V)	UR = /ej/	UR = /æn/
a.	☛	/ði/+/ɛksmɔɹ/	[ði ɛksmɔɹ]	0	0	−1	0	0	0
b.		/ði/+/ɛksmɔɹ/	[ðə ɛksmɔɹ]	−1 W	0	0 L	−1 W	0	0
c		/ði/+/ɛksmɔɹ/	[ðə ʔ ɛksmɔɹ]	0	−1 W	0 L	−1 W	0	0

Table 3.23: Reduction for *the* is blocked before vowels

For Thee Users, the final ranking is:

(45) ∗ə.V ≫ Dep ≫ Reduce ≫ UR = /ej/ ≫ UR = /æn/

Reduce ≫ Ident(V)

Reducers follow a similar ranking, except with a flipped ranking for Reduce and Dep.

3.5.4 Reducers

Reducers use pre-vocalic [ði] to a lesser extent, but still use [ði] before *uh* and *um*. I treat this pattern as categorical: with [ðə] before vowels and consonants, and [ði] before *um*.[3]

The lack of pre-vocalic [ði] follows from the ranking of Reduce above Dep. As a result of the lower ranking of Dep, epenthesis is a viable strategy, satisfying both

[3] Although I treat the pattern as categorical, speakers with variable reduction can be modeled by using weighted constraints in MaxEnt, as is done in §3.7 for variable pre-vocalic *a*. With the constraint set here, all of the variable patterns in §3.7.1 can be captured.

∗ə.V and Reduce. The established ranking ∗ə.V ≫ Dep ensures that pre-vocalic [ðə] is accompanied by ʔ-epenthesis.

				∗ə.V	Reduce	Dep	Ident(V)	UR = /ej/	UR = /æn/
a.	☛	/ði/+/ɛksmɔɹ/	[ðə ʔ ɛksmɔɹ]	0	0	−1	−1	0	0
b.		/ði/+/ɛksmɔɹ/	[ði ɛksmɔɹ]	0	−1 W	0 L	0 L	0	0
c.		/ði/+/ɛksmɔɹ/	[ðə ɛksmɔɹ]	−1 W	0	0 L	−1	0	0

Table 3.24: [ðə] is used before vowels, along with epenthesis

Under this ranking, reduction is still avoided if the function word cannot be cliticized unto the following word, for example when the article is followed by *um*. This is due to the definition of Reduce, which doesn't assign a violation to an uncliticized function word.

				∗ə.V	Reduce	Dep	Ident(V)	UR = /ej/	UR = /æn/
a.	☛	/ði/+/ʌm/	[ði] ɸ [ʌm]	0	0	0	0	0	0
b.		/ði/+/ʌm/	[ðə] ɸ [ʌm]	0	0	0	−1 W	0	0
c.		/ði/+/ʌm/	[ðə ʔ] ɸ [ʌm]	0	0	−1 W	−1 W	0	0

Table 3.25: Reduction is blocked before disfluencies

The final ranking for Reducers is below.

(46) ∗ə.V ≫ Reduce ≫ Dep ≫ UR = /ej/ ≫ UR = /æn/

Reduce ≫ Ident(V)

The ranking above is able to account for the distribution of *a(n)*, ʔ-epenthesis, and *the* reduction. The difference between Reducers and Thee Users follows straightforwardly from the ranking of Dep and Reduce.

3.5.5 Don't block reduction for a

The fact that *the* avoids reduction before vowels begs the question: why doesn't the same thing happen with *a*? This problem is pointed out by Pak (2014), who uses it to argue for subcategorization frames.

(47) *an* before vowels, never *a*

a. *[ej] answer

b. [ən] answer

In the Buckeye results, we find *a answer* in speech errors, but these are extremely rare (§3.4). There needs to be some way to force *an* to be used, even though [ej] can avoid a hiatus.

The answer here is straightforward. Since different URs and reduction are considered in parallel, [ej] always competes alongside [ən] in the candidate set. In the competition between the two, [ən] is chosen over [ej] because it avoids both a violation of ∗ə.V and a violation of Reduce. In the tableau below, [ən] wins so long as Reduce ≫ UR = /ej/. The ranking Reduce ≫ UR = /ej/ is consistent with both the grammars of Thee Users and Reducers from the last sections.

				*ə.V	Dep	Reduce	UR = /ej/	UR = /æn/
a.	☛	/æn/+/ɛksmɔɹ/	[ən ɛksmɔɹ]	0	0	0	−1	0
b.		/æn/+/ɛksmɔɹ/	[æn ɛksmɔɹ]	0	0	−1 W	−1	0
c.		/æn/+/ɛksmɔɹ/	[ən ʔ ɛksmɔɹ]	0	−1 W	0	−1	0
d.		/ej/+/ɛksmɔɹ/	[ə ɛksmɔɹ]	−1 W	0	0	0 L	−1 W
e.		/ej/+/ɛksmɔɹ/	[ej ɛksmɔɹ]	0	0	−1 W	0 L	−1 W
f.		/ej/+/ɛksmɔɹ/	[ə ʔ ɛksmɔɹ]	0	−1 W	0	0 L	−1 W

Table 3.26: [ən] (candidate a) beats [ej] (candidate e)

To summarize, pre-vocalic [ej] isn't an option because reduced [ən] is available in the candidate set. This analysis relies on the fact that UR selection and reduction are evaluated in parallel in URC. If reduction occurred after UR selection, the constraint ∗ə.V would be insufficient to choose between [ej]*exmoor* and [æn]*exmoor*.

3.5.6 Learning the ranking

A unique property of URC is that defaulthood follows solely from constraint ranking: the default is simply the UR with the highest ranked UR constraint. A favorable result of this property is that learning defaulthood is as simple as learning a ranking of constraints (§2.4.2).

The rankings from the previous sections can be straightforwardly learned with a learning algorithm such as Recursive Constraint Demotion (Tesar and Smolensky 1998, 2000), which is able to find a ranking of constraints that picks out the winner from each tableau, if such a ranking exist.

If the learner is provided the tableaux from the previous sections – with URs, SRs, and violation profiles – it will correctly learn that UR = /ej/ ≫ UR = /æn/, along with the rest of the ranking. Crucially, the learner doesn't need to be supplied with the fact that *a* is the default.

I should emphasize that the learner is provided the correct URs. It doesn't need to determine, for example, whether the UR for [ən] is /ən/ or /æn/ or /æ/ and so on. Although I abstract from the hidden structure problem here, UR constraints *can* be used to learn URs, at the same time as learning alternations and defaults (Pater et al. 2012). In fact, UR constraints and the closely related Lexical Constraints of Boersma (2001) were originally proposed as a solution to the hidden structure problem.

3.6 Alternatives

The analysis so far can account for the similarities between PCA and repairs, and it can do so under a single, learnable ranking of constraints. The alternatives to URC can't do this: Priority constraints lack in learnability; morpheme-specific phonology can't capture PCA and repairs under a single ranking; and subcategorization misses the generalization that PCA and repairs are driven by the same phonological constraints.

In this section, I consider each of these in turn.

3.6.1 Priority constraints

In URC, learning that a UR is the default is straightforward, since defaulthood follows solely from a ranking of constraints. This sets URC apart from other models of defaulthood, in which defaulthood comes from a mechanism external to the ranking, such as the order of URs in the input.

One such model uses Priority constraints (Bonet, Lloret, and Mascaró 2003, 2007; Mascaró 2007). Under the Priority model, UR selection is determined by the phonological grammar. The input to phonology consists of an ordered list of URs, and the constraint Priority favors using the default. The short definition of Priority is below.

(48) PRIORITY

Respect lexical priority (ordering) of allomorphs.

A crucial part of this proposal is the listing of URs in the input. The PRIORITY constraint itself is indifferent to individual URs, instead favoring the use of a default whenever one exists. By itself, the constraint ranking says nothing about whether there's a default, or what the default is.

A PRIORITY analysis of *a(n)* is presented below. In general, a URC analysis can be replaced by a PRIORITY analysis, as long as the relevant UR constraints are next to each other in the ranking and a listing of URs is provided.

(49) A PRIORITY account of *a* and *an*

a. Listing of URs: a > an

b. Ranking of constraints: $*$ə.V $\gg$ PRIORITY

For a model like PRIORITY, finding an analysis requires setting two parameters: a ranking of constraints and the ordering of URs. If we don't already the ordering of URs, how do we determine it? One way is to try learning a ranking of constraints for every possible ordering..

While this is straightforward for two URs with a categorical distribution, it becomes less straightforward in systems which contain many instances of allomorphy, such as French liaison discussed in Chapter 4, or systems with variation, in which the preferences between URs are not categorical.

URC provides a solution to this problem. Learning the default in URC is as simple as learning the ranking, a problem which already has many solutions in the literature. In the case of variation, if we move to a theory with weighted constraints, URC is able to learn the weights of UR constraints, capturing non-categorical preferences (§3.7).

3.6.2 Morpheme-specific phonology

The alternation between *a* and *an* is often analyzed as PCA with multiple URs, since there is no external evidence for /n/-deletion after consonants or [n]-epenthesis between vowels.

One might argue, though, that external evidence for deletion or epenthesis isn't necessary if morpheme-specific phonology is permitted in the grammar. Morpheme-specific phonology has been argued in the form of lexically-restricted rules in SPE (minor rules), and in OT as the result of lexically-indexed constraints (Fukazawa 1997; Pater 2010) or co-phonologies (Orgun 1996; Inkelas and Zoll 2007).

For cases such as [ə] and [ən], in which allomorphs are so similar, it's often difficult to distinguish between PCA and morpheme-specific rules or constraints. The discussion here addresses this issue head on by considering the steps required for an OT analysis of n-epenthesis.

In this section, I review the rule-based analysis and then consider morpheme-specific epenthesis in OT under three different theories: lexical indexation of markedness, lexical indexation of faithfulness, and co-phonologies. The problem for these accounts is the existence of other repairs: it's difficult to produce a ranking that favors n-epenthesis in the case of *a* but ʔ-epenthesis elsewhere, or a ranking that avoids hiatus by using the strong form of *the* but n-epenthesis for *a*.

3.6.2.1 Minor rule

Earlier rule-based analyses, such as Vennemann (1974) and Rotenberg (1978), pursue the idea of morpheme-specific epenthesis, positing morpheme-specific n-deletion and n-epenthesis, respectively.

Following Rotenberg, I only consider epenthesis here. Rotenberg treats /ə/ as the underlying form in his rule-based account, since *a* occurs before parentheticals and is acquired before *an*. These are some of the same reasons that I treat /ej/ as the default in the URC account (§3.3).

A rule of determiner-specific n-epenthesis is below.[4]

(50) $\text{Ø} \rightarrow [\text{n}] \;/\; \text{a}]_{\text{D}}\_\_$

The rule above can account for the distribution of [ə] and [ən]. It's also compatible with both reduction and epenthesis, which can be represented by separate rules.

The problem for this account is the strong forms of *a* and *an*: [ej] and [æn]. In addition to n-deletion or n]-epenthesis, deriving both requires morpheme-specific vowel raising /æ/ → [ej] or lowering /ej/ → [æ]. This is equally a problem for the the OT accounts in the next sections.

In the next sections, I show that implementing morpheme-specific phonology in OT is much more difficult. In the following analyses, I set aside the difference between vowels in the strong forms [ej] and [æn], and focus on the [n] alternation. Given the arguments for /ej/ as the default form, I only consider an account with morpheme-specific n-epenthesis.

3.6.2.2 Lexically indexed constraints

Lexically indexed constraints provide an OT implementation of morpheme-specific phonology. Under this type of account, faithfulness constraints (Fukazawa 1997) or markedness constraints (Pater 2010) are indexed to specific lexical items, or sets of lexical items. An indexed constraint is only violated if the corresponding lexical item is part of the locus of violation.

For the simplest set of *a(n)* data, both indexed faithfulness and markedness are viable. However, with the addition of reduction and epenthesis, the two accounts

[4]This is actually different from Rotenberg's analysis, which requires a few other rules and filters for syllabification.

fall short. Indexed markedness fails to capture the conspiracy between the different repairs and PCA, and indexed faithfulness can't capture repairs and PCA under a single ranking.

Indexed markedness. To capture the fact that epenthesis only occurs with /ə/, one might posit a markedness constraint that applies only to *a*.

(51) $*$ə.V_A: Assign one violation for every sequence of two vowels, where one of the vowels belongs to the word *a*.

If this constraint is ranked above DEP(n), we get n-epenthesis but only between *a* and a V-initial word.

(52) $*$ə.$V_A \gg$ DEP(n)

The first problem for this account is the amount of external evidence for general $*$ə.V in English (§3.2), such as reduction, epenthesis, and stem suppletion. A lexically-indexed $*$ə.V misses the generalization that $*$ə.V is active throughout English.

The second problem is that the addition of ʔ-epenthesis leads to serious ranking paradoxes. To obtain ʔ-epenthesis in words like *soda-y*, we might add another $*$ə.V constraint that doesn't apply to *a* and *an*.

(53) DEP(n) $\gg$ $*$ə.$V_{NOT\ A} \gg$ DEP(ʔ)

The ranking above obtains ʔ-epenthesis for *soda-y*, but to prevent ʔ-epenthesis for *a*, the contradictory ranking below is necessary.

(54) DEP(ʔ) $\gg$ $*$ə.$V_A \gg$ DEP(n)

These two rankings are incompatible. With lexically-indexed markedness constraints alone, there is no way to get n-epenthesis for *a* and ʔ-epenthesis elsewhere.

The difference between the lexically-specific rule and the lexically-indexed constraint analysis is that the rule specifies the preferred repair. For the rule, it's easy to capture the fact that [n] is epenthesized for *a*, while [ʔ] is epenthesized elsewhere. For the constraint-based analysis, ∗ə.V is indifferent to how it's repaired, and the choice of epenthetic consonant follows from the constraint ranking. To obtain ʔ-epenthesis in one case but n-epenthesis in another, we need two different rankings of the same faithfulness constraints.

Indexed faithfulness. Like indexed markedness, indexed faithfulness faces a ranking paradox with the full set of data. While it can capture both n-epenthesis and ʔ-epenthesis, it cannot capture them together with reduction.

The difference between ʔ-epenthesis and n-epenthesis comes from the indexed faithfulness constraint below, which can be used to block ʔ-epenthesis in *a*. As a result, n-epenthesis is used instead. To make the analysis possible, I assume that epenthetic consonants are part of the preceding lexical item. The constraint below is violated when epenthesis occurs after *a*.

(55) Dep-[ʔ]$_A$

Assign one violation for every [ʔ] in the output without an input correspondent, if the [ʔ] follows the morpheme *a*.

The ranking of ∗ə.V over Dep gives ʔ-epenthesis, assuming that [ʔ] is the least marked epenthetic segment. Under this ranking, ʔ-epenthesis is the general hiatus resolution strategy in English.

	∗ə.V	Dep-[ʔ]$_A$	Dep
☛ mora [ʔ] ize	0	0	0
mora ize	−1 W	0	0 L

Table 3.27: Indexed faithfulness: ʔ-epenthesis as the general hiatus resolution strategy

As the tableau below shows, the indexed constraint blocks ʔ-epenthesis for *a*, resulting in n-epenthesis. For this to work, [n] must be less marked than other epenthetic consonants, such as [t] and [s].

	*ə.V	Dep-[ʔ]$_A$	Dep
☛ a [n] apple	0	0	−1
a [ʔ] apple	0	−1 W	−1
a apple	−1 W	0	0 L

Table 3.28: Indexed faithfulness: ʔ-epenthesis is blocked

Reduction can be added to this analysis with the constraint Reduce. Assuming the UR /ej/, reduction occurs when Reduce dominates Ident(V). To prevent the candidate [ej]*apple* from winning, the constraint Reduce must be ranked over Dep.

	*ə.V	Dep-[ʔ]$_A$	Reduce	Ident(V)	Dep
☛ [ə] [n] apple	0	0	0	−1	−1
[ə] [ʔ] apple	0	−1 W	0	−1	−1
[ə] apple	−1 W	0	0	−1	0 L
[ej] apple	0	0	−1 W	0 L	0 L

Table 3.29: Indexed faithfulness: reduction and *a*

The problem arrises when we add *the* to the analysis. The ranking above predicts that [ʔ] should also be epenthesized for *the*, since epenthesis is preferred to non-reduction. If we want pre-vocalic [ði] to be optimal, Dep must dominate Reduce.

The ranking paradox is shown below. There is no ranking in which all of the desired winners are optimal. For this to be the case, there must be some ranking in which every L is to the right of some W.

		$*$ə.V	DEP-[ʔ]$_A$	REDUCE	IDENT(V)	DEP
☛	[ə] [n] apple	0	0	0	−1	−1
	[ə] [ʔ] apple	0	−1 W	0	−1	−1
	[ə] apple	−1 W	0	0 L	−1	0 L
	[ej] apple	0	0	−1 W	0 L	0 L
☛	[ði] apple	0	0	−1	0	0
	[ðə] [n] apple	0	0	0 L	−1 W	−1 W
	[ðə] [ʔ] apple	0	0	0 L	−1 W	−1 W
	[ðə] apple	−1 W	0	0 L	−1 W	0

Table 3.30: Indexed faithfulness: A ranking paradox with *the* and *a*

Without PCA, there is no distinguish *the* from *a*. If epenthesis and reduction occur for *a*, they will also occur for *the*. On the other hand, if we rank the constraints so that reduction is blocked for *the*, it will also be blocked for *a*.

These problems are avoided in the PCA analysis since there is only one kind of epenthesis. A [n] occurs in *a(n)* because it's part of the UR /æn/, and [n] is never a possibility for *the*, since there's no UR /ðin/.

3.6.2.3 Cophonologies

Under a theory of cophonologies, different lexical strata are subject to different constraint rankings. We could imagine that *a* and *an* are subject to a different constraint ranking, in which n-epenthesis is preferred.

(56) Ranking for a/an: DEP(ʔ) ≫ $*$ə.V ≫ DEP(n)

(57) Ranking for others: DEP(n) ≫ $*$ə.V ≫ DEP(ʔ)

The problem is that n-epenthesis and ʔ-epenthesis can occur in the very same phrase. This is shown in the example below, which describes someone who believes in aura reading.

(58) an aura[ʔ]ist

For n-epenthesis to occur, *a* and *aura* must be evaluated by the *a*-specific ranking, while ʔ-epenthesis requires *aura* and *ist* to be evaluated by the general ranking. This presents a problem for the indefinite article, which is torn between two rankings.

Variation presents another challenge. Later I present data showing that some speakers use both *a* and *an* before vowels. These speakers always accompany pre-vocalic *a* with ʔ-epenthesis.

(59) Examples from a speaker who varies between *a* and *an*

a. an apple

b. a[ʔ] apple

For a speaker to use both strategies, *a apple* must be assessed under both grammars. This isn't necessarily a problem, but it does weaken the argument that *a* is special because it's subject to a different phonology. Given data like these, *a* is only sometimes special, and the rest of the time, it is a well-behaved member of English phonology.

3.6.2.4 Conclusion

To conclude, while morpheme-specific epenthesis is relatively straightforward with a minor rule, it faces a complicated and unintuitive analysis in OT.

Finding a ranking for the full set of data – including reduction and ʔ-epenthesis – is possible in the PCA analysis, but not with morpheme-specific phonology.

3.6.3 Subcategorization

A final alternative to URC is subcategorization. Under this approach, the choice between *a* and *an* is driven by a subcategorization frame specific to *an*, which requires *an* to occur before V-initial words.

(60) *an* ↔ ___ V

(61) *a* elsewhere

The usual argument against subcategorization is that it fails to capture similarities between PCA and synchronically active constraints. Under subcategorization, any similarities between PCA and repairs are a coincidence, or at least epiphenomena (Wolf 2008).

In URC, we find another argument against subcategorization: an account that uses language-wide constraints requires little additional machinery. If we account for *a(n)* with subcategorization, we still need ∗ə.V to model repairs like reduction and ʔ-epenthesis in English. Since we need markedness constraints anyway, why not use them to model PCA? Similarly, we need something like UR Constraints to encode meaning-UR mappings. Why not use them to model PCA, too?

Unfortunately, the reality is that language-wide constraints can't handle every case of PCA (§2.2.9). But when they can, they are favorable to an approach where PCA follows solely from lexical listing.

3.7 a(n) and variation

So far, the model of *a(n)* and *the* only deals with categorical patterns. The URC analysis accounts for Thee Users (speakers who always use pre-vocalic [ði]) and Reducers (speakers who never do). Both type of speakers always use *an* before vowels and *a* before consonants.

These idealized speakers are far from reality. In the Buckeye results, some speakers use both pre-vocalic *a* and pre-vocalic *an*, and most speakers use pre-vocalic [ðəʔ] about half of the time. When it comes to resolving hiatus, speakers differ in their preferred strategy: some prefer *an*, some prefer ʔ-epenthesis, and some do both equally.

The rest of the chapter extends the account of URC to deal with variation in *a(n)* and ʔ-epenthesis, recasting URC in Maximum Entropy Harmonic Grammar (MaxEnt: Goldwater and Johnson 2003). Under URC in MaxEnt, preferences between repairs and PCA follow from the relative weights of UR constraints, and this can account for differences across speakers with respect to their hiatus-resolution strategies.

The results here depend crucially on the fact that URC is a parallel model. Directly encoding preferences between repairs and URs is possible because repairs and URs are considered together in the candidate set. In this section, I also show that parallelism is necessary to account for the interaction of ʔ-epenthesis and *a(n)*, which is an example of the chicken-egg effect.

3.7.1 ʔ-epenthesis and a(n)

As discussed in §3.2, there are many ways to avoid hiatus in English beyond allomorphy with *a* and *an*. This section focuses on ʔ-epenthesis, which is obligatory between two vowels, especially when V_1 is lax and both vowels are in the same prosodic word.

(62) Contexts with nearly obligatory ʔ-epenthesis

a.	salsa-ing	[sɔlsəʔɨŋ]
b.	samba-ing	[sɑmbəʔɨŋ]
c.	soda-y	[sodəʔi]
d.	zumba-ist	[zumbəʔɨst]

In the earlier URC analysis of *a(n)*, the constraint ranking rules out ʔ-epenthesis after *a*. This is based on the generalization that forms like [əʔ ɛksmoɹ] rarely occur, always losing to [ən ɛksmoɹ]. This is certainly true in general American and British English, where pre-vocalic *a* is only used 5% of the time.

However, there are many Englishes in which pre-vocalic *a* is common. Britain and Fox (2009) cite a number of these cases, including the English of Bolton in the North-West of England Shorrocks (1999 p. 45), African American English (Craig et al. 2003), and Afrikaans English in South Africa (Watermeyer 1996 p. 118). Britain and Fox themselves report findings from a survey of the English of Tower Hamlets, London.

Britain and Fox consider *a(n)* in three social groups of Tower Hamlets London: white British girls, white and mixed race boys, and Bangladeshi boys. Their findings are presented in the table below.

White British girls			White / mixed race boys			Bangladeshi boys		
	___ V	___ C		___ V	___ C		___ V	___ C
[ə]	–	100%	[ə]	–	100%	[ə]	–	100%
[əʔ]	5%	–	[əʔ]	25%	–	[əʔ]	76%	–
[ən]	95%	–	[ən]	75%	–	[ən]	24%	–

Table 3.31: Britain & Fox 2009: article use in Central London

There are two strategies to avoid hiatus in Tower Hamlets, [əʔ] or [ən], and groups differ in their preferences between these strategies. White British girls follow the pattern of general American English, nearly exclusively employing *a(n)* allomorphy. ʔ-epenthesis is only used 5% of the time. The other two groups make prolific use of pre-vocalic *a* accompanied by ʔ-epenthesis. While white boys favor hiatus resolution with [ən], they still use [əʔ] 25% of the time. Bangladeshi boys favor hiatus resolution with [əʔ], using it 76% of the time.

Newton and Wells (2002) and Pak (2014) find similar patterns in acquisition. Allomorphy with *a(n)* isn't fully acquired until rather late – 10 years in Pak (2014). At earlier stages, [ə] is often used before vowels, and whenever it is, it's accompanied by ʔ-epenthesis. As children get older, they become more likely to use pre-vocalic *an*, eventually reaching the adult pattern which relies almost exclusively on *an* allomorphy to avoid hiatus.

The table below reports the probabilities of pre-vocalic *a* from Pak (2014)'s survey of CHILDES (MacWhinney 1995).

Age	%*a* (out of *a*+*an*)
3	70%
4	78%
5	64%
6-7	33%
8-9	26%
10-11	5%
Adults	5%

Table 3.32: Pak 2014: use of pre-vocalic *a* in acquisition

Regardless of their preferred strategy, it seems that English speakers always respect ∗ə.V. The finding that ʔ-epenthesis accompanies pre-vocalic *a* is common across corpus studies, and the same is found with pre-vocalic [ðə]. Speakers who reduce *the* before vowels always accompany reduction with ʔ-epenthesis (Keating et al. 1994).

An overview of these studies is presented in the table below, which shows the percentage of *an* and [ði] before vowels across varieties of English. The table includes data from sociolinguistic studies: – (Britain and Fox 2009) for London and (Guzzo, Britain, and Fox 2007) for Italian English in Bedford – and acquisition: (Pak 2014).

Together with the Buckeye results from §3.4, these form a rich typology of *a(n)* and *the*.

Group	%[ən]	%[əʔ]	%[ði]	%[ðəʔ]	Region & Source
White girls	97	3	100	0	Central London
White boys	75	25	65	35	(Britain & Fox 2009)
Bangladeshi boys	24	76	19	71	
Italian English (2nd gen.)	100	0	90	10	Bedford
Italian English (3rd gen.)	54	45	40	60	(Guzzo et al. 2007)
Speaker #14	95	5	95	5	Buckeye corpus, Ohio
Speaker #17	98	2	50	50	(see §3.4)
Speaker #28	95	5	20	80	
GAE 3 yos	30	70	41	59	
GAE 4 yos	22	78	38	62	CHILDES corpus
GAE 5 yos	36	64	61	39	(from Pak 2014)
GAE 6-7 yos	67	33	77	23	
GAE Adults	95	5	90	10	

Table 3.33: Distribution of pre-vocalic articles across corpus studies

Across all descriptions of the (in)definite article, there are three common generalizations.

- *a* and [ðə] are categorically preferred before consonants.
- *an* and [ði] are always more likely before vowels than consonants.
- Pre-vocalic *a* and [ðə] are always accompanied by ʔ-epenthesis.

The next sections present a probalistic model that can account for the interaction of *a* and ʔ-epenthesis, focusing on these generalizations. The model makes rich use of parallelism and UR constraints: in order to model the interaction of epenthesis and *a(n)* across Englishes, UR selection must occur in parallel with repairs, while UR constraints provide a way to encode preferences between different strategies for hiatus avoidance.

3.7.2 Introduction to Maxent

In earlier sections, URC is couched in Optimality Theory, in which constraints are ranked and a single candidate is optimal (Prince and Smolensky 1993/2004). An alternative model is one in which constraints are weighted, such as Maximum Entropy Harmonic Grammar (MaxEnt: Goldwater and Johnson 2003). Unlike OT, MaxEnt outputs a probability distribution over candidates.

In MaxEnt, each constraint is assigned a numerical weight. Weighted violations are summed for each candidate, resulting in a harmony score for the candidate. The harmonies are then normalized across a candidate set, resulting in a probability distribution across candidates. The probability of each candidate is proportional to the exponential of its weighted sum penalty. In the resulting probability distribution, candidates with a lower harmony score receive less probability.

This is illustrated in the tableau below, which contains the constraint violations and candidates from §2.3. In the tableau, I've added weights, and a harmony score (H). The harmony score for each candidate is calculated by summing its weighted constraint violations. Since violations are negative, and weights are positive, harmony scores are negative.

			*Hiatus	Dep	UR = /ej/	UR = /æn/	
			w = 24	w = 13	w = 14	w = 2	H
a.	/æn/+/ɛksmoɹ/	[ən ɛksmoɹ]	0	0	−1	0	−14
b.	/ej/+/ɛksmoɹ/	[ə ɛksmoɹ]	−1	0	0	−1	−26
c.	/ej/+/ɛksmoɹ/	[ə ʔ ɛksmoɹ]	0	−1	0	−1	−15

Table 3.34: Example of MaxEnt violations and weights

The table below shows how these harmony scores are transformed into probabilities. First, the scores are exponentiated. Then, each score is divided by the sum of all the candidates' exponentiated harmony scores. As a result, the probability of each candidate (in boxes below) is proportional to its exponentiated score.

	Candidates	H	exp(H)	Probability	
a.	[ən ɛksmoɹ]	−14	8.32E − 07	0.73	$\left(\frac{8.32\text{E}-07}{1.4\text{E}-06}\right)$
b.	[ə ɛksmoɹ]	−26	5.11E − 12	<0.01	$\left(\frac{5.11\text{E}-12}{1.4\text{E}-06}\right)$
c.	[ə ʔ ɛksmoɹ]	−15	3.06E − 07	0.26	$\left(\frac{3.06\text{E}-07}{1.4\text{E}-06}\right)$

Table 3.35: Deriving probabilities from harmony scores

A benefit to using MaxEnt is that it has a number of well-understood learning algorithms. The learner takes a tableau with candidates and violations, together with target probabilities for those candidates, and finds the set of weights that gets closest to the target probabilities.

There are many algorithms and software implementations that can do this, and in the following sections I use the MaxEnt Grammar Tool (Wilson and George 2008). In all of the MaxEnt grammars here, the weights were started at 0, and to prevent weights from climbing too high, an L2 (Gaussian) prior was used (Tychonoff and Arsenin 1977), with sigma^2 = 10,000.

3.7.3 A Maxent analysis of the probabilistic pattern

In this section, I show how weighted constraints can capture the PCA and epenthesis patterns from Britain and Fox (2009).

In URC, preferences between non-default URs and repairs come from the ranking of UR constraints and faithfulness constraints. If a faithfulness constraint dominates the relevant UR constraint, the UR beats the repair. Under the opposite ranking, the repair wins out. A demonstration of this can be found in §2.2.5.

In MaxEnt, finer degrees of preference come from weighting UR constraints with respect to faithfulness. In this section, I assume the four constraints from the analysis in chapters 2 and 3.

(63) Constraints

a. ∗ə.V

b. Dep

c. UR = /ej/

d. UR = /æn/

The target probabilities are repeated below. Moving left to right, the varieties exhibit a greater preference for epenthesis (more [əʔ]), and a lesser preference for the non-default UR (less [ən]).

White British girls			White / mixed race boys			Bangladeshi boys		
	___ V	___ C		___ V	___ C		___ V	___ C
[ə]	–	1.0	[ə]	–	1.0	[ə]	–	1.0
[əʔ]	.05	–	[əʔ]	.25	–	[əʔ]	.76	–
[ən]	.95	–	[ən]	.75	–	[ən]	.24	–

Table 3.36: Target probabilities for speakers from Tower Hamlets London

A set of weights was found that closely match these probabilities, using the methods detailed in the last section. The learned probabilities are each within 0.05 of the target probabilities, so I don't report them here. The learned weights are below.

Moving left-to-right, the weight of DEP decreases, while the weight of UR = /ej/ increases. As a result, epenthesis becomes more likely, and the non-default UR becomes less likely, matching the probabilities above.

White British girls		White / mixed race boys		Bangladeshi boys	
Constraint	Weight	Constraint	Weight	Constraint	Weight
∗HIATUS	23.21	∗HIATUS	23.82	∗HIATUS	23.30
DEP	14.96	DEP	12.95	DEP	12.11
UR = /ej/	12.97	UR = /ej/	14.16	UR = /ej/	15.23
UR = /æn/	0.96	UR = /æn/	2.31	UR = /æn/	0.96

Table 3.37: Learned weights

The learned weights aren't perfectly straightforward. In addition to the changes in DEP and UR = /ej/, the weights of ∗ə.V and UR = /æn/ also differ across speakers. To make things clearer, the table below presents the harmony scores for each candidate given the learned weights. Moving left-to-right, we can see that the difference in harmony between [əʔ] and [ən] first decreases, and then then reverses. For Bangladeshi boys, [ən] is preferred to [əʔ]

White British girls			White / mixed race boys			Bangladeshi boys		
	___ V	___ C		___ V	___ C		___ V	___ C
[ə]	-24.2	-0.96	[ə]	-26.1	-2.31	[ə]	-24.3	-0.96
[əʔ]	-15.9	-15.9	[əʔ]	-15.3	-15.3	[əʔ]	-13.1	-13.1
[ən]	-13.0	-14.2	[ən]	-14.2	-14.2	[ən]	-15.2	-15.2

Table 3.38: Harmony scores for each candidate

In summary, modeling preferences between epenthesis and *an* is possible because the URs for *a* and *an* are encoded as weighted constraints. Adjusting the relative weights of UR = /ej/ and Dep changes the strength of the default. This is possible because the candidate set considers both hiatus-avoiding strategies at once.

In the next section, I consider a derivational account of *a(n)* allomorphy and ʔ-epenthesis, arguing that a parallel account is necessary.

3.7.4 Parallelism in a(n)

The interaction of ʔ-epenthesis and *a(n)* is an example of the chicken-egg effect. ʔ-epenthesis is conditioned by UR selection, and vice versa.

(64) The chicken-egg effect in article selection and ʔ-epenthesis

a. ʔ-epenthesis must precede UR selection, since the choice of pre-consonantal *a* is conditioned by the epenthetic [ʔ]

b. UR selection must precede ʔ-epenthesis, since intervocalic ʔ-epenthesis is triggered by the choice of *a*

An alternative approach to dealing with interactions such as ʔ-epenthesis and *a(n)* allomorphy is what I call a *leap of faith* derivational analysis. Under this type analysis, UR selection proceeds blindly, creating marked structure. Later, this marked structure is repaired.

Under a leap of faith analysis, *a* occurs some proportion of the time before vowels, without any lookahead to ʔ-epenthesis. Whenever pre-vocalic *a* occurs, the resulting hiatus is resolved by an independent process of ʔ-epenthesis. The differences between Tower Hamlets Bangladeshi boys and white girls is simply the likelihood that they use pre-vocalic *a*. This account can capture the fact that *a* occurs before vowels, and it can capture the fact that ʔ-epenthesis is a general repair for hiatus.

The problem is that it divorces *a(n)* selection and ʔ-epenthesis: each is an independent process, indifferent to the other. This is a problem because it seems that *a(n)* selection and ʔ-epenthesis are closely tied together. Britain and Fox (2009) note that ʔ-epenthesis is replacing intrusive r as the preferred hiatus resolution strategy in many dialects of English, and suggest that the increasing preference for ʔ-epenthesis is the reason why pre-vocalic *a* is on the rise. A speaker uses more pre-vocalic *a* because ʔ-epenthesis is more readily available a repair.

Support for the relationship between pre-vocalic *a* and epenthesis comes from the definite article *the*. Like *a(n)*, *the* is conditioned by the following context – with [ði] before vowels, and [ðə] before consonants. Interestingly, for the groups studied in Britain and Fox, the rates of pre-vocalic *a* and *an* roughly match the rates of pre-vocalic [ðə] ~ [ði]. Speakers with pre-vocalic [əʔ] tend to use pre-vocalic [ðəʔ]. The same relationship can be observed at all stages of acquisition in Newton and Wells (2002) and Pak (2014),

Why should the use of pre-vocalic [əʔ] entail the use of pre-vocalic [ðəʔ]? Britain and Fox argue that they are connected by ʔ-epenthesis. As ʔ-epenthesis becomes regularized, both pre-vocalic [ðəʔ] and [əʔ] become preferred to pre-vocalic [ði] and [ən].

The leap of faith analysis treats *a(n)* and ʔ-epenthesis as separate: there's no reason that the use of pre-vocalic *a* should relate either to the preference for ʔ-epenthesis over intrusive r, or the use of pre-vocalic [ðə].

In the URC account, the rate of pre-vocalic *a* is a direct consequence of the relative weights of the UR constraints, ∗ə.V, and Dep. If we keep the weights of the other constraints constant, and lower the weight of Dep, the probability of pre-vocalic *a* increases. Let's assume the weights for the other constraints are equal to the weights from the analysis of a Tower Hamlets Bangladeshi boy.

Constraint	Weight
∗Hiatus	23
UR = /æn/	2
UR = /eɪ/	15

Table 3.39: Fixed weights for constraints

Taking the weights above as fixed, varying the weight of Dep gives the probabilities of pre-vocalic *a* below.

w(Dep)	p([əʔ]) ~ p([ən])
10	0.95 ~ 0.05
11	0.88 ~ 0.12
12	0.73 ~ 0.27
13	0.50 ~ 0.50
14	0.27 ~ 0.73
15	0.12 ~ 0.88
16	0.05 ~ 0.95

Table 3.40: Pre-vocalic articles under different weights of Dep (keeping other constraint weights equal)

These probabilities resemble the acquisition data from Pak (2014), repeated below. The difference between a 3- and 5-year-old can be modeled as a difference in the weight of Dep. The table below shows what the weight of Dep would be, given the fixed constraint weights above.

Age	p(*a*)	w(Dep)
3	0.70	12.2
4	0.78	11.8
5	0.64	12.4
6-7	0.33	13.7
8-9	0.26	14
10-11	0.05	16
adults	0.05	16

Table 3.41: Probability of *a* in pre-vocalic position under different weights of Dep

The increasing weight of Dep above also correctly predicts that the rate of pre-vocalic [ðəʔ] will decrease, all else being equal.

In summary, under the URC analysis, an increase in pre-vocalic *a* follows from the increasing availability of ʔ-epenthesis. This is supported by the replacement of intrusive r with epenthetic [ʔ], and pre-vocalic [ðəʔ], which tracks [əʔ]. In a derivational analysis in which UR selection and epenthesis are independent, any connection between epenthesis and pre-vocalic *a* is a coincidence.

3.8 Chapter 3 conclusion

This chapter provided a case study of the indefinite article, supporting the claim that PCA is driven by language-wide constraints in a parallel model of phonology and morphology. The constraint conditioning *a(n)* – ∗ə.V – is active throughout English, as evidenced by a number of different repairs. The active phonological conditioning of *a(n)* can also be observed in its interaction with h-deletion and ʔ-epenthesis. In both cases, *a(n)* accommodates the output of repairs, and may trigger the repairs as well.

These data are modeled with UR constraints, which can account for defaulthood, phonological conditioning, and preferences between repairs and non-default URs. In the case of *a(n)*, corpus evidence supports the analysis of *a* as default, independent repairs support ∗ə.V, and the interaction of repairs and *a(n)* can be seen in ʔ-epenthesis and reduction.

All of these generalizations – defaulthood, phonological conditioning, PCA-repair interactions – follow from ranking or weighting a set of constraints. As a result, these properties can be learned using pre-existing learning algorithms, either in OT or MaxEnt.

CHAPTER 4

FRENCH LIAISON

4.1 Overview of Chapter 4

Chapter 4 presents a second case study in URC: French pre-nominal liaison. French liaison is similar to *a* and *an* in English. There are words with two forms, one C-final ([pœtit]) and one V-final ([pœti]): the C-final form occurs before vowels, and the V-final form occurs before consonants.

(1) PCA in French liaison: *petit*

a.	Listed URs:	/pœti/ and /pœtit/
b.	Conditioning:	[pœti] before consonants
		[pœtit] before vowels
c.	Examples:	[pœti gaʁsɔ̃] 'small boy'
		[pœtit ɔm] 'small man'

Like the other case studies, French liaison is analyzed as PCA, driven by a language-wide constraint. Liaison is lexically restricted and highly idiosyncratic. Only some words undergo liaison, and words differ as to whether the C-final or V-final word are default. I show that using UR constraints for French liaison can account for these properties.

The chapter is outlined as follows.

In §4.2, I provide some background on liaison. These data are used in §4.3 to argue that liaison is the result of PCA, and not epenthesis or deletion. In §4.4, I give a

URC analysis of liaison in adjectives like *petit* above. In this analysis, PCA is driven by the markedness constraint ∗Hiatus.

In the next two sections, I expand this analysis to more cases of liaison, including pre-nominal numerals (§4.5) and Ṽ-final words (§4.6). These cases lend themselves to analysis in URC. In numerals, defaults differ on a word-by-word basis, and these differences can be captured by ranking UR constraints. In Ṽ-final words, PCA interacts with a process of n-epenthesis, and this follows from the ranking of UR constraints and faithfulness. Ṽ-final words also provide another case of variation.

In §4.7, I show that ∗Hiatus, the constraint used throughout the chapter, is independently attested in French. Finally, §4.8 considers an alternative account of liaison with gender suppletion.

The bullet points below summarize how each result of URC is supported in the chapter.

- **Language-wide constraints condition PCA**: hiatus is independently avoided in French (§4.7). The same constraint Hiatus(Ṽ.V)<!– drive both PCA and repairs (§4.6).

- **UR Selection considers the output**: liaison conspires with n-epenthesis, and the choice between them requires parallelism (§4.6).

- **Defaults emerge from ranking**: defaulthood is unpredictable in numerals (§4.5) and Ṽ-final words (§4.6).

The account of Ṽ-final liaison in §4.6 and the account of numerals in §4.5 both diverge from the standard analysis of liaison. The analysis of Ṽ-final liaison treats it as a combination of PCA and epenthesis, which is empirically well-motivated, and possible given the parallel architecture of URC. The analysis of numerals provides an argument for treating liaison as PCA, and argues against an account with floating consonants, such as Tranel (1995).

4.2 Background on liaison

French liaison is a well-known phenomenon, in which the final consonant of a word alternates with zero. The final consonant of a liaison-undergoing word is pronounced before a vowel, but not before a consonant (for an overview, see Dell 1973, Tranel 1987, or Côté 2012). The pair *petit homme* and *petit garçon* are a straightforward example. C-final [pœtit] occurs before vowels, and V-final [pœti] occurs before consonants. The symbol ‿ shows when a liaison consonant is pronounced.

(2) C-final / ___ V

a.	un petit ‿ homme	[ɛ̃ pœtit ɔm]	'a short man'
b.	un grand ‿ homme	[ɛ̃ gʁɑ̃t ɔm]	'a tall man'
c.	huit ‿ hommes	[ɥit ɔm]	'eight men'

(3) V-final / ___ C

a.	un petit garçon	[ɛ̃ pœti gaʁsɔ̃]	'a short boy'
b.	un grand garçon	[ɛ̃ gʁɑ̃ gaʁsɔ̃]	'a tall boy'
c.	huit garçons	[ɥi gaʁsɔ̃]	'eight boys'

Typically, liaison consonants are unpronounced phrase-finally.

(4) V-final / ___ $]_{Ph}$

a.	il est petit	[il ɛ pœti]	'he's short'
b.	il est grand	[il ɛ gʁɑ̃]	'he's tall'

Numerals are an exception For these, whether the final consonant is pronounced at the end of a phrase depends on the word. Some numerals (e.g. *huit*) have pronounced final consonants, while others (e.g. *vingt*) do not.

(5) C-final / ___ $]_{Ph}$

a.	il en a huit	[il ɑ̃n a ɥit]	'he has eight'

b.	il en a vingt	[il ɑ̃n a vɛ̃]	'he has twenty'

These cases are discussed at length in §3.5. The differences between *huit* and *vingt* can be captured straightforwardly with UR constraints.

Dozens of words undergo liaison, and liaison words can belong to nearly any syntactic category, including adjectives, determiners, nouns, verbs, and prepositions. I focus on adjectives and numerals here.

Types of alternations. In addition to an alternating consonant, some liaison words also contain an alternating vowel. In the examples below, we find [ɛ] alternating with [o] in *bel~beau*, [ɛ] alternating with [œ] in *cet~ce*, and [ɔ̃] alternating with [ɔ] in *bon*.

(6) Liaison alongside vowel alternations

a.	un bel homme	[ɛ̃ bɛl ɔm]	'a handsome man'
b.	un beau garçon	[ɛ̃ bo gaʁsɔ̃]	'a handsome boy'
c.	cet homme	[sɛt ɔm]	'that man'
d.	ce garçon	[sœ gaʁsɔ̃]	'that boy'
e.	un bon homme	[ɛ̃ bɔn ɔm]	'a good man'
f.	un bon garçon	[ɛ̃ bɔ̃ gaʁsɔ̃]	'a good boy'

For the most part, the allomorphs of a liaison word differ in whether they end in a consonant or vowel, e.g.. [pœti~pœtit], but there are also liaison words in which the two forms end in VCC and VC. In these words, VCC occurs before vowels, and VC occurs before consonants.

(7) Liaison with VC~VCC alternation

a.	courte/court	[kuʁt(œ)~kuʁ]	'short'
b.	fourte/fort	[fɔʁt(œ)~fɔʁ]	'strong'
c.	lourde/lourd	[luʁd(œ)~luʁ]	'heavy'
d.	ils	[ilz~il]	'they (masc.)'

e.	elles	[ɛlz~ɛl]	'they (fem.)'

In these cases, liaison interacts with epenthesis. The [(œ)] above is an epenthetic vowel, employed when the VCC-final form occurs before consonants (Féry 2004).

Lexical restrictions and tendencies. Liaison is highly idiosyncratic. It only occurs with certain words, and for those words, the liaison consonant is unpredictable. This is the main reason I argue that it's PCA in the next section.

Not every word in French undergoes liaison. Many words – both consonant- and vowel-final – have just one form across all contexts.

(8) Non-alternating adjectives

a.	joli homme	[ʒɔli ɔm]	'pretty man'
b.	joli garçon	[ʒɔli gaʁsɔ̃]	'pretty boy'
c.	jeune homme	[jøn ɔm]	'young man'
d.	jeune garçon	[jøn gaʁsɔ̃]	'young boy'

A list of more singular non-alternating adjectives, taken from Féry (2004), is reproduced below.

(9) Non-alternating singular adjectives (Féry 2004)

a.	honnête	[ɔnɛt]	'honest'
b.	humide	[ymid]	'humid'
c.	correct(e)	[kɔʁɛkt]	'correct'
d.	calm	[kalm]	'quiet'
e.	jaune	[ʒon]	'yellow'
f.	fatigué	[fatige]	'tired'
g.	oblique	[ɔblik]	'oblique'
h.	rouge	[ʁuʒ]	'red'
i.	alerte	[alɛʁt]	'alert'

j.	pauvre	[povʁ]	'poor'
k.	noir(e)	[nwaʁ]	'black'
l.	poli(e)	[pɔli]	'polite'

Feminine adjectives are almost always C-final, and never alternate, C-final or not. This is true even for feminine versions of liaison-undergoing masculine adjectives. While masculine *beau* ([bo]) alternates with *bel* ([bɛl]), feminine *belle* ([bɛl]) does not alternate at all.

(10) Feminine adjectives don't alternate

a.	belle baguette	[bɛl bagɛt]	'beautiful baguette'
b.	belle forchette	[bɛl fɔʁʃɛt]	'beautiful fork'
c.	belle omelette	[bɛl ɔmlɛt]	'beautiful omelette'
d.	belle assiette	[bɛl asjɛt]	'beautiful plate'
e.	elle est belle	[ɛl ɛ bɛl]	'she's beautiful'

Liaison isn't restricted to masculine words. Feminine determiners, unlike adjectives, can undergo liaison, as shown below. Each of the determiners has two forms – one C-final and one V-final – conditioned in the usual way.

(11) Alternating feminine determiners (all nouns are feminine)

a.	ma figure	[ma figyʁ]	'my figure'
b.	mon image	[mɔ̃n imaʒ]	'my image'
c.	sa figure	[sa figyʁ]	'his figure'
d.	son image	[sɔ̃n imaʒ]	'his image'
e.	ta femme	[ta figyʁ]	'your figure'
f.	ton image	[tɔ̃n imaʒ]	'your image'

For the words that undergo liaison, the alternating consonant is unpredictable. There's no way to determine whether a word will have an alternating [l] or [p] or

[z], and so on. The only good predictor is spelling – orthographic t-final words, for example, almost always have [t] as a liaison consonant. There are also tendencies among liaison consonants: most liaison words have [z], [t], or [n]. There are only a few words with other consonants, e.g. [ʁ] in *dernier*, [l] in *bel*, [j] in *gentil*, [p] in *beaucoup*, [k] in *cinq*, and [g] in *long*.

It's worth mentioning now that most adjectives in French occur after nouns, with only a small set occurring before (adjectives of beauty, age, goodness, size). While *jeune homme* ("young man") is standard, *jaune homme* ("yellow man") is viewed as archaic or literary. Despite this, many authors report that speakers have judgments for liaison in these contexts. Thuilier (2012) shows that a binary before-or-after divide for adjectives is inappropriate, since many adjectives are variable, their placement conditioned by many factors, including lexical frequency. Unless noted otherwise, all of the adjectives used before nouns in this chapter are characteristic of the usage of standard French.

Before moving on to the analysis, there are two more complicating factors to be addressed: variation in liaison and H-aspiré. I discuss these in turn below.

Intraspeaker variation in liaison. French liaison is subject to a great deal of variation, both within and across speakers.

The discussion here largely concerns intraspeaker variation, whose existence is supported by both speaker judgments and corpus data. Encreve (1988)'s study of liaison rates in politicians shows that liaison applies variably for the same individual using the same words. There are also interspeaker differences: Encrevé shows that different politicians have different baseline rates.

While many factors influence the probability of liaison, the most important seems to be prosody. The more likely two words are to be parsed in the same prosodic unit, the more likely liaison is to occur (see Côté 2012 for an overview of prosodic accounts).

The traditional description (e.g., Delattre 1947; Tranel 1987) separates liaison into three categories: obligatory liaison, variable liaison, and forbidden liaison. Below, I show examples of each. These aren't complete lists, and some authors use a more fine-grained frequency scale, e.g. one with 10 points in Delattre (1966).

Liaison is obligatory after clitics, such as determiners and pronouns, and between a pre-nominal adjective and the following noun. These are the cases I focus on in the first part of the chapter.

(12) Clitic + X (obligatory)

a. ils ‿ ont mangé — 'they have eaten'
(ils = subject pronoun)

b. ils ‿ y vont — 'they're going there'
(ils = subject pronoun)

c. les ‿ hommes — 'the guys'
(les = determiner)

d. ces ‿ hommes — 'those guys'
(ces = determiner)

e. des ‿ hommes — 'some guys'
(des = determiner)

(13) Adj + N (obligatory)

a. grand ‿ homme — 'tall man'

b. petit ‿ homme — 'short man'

The facts above are reported in Tranel (1987), but there are a few complications. Delattre (1966) and Durand and Lyche (2008) report that Adj+N isn't obligatory, citing some corpus counterexamples. For simplicity, and since they are nearly obligatory, I treat them as obligatory here.

Liaison is also obligatory in fixed phrases like *États ‿ Unis* ("United States"), *il était ‿ une fois* ("once upon a time"), and *petit ‿ à petit* ("little by little"). A long list of fixed phrases can be found in Moisset (2000).

Moving on, liaison is forbidden in contexts like the ones below, which are usually taken to be separated by strong prosodic boundaries.

(14) Subject + V (forbidden, unless subject is a clitic as above)

a. *l'enfant ‿ a réussi — 'the child succeeded'

b. *les gens ‿ ont faim — 'people are hungry'

(15) Singular N + Adj (forbidden)

a. *le soldat ‿ anglais — 'the British soldier'

Finally, we find variable liaison in the contexts below.

(16) Prep + X (variable)

a. pendant ‿ une semaine — 'for a week'

b. après ‿ avoir mangé — 'after eating'

(17) Aux + V (variable)

a. ils ont ‿ acheté — 'they have bought'

b. vous devez ‿ aller — 'you must go'

(18) Plural N + Adj (variable)

a. les soldats ‿ anglais — 'the British soldiers'

Prep+NP and Aux+V liaison are interesting, since these variable cases are also subject to lexical variation. Some auxiliaries and prepositions have higher baseline rates than others, in a seemingly arbitrary way. I return to this later.

We also find, interestingly, a split between liaison in plural N + Adj and singular N + Adj, which are variable and forbidden, respectively. This is just one case of plurals behaving unusually with respect to liaison. Liaison is more likely to apply in plurals, and speakers even over-apply it, using a liaison consonant with plural words that don't usually have one. To account for this, liaison with [z] in plural contexts is sometimes analyzed as the result of a plural prefix (Gougeheim 1938; Morin and Kaye 1982). Because of this analytic ambiguity, I try to avoid liaison with plural [z] in later sections.

Beyond prosody and phonology, a number of factors affect the likelihood of a word to undergo liaison. Most of these won't be discussed here, but I note them for completeness. Liaison is influenced by style (formal vs. vernacular, Moisset 2000), the length of the liaison-undergoing word (De Jong 1988; Moisset 2000), lexical frequency (De Jong 1994; Fougeron et al. 2001), speech rate (Pak and Friesner 2006), and structural frequency (Bybee 2001).

Even after controlling for lexical frequency and other factors, liaison is subject to lexically idiosyncratic variation. Ågren (1973) shows that different forms of the same verb undergo liaison at different rates in seemingly arbitrary ways. Mallet (2008) and De Jong (1994) find similarity arbitrary differences between different adverbs.

	très "very"	*plus* "more"	*bien* "well"	*pas* "not"
Mallet (2008)	97%	64%	43%	1%
de Jong (1994)	99%	96%	82%	7%

Table 4.1: Percent liaison in adverbs from Mallet (2008) and de Jong (1994), as presented in Côté (2012)

I won't provide an account for the differences above, but generally, using weighted constraints in URC can capture lexically-conditioned differences like the ones above (see §3.5 and §5.8 for examples).

H-aspiré. One issue complicating any discussion of liaison is H-aspiré. An h-aspiré word begins with a vowel but patterns as if it began with a consonant. As a result of this invisible consonant, an H-aspiré word doesn't trigger liaison, nor does it resolve hiatus through deletion like other V-initial words.

This is shown by *homme*, *hibou*, and *garçon* below. Both *homme* and *hibou* are V-initial, but *hibou* is an H-aspiré word. Because of this, it patterns exactly like C-initial *garçon*. Liaison and deletion occur for *homme* but not *hibou*.

(19) V-initial (*homme*), H-aspiré (*hibou*), and C-initial (*garçon*)

a.	les ‿ hommes	[lez ɔm]
b.	cet homme	[sɛt ɔm]
c.	l'homme	[l ɔm]
d.	les hibous	[le ibu]
e.	ce hibou	[sœ ibu]
f.	le hibou	[lœ ibu]
g.	les garçons	[le gaʁsɔ̃]
h.	ce garçon	[sœ gaʁsɔ̃]
i.	le garçon	[lœ gaʁsɔ̃]

Whether a word begins with a phonologically well-behaved vowel or an H-aspiré is phonologically unpredictable. There are minimal pairs like [lœ aʃ] (*le hache* "the axe") and [laʃ] (*l'H* "the letter H"). The phonological unpredictability of H-aspiré is supported by the fact that it's subject to rampant interspeaker variation and change, especially in lower frequency words like proper names (Grevisse 1994).

So far, all of the generalizations about liaison exclude H-aspiré words. Every instance of "vowel-initial" could be replaced with "vowel-initial (except H-aspiré)". This might seem suspiciously circular: liaison doesn't apply before some vowel-initial words because of H-aspiré, and one way we determine H-aspiré-hood is liaison.

The important thing here is that H-aspiré words behave consistently as consonant-initial. If an H-aspiré word does not trigger deletion, we know that it will not trigger liaison, and vice versa. As a result, we can independently diagnose H-aspiré-hood, and excluding H-aspiré words from the analysis of liaison is not a case of analytic cherry-picking.

Interim summary. To summarize, the main generalizations are below.

- Liaison is lexically restricted.
- The C-final form occurs before vowels. (e.g., *bel homme*)
- The V-final form occurs before consonants. (e.g., *beau garçon*)
- Typically, the V-final form occurs phrase-finally. (e.g., *il est beau*)
- Liaison is obligatory in Adj+N and Det+N constructions.

4.3 Liaison is PCA

The account I develop here is that a liaison-undergoing word has two URs, one for the V-final form, and one for the C-final form.

(20) The PCA account: two URs for *petit*

a. /pœti/ before consonants and phrase-finally

b. /pœtit/ before vowels

A PCA account is commonly used for the words with vowel alternations, such as *beau~bel* and *ce~cet*. These require a number of different vowel adjustment processes that are unsupported in French. No matter what analysis is assumed for liaison, at the very least, words like *beau* require PCA.

For simple words like *petit*, which are only subject to a consonant alternation, the PCA account is used less often. In its place we find accounts with epenthesis and deletion, each of which I discuss below. Again, the position I take here is that nearly all pre-nominal liaison should be treated as PCA. A similar all-PCA approach has been argued in Gaatone (1978a), Perlmutter (1998) and Plénat (2008), among others.

The main argument for a PCA account is that liaison is lexically restricted. As shown in the background section (§4.2), many words fail to undergo liaison.

(21) Non-alternating adjectives

a.	joli homme	[ʒɔli ɔm]	'pretty man'
b.	joli garçon	[ʒɔli gaʁsɔ̃]	'pretty boy'
c.	jeune homme	[ʒøn ɔm]	'young man'
d.	jeune garçon	[ʒøn gaʁsɔ̃]	'young boy'

Any general rule of epenthesis or deletion would result in alternations for the words above. If we used deletion to derive the difference between [pœtit] and [pœti], we would expect the final consonant of *jeune garçon* to delete as well. On the other hand, if we used epenthesis, we would expect a [t] in *joli homme*. Under the PCA account, *jeune* and *joli* don't alternate because they each have a single UR: /ʒøn/ and /ʒɔli/.

Morpheme-specific epenthesis and deletion offer a solution to this problem, but as I show, neither looks promising.

4.3.1 Not morpheme-specific epenthesis

Under a morpheme-specific epenthesis account, liaison words undergo intervocalic epenthesis. For example, a [t] is epenthesized between *petit* and *homme*.

The most obvious problem for such an account is that the liaison consonant is unpredictable given its phonological context. With morpheme-specific epenthesis, accounting for the range of possible liaison consonants requires a number of different processes – t-epenthesis, z-epenthesis, p-epenthesis, etc. – each of which applies to a small set of words.

One way around this problem is to have a single epenthesis process, and to store the identity of the epenthetic consonant in the lexical listing of the word (Rotenberg

1978). This approach moves the alternating consonant to the lexicon, just like the PCA account. As far as I can tell, the stored epenthetic consonant approach works just as well as the PCA approach.

The benefit of the PCA approach is that it doesn't require any additional mechanisms specific to liaison. As noted above, any account of liaison must permit PCA for *beau~bel* and *ce~cet*. Once PCA is used for these words, why not use it for *petit*? In the choice between an account with PCA and an account with PCA plus lexically-stored epenthetic consonants, simplicity favors the latter.

That's not to say that PCA should always be favored over a phonological analysis. If t-epenthesis were independently motivated in French, then an analysis with epenthesis would be the best account for the alternation in *petit*. However, the sort of morpheme-specific epenthesis required has just as much lexical listing as the PCA analysis.

In §4.5, I discuss Ṽ-final words. Unlike the other cases of liaison above, Ṽ-final words nearly always take [n] as a liaison consonant, and the process is extremely productive. To account for these, I argue for an account with n-epenthesis. The difference between n-epenthesis and the epenthesis discussed above is that the former is independently motivated and productive in French.

4.3.2 Not deletion or floating consonants

Under a morpheme-specific deletion account, a liaison word undergoes final-consonant deletion. The underlying form of *petit* is /pœtit/, and the /t/ is deleted in *petit garçon*. Unlike epenthesis, morpheme-specific deletion is able to account for the fact that liaison consonants differ on a word by word basis. The different liaison consonants of *petit* and *trop* come from differences in their URs.

Deletion faces a new problem: final consonants are not pronounced phrase-finally, as shown below. Capturing phrase-final [pœti] requires two processes – one that deletes /t/ before consonants (as in *petit garçon*) and one that deletes /t/ at the end of phrases.

(22) Liaison consonants are usually unpronounced phrase-finally

a.	il est petit	[il ɛ pœti]	'he's short'
b.	il est grand	[il ɛ gʁɑ̃]	'he's tall'

One solution to this problem is to use floating consonants, consonants which are underlyingly present but unlinked to the autosegmental skeleton, or syllable, or both. An overview of different accounts of this type can be found in Tranel (1995).

Under a floating consonant account, we find an unlinked final consonant in *petit*. This consonant requires a docking site, which is only provided by a following onsetless syllable. As a result, the *t* in *petit* is pronounced before *homme*, but not before *garçon* or at the end of a phrase. This account also captures the difference between *petit* and non-liaison-undergoing words like *joli* and *jaune*: *petit* has a floating consonant, and the other words do not.

The floating consonant account is challenged by the idiosyncratic behavior of some liaison-undergoing words. While liaison consonants are *usually* unpronounced phrase-finally, some numerals behave exceptionally. I give some examples below, but much more data can be found in §4.5, along with the PCA analysis.

First, we see that *vingt* and *huit* behave in the typical liaison way.

(23) Numerals: liaison consonants before vowels

a.	vingt hommes	[vɛ̃t ɔm]	'twenty men'
b.	vingt garçons	[vɛ̃ gaʁsɔ̃]	'twenty boys'
c.	huit hommes	[ɥit ɔm]	'eight men'
d.	huit garçons	[ɥi gaʁsɔ̃]	'eight boys'

However, in the examples below, phrase-final *vingt* has a consonant, while phrase-final *huit* does not.

(24) Numerals: unpredictable phrase-final C or V

a.	il en a vingt	[il ɑ̃n a vɛ̃]	'he has twenty'
b.	il en a huit	[il ɑ̃n a ɥit]	'he has eight'

For a floating consonant analysis of numerals, we need two types of floating consonants: one type that can dock phrase-finally; and one type that cannot. This addition undermines the floating consonant analysis, which argues for a simple representational solution to liaison.

To account for the schizophrenic behavior of numerals, Tranel (1996) proposes a mixed account that uses PCA for words like *huit*, and floating consonants elsewhere. This solution, while possible, is unattractive in URC, where PCA is available to account for the same data, and floating consonants offer no empirical or theoretical advantages.

In conclusion, an analysis that relies on epenthesis, deletion, or floating consonants cannot account for the full range of facts. In the sections that follow, I show that a PCA analysis can.

4.4 Account of adjectives

In this section, I present the URC account of French adjectives. These are the simplest case of liaison.

4.4.1 Target of explanation

The following generalizations are the target of analysis:

- The V-final form occurs phrase-finally. (e.g., *il est beau*)
- The C-final form occurs before vowels. (e.g., *bel homme*)

- The V-final form occurs before consonants. (e.g., *beau garçon*)

- Only some adjectives undergo liaison.

The analysis in this section doesn't address numerals, which appear with a C-final form at the end of this phrase. These are taken up in §4.5.

4.4.2 Constraints

In URC, phonological conditioning in PCA is often the result of markedness constraints ranked above UR constraints. The markedness constraint I use here is ∗HIATUS. This constraint ensures that C-final forms are chosen before vowels.

(25) ∗HIATUS

Assign one violation mark for every two adjacent vowels.

∗HIATUS is well-motivated in French. In §4.7, I show that it conditions other repairs, supporting the LWC Hypothesis. The same constraint has been used to to account for liaison in earlier OT accounts, such as Steriade (1999) and Tranel (2000).

In the PCA analysis, a liaison-undergoing adjective has two (or more) URs, with a UR constraint for each. The UR constraints for the two forms of *beau* are below.

(26) {BEAUTIFUL, MASC} → /bo/ (abbreviated: UR = /bo/)

(27) {BEAUTIFUL, MASC} → /bɛl/ (abbreviated: UR = /bɛl/)

The analysis here uses *beau*, but it can be generalized to any word that undergoes liaison. In the analysis, V-final /bo/ could be replaced with V-final /pœti/, and likewise for /bɛl/ and /pœtit/.

4.4.3 Ranking

4.4.3.1 Ruling out repairs

Before ranking the UR constraints, we need to rule out other repairs for ∗Hiatus. With the exception of a few contextually-restricted repairs, this constraint is freely violated in French, as evidenced by sentences like the one below.

(28) Elle a haït Haïti [ɛ.la.a.i.a.i.ti]

The fact that ∗Hiatus is violable has resulted in some skepticism about its use in accounts of liaison (e.g., Morin 2005). This isn't a worry in an OT account, in which constraints can be violated in surface forms but show an effect elsewhere.

For the analysis here, the important thing is that we rule out epenthesis and deletion. This is accomplished by the ranking Max, Dep ≫ ∗Hiatus, which I assume in all of the tableaux that follow.

(29) Max, Dep ≫ ∗Hiatus

Later, I argue that schwa deletion also resolves hiatus, which is incompatible with the ranking above. Schwa is the only vowel to delete in French, and its deletability can be captured by dividing Max into more constraints.

4.4.3.2 The V-final form occurs phrase-finally

The generalization that the V-final form occurs phrase-finally follows if we treat it as the default. This is captured by ranking the UR constraint for the V-final form, UR=/bo/, over the UR constraint for the C-final form, UR=/bɛl/. The tableau below shows the final word of the phrase *il est beau*.

Ranking arguments: UR = /bo/ ≫ UR = /bɛl/

		MAX/DEP	*HIATUS	UR = /bo/	UR = /bɛl/
☛ /bo/	[bo]	0	0	0	−1
/bɛl/	[bɛl]	0	0	−1 W	0 L

Table 4.2: V-final form occurs phrase-finally in *il est beau*

This analysis predicts that an adjective could have a C-final default, if the UR constraint for its C-final form were ranked above the UR constraint for its V-final form. While this prediction is not borne out in adjectives (which all seem to have V-final defaults), some numerals do have C-final defaults (§4.5).

4.4.3.3 The C-final form occurs before vowels

The general preference for *beau* over *bel* can be overridden by a higher ranked markedness constraint, in this case *HIATUS. As long as *HIATUS is ranked above UR =/bo/, consonant-final *bel* will be used before vowels to avoid hiatus.

Ranking arguments: *HIATUS ≫ UR = /bo/

		MAX/DEP	*HIATUS	UR = /bo/	UR = /bɛl/
☛ /bɛl/+/ɔm/	[bɛl ɔm]	0	0	−1	0
/bo/+/ɔm/	[bo ɔm]	0	−1 W	0 L	−1 W

Table 4.3: C-final form occurs before vowels in *bel garçon*

4.4.3.4 The V-final form occurs before consonants

The fact that the V-final form occurs before consonants follows straightforwardly from the ranking UR = /bo/ ≫ UR = /bɛl/.

Ranking arguments: UR = /bo/ ≫ UR = /bɛl/

			Max/Dep	*Hiatus	UR = /bo/	UR = /bɛl/
☛	/bo/+/garsɔ̃/	[bo garsɔ̃]	0	0	0	−1
	/bɛl/+/garsɔ̃/	[bɛl garsɔ̃]	0	0	−1 W	0 L

Table 4.4: V-final form occurs before consonants in *beau garçon*

4.4.3.5 Only some adjectives undergo liaison

Under the PCA account, only adjectives with multiple URs undergo liaison. For an adjective like *belle* or *joli*, which doesn't alternate, there's only one UR and only one UR constraint.

(30) {BEAUTIFUL, FEM} → /bɛl/ (abbreviated : $\text{UR}_{(\text{fem.})}$= /bɛl/)

(31) {PRETTY, FEM} → /ʒɔli/ (abbreviated : UR = /ʒɔli/)

Given the candidate generation algorithm of URC (§2.2.4), there's no way for URs other than /ʒɔli/ to compete when the input is {PRETTY, FEM}. Since the candidate set for this input doesn't contain other URs, and epenthesis and deletion are ruled out, there's no way for *joli* to avoid hiatus.

			Max/Dep	*Hiatus	$\text{UR}_{(\text{fem.})}$= /bɛl/
☛	/ʒɔli/+/ɔm/	[ʒɔli ɔm]	0	−1	0
	/ʒɔli/+/ɔm/	[ʒɔli t ɔm]	−1 W	0 L	0
	/ʒɔli/+/ɔm/	[ʒɔl ɔm]	−1 W	0 L	0

Table 4.5: *joli* doesn't undergo liaison in *joli homme*

4.4.3.6 Summary of ranking

The final ranking for *beau* and *bel* is below.

(32) MAX/DEP ≫ ∗HIATUS ≫ UR = /bo/ ≫ UR = /bɛl/

Under this ranking, *beau* is generally preferred to *bel*, except when *bel* can avoid a violation of ∗HIATUS. Although PCA avoids hiatus, epenthesis and deletion do not, and these facts follow from a single ranking of constraints.

4.5 Account of numerals

In this section, I extend the URC account to numerals. Numerals provide a real challenge to previous theories, as shown in §4.3, but follow naturally in URC. Differences between numerals follow from the ranking of their corresponding UR constraints.

4.5.1 Numerals: Pattern

At first glance, numerals are like adjectives. V-final forms appear before consonants, and C-final forms appear before vowels.

(33) Numeral suppletion

a.	vingt hommes	[vɛ̃t ɔm]	'twenty men'
b.	vingt garçons	[vɛ̃ gaʁsɔ̃]	'twenty boys'
c.	huit hommes	[ɥit ɔm]	'eight men'
d.	huit garçons	[ɥi gaʁsɔ̃]	'eight boys'

The difference is that numerals have unpredictable defaults. The default can be either V- or C-final, in a completely arbitrary fashion (Schane 1968; Tranel 1976, 1996). In the examples below, the default form of *vingt* has a final consonant, while the default form of *huit* does not.

(34) For alternating numbers, the default is either C-final or V-final

a.	il en a vingt	[il ɑ̃n a vɛ̃]	'he has twenty'

b. il en a huit [il ɑ̃n a ɥit] 'he has eight'

The tables below summarize the pattern for contemporary standard French. The data are based on discussions with native speakers, and descriptions in Tranel (1995) and Malécot (1954). The first table shows well-behaved numerals, which have V-final defaults and pattern exactly like alternating adjectives. In the table, an asterisk indicates that the form in the table differs from Malécot (1954)'s description of the French numeral system. I discuss these differences throughout.

Word	Phrase-final J'en ai ___	Pre-Vocalic ___ homme(s)	Pre-Consonantal ___ garçon(s)
un (1)	[ɛ̃]	[ɛ̃n]	[ɛ̃]
deux (2)	[dø]	[døz]	[dø]
trois (3)	[tʁwa]	[tʁwaz]	[tʁwa]
vingt (20)	[vɛ̃]*	[vɛ̃t]	[vɛ̃]
cent (100)	[sɑ̃]	[sɑ̃t]	[sɑ̃]

Table 4.6: Alternating numbers with V-final defaults

The word *vingt* is starred because the phrase-final form used in contemporary French ([vɛ̃]) differs from the one provided by Malécot (1954) ([vɛ̃t]). In 1954, *vingt* was an alternating number with a C-final default and would be in the table below, which shows numerals with C-final defaults.

Word	Phrase-final J'en ai ___	Pre-Vocalic ___ hommes	Pre-Consonantal ___ garçons
six (6)	[sis]	[siz]	[si]
huit (8)	[ɥit]	[ɥit]	[ɥi]
dix (10)	[dis]	[diz]	[di]

Table 4.7: Alternating numbers with C-final defaults

There are some numbers (*six* and *dix*) that have three allomorphs. In addition to having a pre-consonantal form and a phrase-final form, they have a unique pre-vocalic form with a voiced fricative. I return to these at the end of the section

Just as there are non-alternating adjectives, there are many non-alternating numbers. Out of the non-alternating numbers below, all are C-final with the exception of *zéro*.

Word	Phrase-final J'en ai ___	Pre-Vocalic ___ hommes	Pre-Consonantal ___ garçons
zéro (0)	[zeʁo]	[zeʁo]	[zeʁo]
cinq (5)	[sɛ̃k]	[sɛ̃k]	[sɛ̃k]*
sept (7)	[sɛt]	[sɛt]	[sɛt]*
neuf (9)	[nœf]	[nœf]*	[nœf]*
onze (11)	[ɔ̃z]	[ɔ̃z]	[ɔ̃z]
douze (12)	[duz]	[duz]	[duz]
treize (13)	[tʁɛz]	[tʁɛz]	[tʁɛz]
quatorze (14)	[katɔʁz]	[katɔʁz]	[katɔʁz]
quinze (15)	[kɛ̃z]	[kɛ̃z]	[kɛ̃z]
seize (16)	[sɛz]	[sɛz]	[sɛz]
trente (30)	[tʁɛ̃t]	[tʁɛ̃t]	[tʁɛ̃t]
quarante (40)	[ɑ̃t]	[ɑ̃t]	[ɑ̃t]
cinquante (50)	[ɑ̃t]	[ɑ̃t]	[ɑ̃t]
soixante (60)	[swasɑ̃t]	[swasɑ̃t]	[swasɑ̃t]
mille (1000)	[mil]	[mil]	[mil]

Table 4.9: Non-alternating numbers

The three starred forms in the table above (*cinq*, *sept*, *neuf*) are V-final before consonants in Malécot (1954)'s description, patterning like *six* and *huit*. In contemporary French, they don't alternate at all, except in fixed phrases, e.g. *cinq cent* ([sɛ̃ sɑ̃] "500"). Morin (1986) cites the change from [sɛ̃] to [sɛ̃k] as an example of stem leveling in liaison. Rather than maintain a paradigm with two allomorphs, speakers have collapsed the paradigm.

To summarize, the table below shows the possible patterns for French numerals.

Phrase-final *J'en ai ___*	Pre-Vocalic *___ hommes*	Pre-Consonantal *___ garçons*	Example
C-final	C-final	C-final	*cinq*
C-final	C-final	V-final	*huit*
V-final	C-final	V-final	*vingt*
V-final	V-final	V-final	*zéro*

Table 4.10: Attested patterns for numerals

This table reveals an interesting generalization about French numerals: if a numeral has two forms (a C-final form and a V-final one), they must be used in an optimizing way: C-final before vowels, and V-final before consonants. All patterns, both present and past, conform to this generalization.

We never find the patterns below, in which there's a C-final form that isn't used to resolve hiatus, or a V-final form that isn't used before consonants.

Phrase-final *J'en ai ___*	Pre-Vocalic *___ hommes*	Pre-Consonantal *___ garçons*
C-final	V-final	V-final
V-final	C-final	C-final
C-final	V-final	C-final
V-final	V-final	C-final

Table 4.11: Unattested patterns for numerals

The analysis in the next section captures this generalization.

Voicing alternations in numbers. As noted above, some numbers have three allomorphs, with a pre-vocalic form ending in a voiced fricative.

(35) Voicing alternations in numbers

a. dix [dis]

b. dix amis [diz ami]

c. dix garçons [di gaʁsɔ̃]

d. six [sis]

e. six amis [siz ami]

f. six garçons [si gaʁsɔ̃]

This voicing alternation is most likely PCA. It can't be the result of a general rule of intervocalic voicing, as shown by its non-application in *dix secondes*, where the fricative is part of the following word.

(36) Voicing alternations only occur when the fricative is part of the number

a. dix [dis]

b. dix amis [diz ami]

c. dix secondes [di sœgɔ̃d]

There are also many words that don't undergo this alternation, such as *grosse*.

(37) Voicing alternations only occur when the fricative is part of the number

a. grosse [gʁɔs]

b. grosse ami [gʁɔs ami]

I don't provide a worked out analysis of voicing alternations here, but the natural account in URC is to use a constraint requiring intervocalic voicing.

In French, we not only see an effect of this constraint on numeral allomorphy, but also in prefixal allomorphy with *trans-* (Schane 1968; Tranel 1981a). The allomorph [tʁɑ̃z] occurs before vowels, while [tʁɑ̃s] occurs before consonants.

(38) Tranel (1981): p. 20: *trans-* words avoids hiatus

a. transatlantique [tʁɑ̃zatlantik] 'chaise longue'

b.	transaction	[tʁɑ̃zaksjɔ̃]	'transaction'
c.	transpercer	[tʁɑ̃spɛʁse]	'to pierce through'
d.	transmettre	[tʁɑ̃smɛtʁ]	'to transmit'

4.5.2 Target of explanation

The next section presents a URC account of numerals. The generalizations below are the target of analysis.

- Depending on the numeral, either the C-final form or V-final form occurs phrase-finally. (e.g., *j'en ai huit*, *j'en ai ving(t)*)
- If there is one, the C-final form occurs before vowels. (e.g., *vingt ‿ hommes*, *huit ‿ hommes*)
- If there is one, the V-final form occurs before consonants. (e.g., *ving(t) garçon*, *hui(t) hommes*)
- If there are two allomorphs, they are used in an optimizing way.

4.5.3 Constraints

To analyze numerals, I use the constraints from the analysis of adjectives: UR constraints for V-final and C-final allomorphs, and the constraint ∗Hiatus.

To model numerals like *huit*, an additional constraint is necessary.

(39) ∗CC

Assign one violation for every sequence of two adjacent consonants.

This constraint is the consonantal counterpart of ∗Hiatus, and prevents liaison before consonants. In the analysis that follows, I show why such a constraint is necessary.

4.5.4 Ranking

4.5.4.1 Either the C-final form or V-final form occur phrase-finally

In the tableaux below, the difference between *vingt* and *huit* follows from the ranking of their UR constraints. For *vingt*, the default is V-final, and for *huit*, the default is C-final.

Ranking arguments:UR = /vɛ̃/ ≫ UR = /vɛ̃t/

			*CC	*Hiatus	UR = /vɛ̃/	UR = /vɛ̃t/
☛	/vɛ̃/	[vɛ̃]	0	0	0	−1
	/vɛ̃t/	[vɛ̃t]	0	0	−1 W	0 L

Table 4.12: V-final default for *vingt*

Ranking arguments: UR = /ɥit/ ≫ UR = /ɥi/

			*CC	*Hiatus	UR = /ɥit/	UR = /ɥi/
☛	/ɥit/	[ɥit]	0	0	0	−1
	/ɥi/	[ɥi]	0	0	−1 W	0 L

Table 4.13: The C-final default for *huit*

The ranking of UR constraints is enough to account for the differences between *vingt* and *huit*. No representational differences are necessary.

4.5.4.2 The C-final form occurs before vowels

For *huit*, the fact that the default is C-final is sufficient to get the C-final form before vowels. No other ranking is necessary.

Ranking arguments: Nothing new

		*CC	*HIATUS	UR = /ɥit/	UR = /ɥi/
☛ /ɥit/+/ami/	[ɥit ami]	0	0	0	−1
/ɥi/+/ami/	[ɥi ami]	0	−1 W	−1 W	0 L

Table 4.14: The C-final form occurs before vowels in *huit amis*

For *vingt*, the default is V-final. To get the C-final allomorph before vowels, another constraint, like *HIATUS, is necessary. When *HIATUS dominates UR = /vɛ̃/, the default is abandoned in favor of the optimizing C-final form.

Ranking arguments:*ə.V ≫ UR = /vɛ̃/

		*CC	*HIATUS	UR = /vɛ̃/	UR = /vɛ̃t/
☛ /vɛ̃t/+/ɔm/	[vɛ̃t ɔm]	0	0	−1	0
/vɛ̃/+/ɔm/	[vɛ̃ ɔm]	0	−1 W	0 L	−1 W

Table 4.15: The C-final form occurs before vowels in *vingt hommes*

4.5.4.3 The V-final form occurs before consonants

For *vingt*, the default is V-final, so no further constraints or rankings are necessary to obtain the V-final form before consonants.

For *huit*, the default is C-final. To get the V-final form before consonants, we need a constraint like *CC.

(40) *CC

Assign one violation for every sequence of two adjacent consonants.

Although it's not very well motivated in French outside of liaison, it captures the generalization that liaison creates alternating C-V sequences. The ranking of *CC over UR = /ɥit/ captures the pattern, as shown below.

Ranking arguments: ∗CC ≫ UR = /ɥit/

			∗Hiatus	∗CC	UR = /ɥit/	UR = /ɥi/
☛	/ɥi/+/gaʁsɔ̃/	[ɥi gaʁsɔ̃]	0	0	−1	0
	/ɥit/+/gaʁsɔ̃/	[ɥit gaʁsɔ̃]	0	−1 W	0 L	−1 W

Table 4.16: The V-final form occurs before consonants in *huit garçons*

A constraint like NoCoda won't work in this case, since the ranking NoCoda ≫ UR = /ɥit/ would also cause V-final [ɥi] to be used phrase-finally.

4.5.4.4 Summary of ranking

To summarize, the distribution of numerals follows from the rankings below. Both of these rankings are compatible. Under the ranking for *huit*, the default is C-final, and the V-final allomorph is used to avoid a violation of ∗CC.

(41) Max, Dep ≫ ∗CC ≫ UR = /ɥit/ ≫ UR = /ɥi/

Under the ranking for *vingt*, the default is V-final, and the C-final allomorph is used to avoid a violation of ∗Hiatus.

(42) Max, Dep ≫ ∗Hiatus ≫ UR = /vɛ̃/ ≫ UR = /vɛ̃t/

In the next section, I consider the final generalization: allomorphs are always used in an optimizing way.

4.5.4.5 Alternating numerals are always optimizing

If a numeral has two allomorphs, they must be used in an optimizing way: C-final before vowels, and V-final before consonants. I exemplify an unattested pattern with the made-up number *guix*. It has two allomorphs: [gwi] and [gwis].

(43) An unattested pattern with imaginary number *guix*

a. Phrase-finally: j'en ai [gwis]

b. Before consonants: [gwi] garçons

c. Before vowels: [gwi] hommes

Given the constraint set here, there's no ranking that will result in this unattested pattern.

In URC, the ranking of UR constraints establishes the default. A non-default allomorph is used when doing so avoids a violation of a higher-ranked markedness constraint. Since no markedness constraint in the analysis favors V-final allomorphs before vowels, there's no reason to deviate from a C-final default as in *gwis*.

The comparative tableau below shows the pattern's impossibility: there's no ranking in which every loser-favoring constraint (L) is dominated by at least one winner-favoring constraint (W).

		*Hiatus	*CC	UR = /gwis/	UR = /gwi/
W~L	j'en ai [gwis] ~j'en ai [gwi]			W	L
W~L	[gwi] garçons ~ [gwis] garçons		W	L	W
W~L	[gwi] hommes ~ [gwis] hommes	L		L	W

Table 4.17: No possible ranking for all three desired winners.

Likewise, given a V-final default, there's no markedness constraint to compel using a C-final allomorph before consonants. As a result, a pattern like the one below is impossible. In this pattern, the word *fleaux* is realized with a liaison consonant before consonants.

(44) An unattested pattern with imaginary number *fleaux*

a. Phrase-finally: j'en ai [flo]

b. Before consonants: [floz] garçons

c. Before vowels: [flo] hommes

In summary, the ranking of UR constraints determines the default, and a non-default is only used when a higher-ranked constraint favors it. As a result, non-optimizing PCA can't be captured with markedness and UR constraints alone.

4.6 Account of Ṽ-final words

In this section, I consider another set of liaison cases: Ṽ-final words. I argue that liaison in words such as *un* ([ɛ̃]) and *mon* ([mɔ̃]) is best analyzed as the result of n-epenthesis, and this process of n-epenthesis conspires with PCA to avoid hiatus.

I provide an analysis first in Optimality Theory, using categorical data, then in MaxEnt, using data subject to variation. The account of Ṽ-final words makes use of two aspects of URC: preferences between PCA and repairs follow from constraint ranking; and repairs and UR selection occur in parallel.

4.6.1 Arguments for n-epenthesis

Words with a Ṽ-final citation form can undergo three types of liaison, patterning like *un*, *bon*, or *vingt* below.

(45) Ṽ-final words before a vowel

a. **ṼN liaison**: [Ṽ] → [Ṽn]

un ‿ ami [ɛ̃] → [ɛ̃n ami]

b. **VN liaison**: [Ṽ] → [Vn]

bon ‿ ami [bɔ̃] → [bɔn ami]

c. **ṼC liaison**: [Ṽ] → [ṼC]

vingt ‿ amis [vɛ̃] → [vɛ̃t ami]

The majority of Ṽ-final words undergo one of the first two patterns, but there's a great deal of interspeaker variation, both regionally and diachronically (Tranel 1981b). For example, speakers differ in their preferred liaison form for *son* – either [sɔn] or [sɔ̃n]. In addition, some words, especially the pronouns *mon*, *ton*, and *son*, participate in both patterns within the same speaker. I revisit intraspeaker variation in §4.6.3.

I treat VN/ṼC liaison and ṼN liaison as the result of different mechanisms. The former two are the result of PCA, while the latter is the result of n-epenthesis.[1]

(46) Analysis of Ṽ-final words

a.	**VN liaison**:	Citation form	Before vowels
		/Ṽ/	/VN/
b.	**ṼC liaison**:	Citation form	Before vowels
		/Ṽ/	/ṼC/
c.	**ṼN liaison**:	Citation form	Before vowels
		/Ṽ/	/Ṽ/ → [ṼN]

Tranel (1990) and Côté (2005) take a similar stance to the one here, treating VN liaison as the result of suppletion, while treating ṼN as the result of a floating consonant (Tranel) or epenthesis (Côté). Côté, unlike the account here, maintains that most liaison consonants are epenthetic. Here, I argue that most cases of liaison are PCA, except for ṼN liaison.

The argument for ṼN liaison as n-epenthesis comes from productivity. Unlike other cases of liaison, ṼN liaison is predictable and exceptionless. N-epenthesis is described below as a phonological rule.

(47) $\emptyset \rightarrow [\text{n}] \;/\; \tilde{\text{V}}\_\_\_ \begin{Bmatrix} \tilde{\text{V}} \\ \text{V} \end{Bmatrix}$

[1] It may be that some ṼN liaison forms are stored as URs, just as other outputs of phonological rules are stored. The approach here abstracts away from this, and treats all ṼN liaison as epenthesis.

N-epenthesis resolves hiatus by inserting an [n], but only if the epenthetic [n] follows a nasal vowel. This restriction is motivated by the existence of many [V.Ṽ] sequences of French, e.g. in *Léon, jouons, éon, éancéen*, which aren't subject to n-epenthesis.

The rule above is also prosodically restricted, not applying across strong prosodic boundaries. There are many examples like the one below, in which a [Ṽ.V] sequence occurs across a noun and verb. This is the same prosodic context in which liaison is forbidden.

(48) N-epenthesis doesn't apply across a prosodic boundary

Jean a dit [ʒɑ̃ a di]

Outside of cases with strong prosodic boundaries like the ones above, there are nearly no [Ṽ.V] or [Ṽ.Ṽ] sequences in French (Dell 1970 p. 59). There is only a single exception in Tranel (1981b) – *Panhard* ([pɑ̃.aʁ]), a French car company – and a handful of exceptions in Withgott (1982), all of which contain word-internal H-aspiré, such as *enhardir* ([ɑ̃.aʁ.diʁ]). To account for the lack of [Ṽ.V] sequences, we need something like the n-epenthesis rule above.

Treating ṼN liaison as n-epenthesis also accounts for the fact that every Ṽ-final word undergoes liaison. Recall that there are non-alternating words like *joli*, which always occur with a final vowel and never undergo liaison. Of these words, every single one ends in an oral vowel. The unattested pattern is illustrated below with the made-up word *boin*.

(49) An unattested pattern with imaginary *boin*

a. Phrase-finally: il est [bwɑ̃]

b. Before consonants: [bwɑ̃] garçons

c. Before vowels: [bwɑ̃] amis

Without n-epenthesis, the lack of patterns like the one above is coincidental. If we analyzed ṼN liaison as suppletion, it would need to be the case that every Ṽ-final word happened to have multiple URs: one /Ṽ/, one /Ṽn/. This fact would be especially surprising given the large number of vowel-final words like *joli* that don't alternate.

Further support for an analysis of n-epenthesis is the fact that [n] is different from other liaison consonants. The table below reports the likelihood of liaison consonant realization from two corpus studies: Malécot (1975) and Mallet (2008). While [t] and [z] are realized variably, [n] is realized nearly categorically.

(50)

Liaison consonant	Malecot (1975)	Mallet (2008)assuming
n	94%	90%
z	61%	43%
t	52%	23%

Table 4.18: Percent of liaison consonant realization by liaison consonant

This difference follows straightforwardly from n-epenthesis. Liaison with [n] is the product of epenthesis, which is nearly obligatory, while [z] and [t] are the result of a different mechanism.

To summarize, surface [Ṽ.V] sequences are almost never found in liaison contexts, and every Ṽ-final word can undergo liaison. Both of these facts are captured by assuming categorical n-epenthesis, which applies to all Ṽ-final words, ensuring that [Ṽ.V] sequences never arise. The fact that liaison is more likely to apply when the liaison consonant is [n] can be explained as a result of categorical n-epenthesis.

4.6.1.1 Sampson 2001

Sampson (2001) provides data challenging productive n-epenthesis. While liaison is obligatory in [Ṽ]-final words that are typically used before nouns, liaison does *not* apply when atypically pre-nominal [Ṽ]-final words are tested. In this experiment, eleven informants were given six sentences with pre-nominal Ṽ-final adjectives. Some of the test phrases are below.

(51) Sample test phrases from Sampson (2001)

a. mignon ‿ object d'art

b. souverain ‿ air

c. malin ‿ espoir

Sampson finds liaison is only produced 20% of the time in these sentences, contrary to the claims about productivity I make here. There are three objections to these findings.

First, the experiment's design seeks to maximize the likelihood of liaison by putting speakers in a formal setting and encouraging careful pronunciation (p. 246). If liaison is conditioned by prosody as is often claimed, not occurring across prosodic breaks (see Côté 2012), then careful and deliberate speech will discourage its application. Sampson's answer to this was to allow speakers a minute or two with the sentences before production, to familiarize themselves with the materials and avoid hesitations and pauses.

This leads us to the second objection, which is that the experiment encourages metalinguistic reasoning about the application of liaison. Speakers were given time with the sentences before production, and many quickly realized that liaison was being tested (p. 246). Sampson notes that many subjects felt tension between using no liaison and conforming to "correct" pronunciation with liaison, suggesting that speakers deliberated about the use of liaison, and moreover, know that liaison is “correct” in these cases.

The third and final objection is that the adjectives used in the experiment typically do not occur in pre-nominal position. This is, of course, required to test liaison’s productivity, but it may be that atypically pre-nominal adjectives are treated differently from the usual, closed set of pre-nominal adjectives.

Hsu (2013) provides an account of Sampson’s findings along these lines. He analyzes the failure of liaison in these words as the result of prosodification: atypically pre-nominal adjectives are phrased as separate prosodic words when they occur before the noun, while typically pre-nominal adjectives are phrased together with the noun. Given the fact that n-epenthesis doesn’t occur across strong prosodic boundaries (as discussed in the last section), we expect no n-epenthesis for these atypically pre-nominal words under Hsu’s account.

4.6.2 OT Account

The goal of this section is to provide an account of Ṽ-final words that undergo either obligatory epenthesis (*un*) or obligatory suppletion (*bon*). Later in the section, I extend the analysis to handle variation.

4.6.2.1 Constraints

I assume that the markedness constraint driving epenthesis in Ṽ-final words is *HIATUS(Ṽ.V).

(52) *HIATUS(Ṽ.V)

Assign one violation for every sequence of two adjacent vowels, in which the first vowel is a nasal vowel, and the second vowel is an oral vowel.

This is similar constraint to the constraint used in Hsu (2013)'s account of nasal liaison. Hsu's account differs, though, in his assumption that both ṼN liaison and VN liaison are the result of epenthesis.

The constraint militating against n-epenthesis is Dep(n).

(53) Dep(n)

Assign one violation for every [n] in the SR without a correspondent in the UR.

One issue I will not take up in this analysis is the choice of epenthetic consonant. [n] is the only epenthetic consonant that occurs after nasal vowels. This could be because the epenthetic consonant receives features from the preceding nasal vowel, or because the epenthetic consonant must agree in nasality.

4.6.2.2 ṼN liaison words

For a word like *un*, liaison is the result of epenthesis. Since there is only one UR for *un*, there is only one UR constraint for the word.

(54) {Def, Det} → /ɛ̃/ (abbreviated UR = /ɛ̃/)

Epenthesis for *un* comes from ranking *Hiatus(Ṽ.V) above Dep(n), as shown below. The candidate set does not contain a UR like /ɛn/, since there's only the UR constraint above.

Ranking arguments: Hiatus(Ṽ.V) ≫ Dep(n)

			Hiatus(Ṽ.V)	Dep(n)	UR = /ɛ̃/
☛	/ɛ̃/+/ami/	[ɛ̃n ami]	0	−1	0
	/ɛ̃/+/ami/	[ɛ̃ ami]	−1 W	0 L	0

Table 4.19: Tableau for ṼN liaison in *un ami*

As shown in the tableau, the constraint UR= /ɛ̃/ can be ranked anywhere. Since GEN will only generate candidates with /ɛ̃/, the UR constraint will face no competition.

4.6.2.3 VN liaison words

For a word with allomorphs containing both oral and nasal vowels, such as *bon*, there are two UR constraints, one for each allomorph.

(55) {GOOD, MASC.} → /bɔ̃/ (abbreviated UR = /bɔ̃/)

(56) {GOOD, MASC.} → /bɔn/ (abbreviated UR = /bɔn/)

In URC, the default comes from the ranking of these UR constraints. The preference for [bɔ̃] phrase-finally follows from ranking UR = /bɔ̃/ ≫ UR = /bɔn/. The tableau below shows the final word of the phrase *il est bon*.

Ranking arguments :UR = /bɔ̃/ ≫ UR = /bɔn/

			HIATUS(Ṽ.V)	DEP(n)	UR = /bɔ̃/	UR = /bɔn/
☛	/bɔ̃/	[bɔ̃]	0	0	0	−1
	/bɔn/	[bɔn]	0	0	−1 W	0 L

Table 4.20: The default emerges in *il est bon*

When *bon* is before a V-initial noun, the allomorph [bɔn] occurs. This follows from the ranking of *HIATUS(Ṽ.V) ≫ UR = /bɔ̃/.

Ranking arguments: HIATUS(Ṽ.V) ≫ UR = /bɔ̃/

			HIATUS(Ṽ.V)	UR = /bɔ̃/	UR = /bɔn/
☛	/bɔn/+/ami/	[bɔn ami]	0	−1	0
	/bɔ̃/+/ami/	[bɔ̃ ami]	−1 W	0 L	−1 W

Table 4.21: VN liaison occurs before vowels in *bon ami*

The trick in this analysis is to rule out the candidate with epenthesis, [bɔ̃n ami]. This candidate is attractive because it both uses the default UR and satisfies the constraint against hiatus. As a result ranking Dep(n) above the UR constraints, the non-default UR is preferred to epenthesis.

Ranking arguments: Dep(n) ≫ UR = /bɔ̃/

			Hiatus(Ṽ.V)	Dep(n)	UR = /bɔ̃/	UR = /bɔn/
☛	/bɔn/+/ami/	[bɔn ami]	0	0	−1	0
	/bɔ̃/+/ami/	[bɔ̃n ami]	0	−1 W	0 L	−1 W

Table 4.22: N-epenthesis loses in *bon ami*

In the tableau above, there are two ways to satisfy Hiatus(Ṽ.V) – a repair and a non-default – and the choice between them follows from the ranking of faithfulness and UR constraints.

4.6.2.4 Summary of ranking

The final ranking is below.

(57) *Hiatus(Ṽ.V) ≫ Dep(n) ≫ UR = /bɔ̃/ ≫ UR= /bɔn/; UR = /ɛ̃/ unrankable

Under this ranking, both epenthesis and PCA accomplish the same goal, satisfying the high-ranked and never-violated *Hiatus(Ṽ.V). Epenthesis is a last resort, employed only when suppletion is unavailable.

4.6.2.5 Predictions

In French, we expect the ranking *Hiatus(Ṽ.V) ≫ Dep(n) to hold across the language. However, individual UR constraints can be ranked in any way with respect to these constraints. For *bon*, both UR constraints are ranked below *Hiatus(Ṽ.V) and Dep(n). For *un*, the UR constraint UR = /ɛ̃/ can be ranked anywhere. What about other possible rankings? Ideally, there should be no ranking of UR constraints with respect to *Hiatus(Ṽ.V) and Dep(n) that generates an unattested pattern.

For French Ṽ-final words, there are only three patterns that are attested, out of 27 possibilities ($3 * 3 * 3$).

Phrase-final *J'en ai ___*	Pre-Vocalic *___ hommes*	Pre-Consonantal *___ garçons*	Example
Ṽ	ṼN	Ṽ	*un*
Ṽ	VN	Ṽ	*bon*
VN	VN	VN	*bonne*

Table 4.23: Attested patterns for Ṽ-final and VN-final words

With the four constraints – UR =/bɔn/, UR =/bɔ̃/, *Hiatus(Ṽ.V) and Dep(n) – these are the only patterns that can generated. I go through each of these patterns in turn.

If UR =/bɔn/ is ranked above UR =/bɔ̃/, /bɔn/ will be the default. Once it's the default, there's no reason to use [/bɔ̃/]. In the resulting language, VN occurs across contexts. French has non-alternating VN adjectives like this, especially feminine adjectives like *bonne* and *brune*.

(58) Examples of adjectives that are VN regardless of context

a. bonne is always [bɔn]

L'image est bonne.

Une bonne image.

Une bonne jupe.

b. brune is always [bʁyn]

L'image est brune.

Une brune image.

Une bonne jupe.

This is the bottom row in table of attested patterns.

To get an alternating adjective, it must be the case that UR = /bɔ̃/ ≫ UR = /bɔn/, since the reverse ranking gives the pattern above. In addition, given the established ranking, *HIATUS(Ṽ.V) must dominate DEP(n). Once we remove rankings that don't meet these requirements, only six remain.

(59) Possible rankings that remain

R1. *HIATUS(Ṽ.V) ≫ DEP(n) ≫ UR = /bɔ̃/ ≫ UR = /bɔn/

R2. *HIATUS(Ṽ.V) ≫ UR = /bɔ̃/ ≫ DEP(n) ≫ UR = /bɔn/

R3. *HIATUS(Ṽ.V) ≫ UR = /bɔ̃/ ≫ UR = /bɔn/ ≫ DEP(n)

R4. UR = /bɔ̃/ ≫ UR = /bɔn/ ≫ *HIATUS(Ṽ.V) ≫ DEP(n)

R5. UR = /bɔ̃/ ≫ *HIATUS(Ṽ.V) ≫ DEP(n) ≫ UR = /bɔn/

R6. UR = /bɔ̃/ ≫ *HIATUS(Ṽ.V) ≫ UR = /bɔn/ ≫ DEP(n)

In the original analysis of French above, [bɔn ami] is able to beat [bɔ̃n ami] because epenthesis is worse than PCA, as determined by DEP(n) ≫ UR = /bɔ̃/. This is the first ranking (R1).

In the rankings that remain (R2–R6), UR = /bɔ̃/ dominates DEP(n). As a result, the candidate with epenthesis ([bɔ̃n ami]) beats the candidate with suppletion ([bɔn ami]) every time. The resulting languages will always use /bɔ̃n/ before vowels, and never use /bɔn/. The result is a ṼC liaison word like *un*, which always occurs with a nasal vowel, regardless of context.

With the constraint set here, only the three attested patterns can be generated. A word will always occur as /VN/, e.g. *bonne*, a word will alternate between /Ṽ/ and /VN/ to avoid hiatus, e.g. *bon*, or a word will always occur as /Ṽ/, e.g. *un*. As shown in §4.4, only an optimizing system is possible in URC. Although preferences are encoded on a UR-by-UR basis, there's no ranking that results in a language that has a default form but doesn't it when it's phonologically optimizing.

Of course, what counts as optimizing depends entirely on the constraint set under consideration. In the discussion above, I only consider the constraints in this section. If we include the constraints from the account of numerals, namely ∗CC, we predict one additional pattern.

Phrase-final	Pre-Vocalic	Pre-Consonantal
J'en ai ___	___ *hommes*	___ *garçons*
VN	VN	Ṽ

Table 4.24: An unattested pattern that follows from ∗CC

This word looks just like *huit*, with a V-final allomorph before consonants, and C-final allomorph before vowels and at the ends of phrases. This pattern is possible with ∗CC because ∗CC prefers Ṽ-final forms before consonants. As a result, it's possible to set VN as the default, and then compel deviating from the default to satisfy *CC.

I don't have an explanation for why such a word is missing from the French system, and given the existence of words like *huit*, its absence is a bit surprising.

4.6.3 Variation data

In this section, I present data showing that some Ṽ-final words have multiple liaison forms. These words behave like both *un* and *bon*, varying between ṼN and VN liaison. The data here is taken primarily from Tranel (1981b), who provides an extensive historical and geographic overview of this variation.

In descriptions of Standard French, Ṽ-final words behave categorically. They undergo either ṼN or VN liaison.

(60) Liaison in Ṽ-final words in Standard French (Tranel 1981)

a. ṼN liaison

un, aucun, chacun, commun, mon, ton, son, on, en, bien, rien

b. VN liaison

bon, plein, certain, prochain, ancien, divin

Whether a word is ṼN or VN can't be predicted based on its phonological properties.

This can be seen most in the history of Ṽ-final liaison, summarized in Tranel (1981b), in which words oscillate between the two types. In the 16th century, liaison vowels were probably nasalized, undergoing ṼN liaison exclusively. They moved from generally nasalized to generally denasalized in the 17th and 18th centuries, but this change affected words unevenly (ṼN → VN). As a result, the 19th century is filled with grammarians trying to unite the phenomena, arguing whether it's better to use liaison with ṼN or VN. By the 20th century, the pattern changed course, tending towards ṼN and giving us only a small number of VN liaison words (VN → ṼN).

At every stage, there was variation both across and within words. This can be seen in descriptions by Dangeau (1694/1754) and Vaudelin (1713).

(61) Dangeau (1694)

a. ṼN — bon, on, bien

b. VN — certain

c. either ṼN or VN — mon

(62) Vaudelin (1713)

a. ṼN — on, en, bien

b. VN — bon

c. either ṼN or VN — mon, ton, son

Variation within words is especially well-attested for the possessive pronouns: *mon* (my), *ton* (yours), and *son* (his). Describing liaison in the early 20th century, Bruneau (1931) writes: “On hésite entre les deux prononciations pour: mon ami, ton ami, son ami.”[2]Grammont (1914) and Pierre (1959) also note intraspeaker variation for *mon, ton,* and *son*, but with a preference for ṼN over VN.

Martinet (1945) provides counts for ṼN liaison in *mon* for six groups of speakers. These data show both the increasing preference for ṼN and the existence of intraspeaker variation.

	N France	Paris
Born before 1900	71	88
Between 1900 and 1910	73	85
Between 1910 and 1921	78	96

Table 4.25: Martinet (1945): Percent nasalization of liaison in *mon*, for six groups of French speakers

In the next section, I present a MaxEnt model of these probabilities. This model builds on the OT analysis from the last section.

4.6.4 MaxEnt account

In this section, I provide a URC MaxEnt analysis of three word types: words that undergo VN liaison, words that undergo ṼN liaison, and words that undergo both.

(63) Three kinds of Ṽ-final words:

VN liaison	*bon*
ṼN liaison	*un*
Alternating	*mon*

[2]Translation: “One hesitates between the two pronunciations for: mon ami, ton ami, son ami”

I model two types of speakers. Both speakers have categorical *bon* and *un*, but they differ with respect to the rate of nasalization in *mon*.

4.6.4.1 Constraints

Under the URC analysis, Ṽ-final liaison is driven by the constraint *Hiatus(Ṽ.V), repeated below.

(64) *Hiatus(Ṽ.V)

Assign one violation for every sequence of two adjacent vowels, in which the first vowel is a nasal vowel, and the second vowel is an oral vowel.

Ṽ-final words avoid violations of this constraint in different ways. Some use the non-default UR, some use n-epenthesis, and some use both.

For the words that can go undergo VN liaison, like *bon* or *mon*, there are two URs. For a word like *un*, liaison is the result of n-epenthesis, and a single UR constraint is sufficient. I transcribe *un* as [œ̃] here, reflecting its earlier pronunciation.

(65) UR Constraints

mon	UR = /mɔn/
mon	UR = /mɔ̃/
bon	UR = /bɔn/
bon	UR = /bɔ̃/
un	UR = /œ̃/

These constraints are weighted to model the grammar of two speakers from Martinet (1945): a N. France speaker, born around 1915, who nasalizes *mon* 73% of the time, and a Parisian speaker, born around 1905, who nasalizes *mon* 85% of the time.

4.6.4.2 A N. France speaker, born ca. 1915

The target probabilities are below. This speaker always uses a Ṽ-final form before consonants and in the citation form, but what happens before a vowel depends on the word.

		___ V	___ C
mon	[mɔn]	.27	–
	[mɔ̃n]	.73	–
	[mɔ̃]	–	1.0
bon	[bɔn]	1.0	–
	[bɔ̃n]	–	–
	[bɔ̃]	–	1.0
un	[œn]	–	–
	[œ̃n]	1.0	–
	[œ̃]	–	1.0

Table 4.26: Target probabilities for N. France speaker

To find constraint weights that match the probabilities above, I used the R script Solver.R (Staubs 2013). As in the other MaxEnt analyses, the learner was provided all candidates and constraint violations, including URs, and the learned weights fit the closely match the target probabilities (within 0.01). The learned weights are below.

(66) Constraints and learned weights

UR = /mɔn/	3.84
UR = /mɔ̃/	26.37
UR = /bɔn/	0.00
UR = /bɔ̃/	10.76
UR = /œ̃/	0.00
*HIATUS(Ṽ.V)	33.72
DEP(n)	22.54

In the learned grammar, *HIATUS(Ṽ.V) is the highest weighted constraint. This is consistent with the fact that it is never violated in the surface forms.

For *un*, near-categorical epenthesis occurs due to the difference between the weights of *HIATUS(Ṽ.V) and DEP(n). UR = /œ̃/ has no weight, since there's no competing UR constraint. When there's only one UR, the UR constraint can have any ranking or weight, since all of the candidates satisfy it. N For both *bon* and *mon*, the Ṽ-final URs are higher weighted than the VN-final ones. As a result, the default is Ṽ-final, and this form occurs at the ends of phrases and before consonants.

The most important result of the model is the difference between *mon* and *bon*. The difference follows from the weights of their UR constraints: *bon* has a weaker preference for its Ṽ-final form than *mon* does. For *bon*, epenthesis is not an option due to the low weight of UR = /bɔ̃/ relative to DEP(n). Although UR = /bɔn/ has no weight, VN liaison is still bette. For *mon*, epenthesis can occur because of the greater preference for /mɔ̃/. This stronger preference lets *mon* overcome the penalty against epenthesis. However, the weight of DEP(n) means that *mon* [mɔn] *ami* can still win, despite the low weight of UR = /mɔn/.

The way differences in the weight of UR constraints capture differences in preferences between n-epenthesis and PCA is the same as the account of *a(n)* and ʔ-epenthesis in §3.7. A high-weighted markedness constraint is always obeyed, but the strategy for obeying it depends on the weights of faithfulness and UR constraints. The strength of a word's default, relative to the preference for the repair, determines whether to use epenthesis, suppletion, or both.

4.6.4.3 A Paris France speaker, born ca. 1905

For comparison, consider a Paris speaker, who has more nasalization for *mon* (85%), but is otherwise the same.

		___ V	___ C
mon	[mɔn]	.15	–
	[mɔ̃n]	.85	–
	[mɔ̃]	–	1.0
bon	[bɔn]	1.0	–
	[bɔ̃n]	–	–
	[bɔ̃]	–	1.0
un	[œn]	–	–
	[œ̃n]	1.0	–
	[œ̃]	–	1.0

Table 4.27: Target probabilities for a Paris speaker

The probabilities above were used to learn constraint weights, which closely match the target probabilities.

(67) Constraints and learned weights for the Paris France speaker

UR = /mɔn/	1.51
UR = /mɔ̃/	24.11
UR = /bɔn/	3.28
UR = /bɔ̃/	12.81
UR = /œ̃/	0.00
*HIATUS(Ṽ.V)	33.86
DEP(n)	20.87

This grammar is similar to the one in the last section: *HIATUS(Ṽ.V) is weighted above DEP(n), and there is a preference for Ṽ-final /mɔ̃/ and /bɔ̃/ over VN-final /mɔn/ and /bɔn/.

The difference between this speaker and the other comes primarily from the lower weight of DEP(n). Since DEP(n) has a lower weight, epenthesis is more likely to occur as a repair. Since epenthesis is more likely, the default /mɔ̃/, which requires epenthesis, is used more often.

Again, this grammar shows how the relative weights of UR constraints and phonological constraints can capture different preferences across repair strategies.

4.6.4.4 Summary and discussion

In summary, the MaxEnt analysis weights UR constraints to capture differences between strongly-preferred defaults and weakly-preferred defaults. For some words, there is a strong preference between URs, while other words have a preference, but are more willing to deviate from it. I pursue this idea more in the next chapter, where I show the same sorts of differences between *-(a)licious* and *-(a)thon*.

The analysis here relies on the fact that URC is a parallel model. Capturing preferences between repairs and PCA is only possible because repairs and UR selection are considered together in the candidate set. In the next section, I consider an alternative derivational account, which fails to capture some key generalizations for Ṽ-final words.

4.6.5 Alternative: Derivational accounts

In URC, the grammar considers epenthesis at the same time as it considers UR selection. As a result, UR has full access to the outputs of repairs.

An alternative is to treat UR selection and phonology as independent: UR selection can occur before repairs, or after repairs, but they never occur simultaneously. This derivational alternative is the same one discussed in Chapter 3, with respect to *a(n)* and ʔ-epenthesis.

While the derivational account works for words that have only one hiatus-resolution strategy, can't easily account for words that have multiple strategies. Under the derivational account, UR selection occurs first, followed later by n-epenthesis. /ɛ̃/ is selected without knowledge that hiatus can be resolved through n-epenthesis.

(68) Input un+homme

a.	Step 1: Select UR	/ɛ̃/+ /ɔm/
b.	Step 2: Phonology	ɛ̃n ɔm
c.	Output	[ɛ̃n ɔm]

For a word like *bon*, in which suppletion can avoid hiatus, hiatus is resolved at UR selection.

(69) Input bon+homme

a.	Step 1: Select UR	/bɔn/ + /ɔm/
b.	Step 2: Phonology	—
c.	Output	[bɔn ɔm]

Although they occur at different steps, both UR selection and phonology conspire to avoid hiatus.

For simple cases like *un* and *bon*, it seems that parallel URC and the derivational alternative work equally well. They both capture the pattern, and they both capture the conspiracy between suppletion and epenthesis. The place where they diverge is cases of variation.

Words like *mon* sometimes undergo suppletion and sometimes undergo epenthesis: [mɔn ɔm] and [mɔ̃n ɔm]. However, these words never occur with a hiatus, and forms like [mɔ ɔm] and [mɔ̃ ɔm] are unattested. To capture this generalization in a derivational account, *mon* can resolve hiatus at step 1 or step 2, but must always resolve hiatus at one or the other.

(70) Input mon+homme

a. Step 1: Select UR — /mɔn/+ /ɔm/
b. Step 2: Phonology — —
c. Output — [mɔn ɔm]

(71) Input mon+homme

a. Step 1: Select UR — /mɔ̃/ + /ɔm/
b. Step 2: Phonology — mɔ̃n ɔm
c. Output — [mɔ̃n ɔm]

The problem is the second derivation above. Under this derivation, UR selection creates an intermediate form that violates hiatus, even though there's a perfectly well-formed alternative. Why should the grammar choose /mɔ̃/ when /mɔn/ is a possibility?

Whatever answer is provided, it must account for the fact that we never see the grammar do similar things with non-nasal vowels. For example, imagine *beau* were like *mon*, and UR selection at step 1 sometimes created hiatus.

(72) Input beau+homme

a.	Step 1: Select UR	/bo/ + /ɔm/
b.	Step 2: Phonology	—
c.	Output	bo ɔm[3]

The derivational account must be restricted: the only time that UR selection may create an intermediate form with a hiatus is when a repair is available. To model this, UR selection needs lookahead to phonology: the grammar needs to know whether a marked structure at Step 1 can be fixed at Step 2.

In URC, this sort of problem is avoided. Since the candidate set contains all combinations of possible URs and repairs, UR selection has full access to the output of repairs, and since URC is monostratal, there is never need to posit intermediate forms with marked structure.

4.7 Hiatus in French

In this section, I present more examples of hiatus avoidance in French, supporting an analysis in which PCA is driven by ∗Hiatus. There are three repairs where hiatus avoidance can be observed: schwa deletion, schwa epenthesis, and glide formation.

French schwa ([œ]) is a well-known case of hiatus avoidance. Schwa is obligatorily deleted before a vowel, but not before a consonant (Dell 1973). This is even represented in the orthography for the clitics *je*, *le*, *me*, *de*, and *ne*.

(73) Schwa deletion

a.	je ne pense pas	je n’ose pas
b.	le garçon	l’homme
c.	je pense	j’ose

3 unattested

There are some exceptional cases where schwa doesn't delete before a vowel, and these schwas may be preserved for morphosyntactic reasons (Dell 1985 p. 258).

Schwa epenthesis is likewise conditioned by hiatus. While nearly obligatory in the context CC_C, epenthesis cannot occur in the context CC_V (Charette 1991).

(74) Schwa ([œ]) epenthesis

a.	garde-robe	[gaʁd œ ʁɔb]
	CC___ C	*[gaʁd ʁɔb]
b.	garde-arme	[gaʁd aʁm]
	CC___ V	*[gaʁd œ aʁm]

One explanation is that epenthesis before a vowel is blocked because it creates a hiatus. Epenthesis also occurs before h-aspiré words, and in this context, these words behave differently than both C-initial and V-initial ones (see Boersma 2007 and references within).

Finally, in French, a process of glide formation turns high vowels /i u y/ into their corresponding glides [j w ɥ] before vowels, avoiding a hiatus (Kaye and Lowenstamm 1984; Tranel 1987).

(75) Glide formation (Tranel 1987: 119)

scie	[si]	’saw’
scier	[sje] *[sie]	’to saw’
défi	[defi]	’challenge’
défier	[defje] *[defi]	’to challenge’
tue	[ty]	’kills’
tuer	[tɥe] *[tye]	’to kill’
mue	[my]	’shedding’
muer	[mɥe] *[mye]	’to shed’
secoue	[sœku]	’shakes’
secouer	[sœkwe] *[sœkue]	’to shake’
loue	[lu]	’rents’
louer	[lwe] *[lue]	’to rent’

These three repairs – schwa deletion, schwa epenthesis, and glide formulation – show that French actively avoids hiatus, and as a result, independently needs a constraint like ∗HIATUS.

4.8 Liaison is not gender suppletion

In this section, I address a final alternative analysis of French liaison: liaison is the result of gender suppletion. Before vowels, a feminine adjective is used in place of a masculine one (Steriade 1999; Tranel 1981b, 1996b; Perlmutter 1998). Gender suppletion follows from the observation that the liaison form of a masculine adjective typically resembles the feminine form.

Masc. citation	Masc. liaison form	Fem. citation
beau [bo]	bel [bɛl]	belle [bɛl]
bon [bɔ̃]	bon [bɔn]	bonne [bɔn]
petit [pœti]	petit [pœtit]	petite [pœtit]
vieux [vjø]	viel [vjɛj]	vielle [vjɛj]

Table 4.28: Liaison forms match feminine forms

Gender suppletion poses a challenge for the URC account. In URC, URs can only compete if they express the same features (§2.2.2). For URC, forms like [bɛl] must be listed twice: once as a possible realization of masculine *beau*, and again as the realization of feminine *belle*.

In the rest of this section, I argue in favor of double listing forms like [bɛl]. First, I show that the generalization that masculine liaison forms resemble feminine forms isn't very robust. Then, I show how historical sound change can account for adjectives in which this resemblence holds. Double listing of liaison forms isn't unique to URC, and many of the arguments here come from previous work arguing double-listing is necessary, especially Bonami, Boyé, and Tseng (2004).

There are many adjectives in which masculine suppletive forms don't match feminine forms. Steriade (1999) gives a number of adjectives that have three allomorphs. The masculine liaison form is unique – matching neither the masculine citation form nor the feminine form.

Masc.	Masc. liaison form	Fem. citation
gros [gʁo]	gros [gʁɔz]	grosse [gʁɔs]
grand [gʁɑ̃]	grand [gʁɑ̃t]	grande [gʁɑ̃d]
dernier [dɛʁnje]	dernier [dɛʁnjeʁ]	dernière [dɛʁnjɛʁ]
sot [so]	sot [sot]	sotte [sɔt]

Table 4.29: Steriade (1999): liaison forms that don't match feminine forms (but are close)

Steriade (1999) provides an analysis of these mismatches, claiming that the base of masculine liaison is the feminine form of the adjective, but this form is adjusted in various ways. The differences between *gros~grosse* and *grand~grande* follow from restrictions on liaison consonants: the majority of liaison forms end in [t] or [z] (as noted in §4.2). Steriade accounts for vowel differences in words like *dernier* and *sot* by analyzing the masculine liaison form as a compromise between the masculine citation form and the feminine citation form. The liaison form takes the final consonant of the feminine form, but the vowel must match the masculine citation form, in order to signal that the liaison form is masculine.

This account is challenged by a large number of cases in which a feminine form exists but isn't used to avoid hiatus, not even with adjustment (Morin 2003; Bonami, Boyé, and Tseng 2004). Bonami, Boyé, and Tseng (2004) report that there are a dozen such adjectives.

Masc.	Masc. liaison form	Fem. citation
froid [fʁwa]	froid [fʁwa]	froide [fʁwad]
chaud [ʃo]	chaud [ʃo]	chaude[ʃod]
vif [vif]	vif [vif]	vive [viv]

Table 4.30: Liaison forms that don't match feminine forms

As noted in Bonami et al. (fn. 11), Steriade's analysis, in which liaison [gʁɑ̃t] is derived from feminine [gʁɑ̃d], predicts liaison [fʁwat] from feminine [fʁwad], and liaison [ʃot] from feminine [ʃod]. These aren't the forms that are used, suggesting that the link between masculine liaison forms and feminine forms is not productive.

If masculine liaison forms and feminine forms are stored separately, as I argue here, there needs to be some explanation for their similarities. With the exceptions noted above, most masculine liaison forms are identical to feminine adjectives.

In the rest of the section, I present a historical explanation for this resemblence. The basic account is that feminine adjectives were once derived from masculine ones, and due to sound change, the feminine forms of adjectives grew to resemble the masculine liaison forms. This explanation can account for most similarities,

First, I consider the source of liaison consonants in masculine nouns. This discussion here summarizes the history of final consonants from Morin (1986).

The majority of liaison consonants come from fixed final consonants which became unpronounced between the 12th and 16th centuries. These fixed consonants can still be seen in the orthography, e.g. the final *t* in *petit*. The loss of final consonants happened first before consonants, and then phrase-finally. Before vowels, these final consonants were retained, where they remain today in liaison contexts. I show this in the derivation below, in which an unpronounced consonant is in parentheses.

(76) Simplified history of liaison for modern day *petit*

Old French	petit	petit V	petit C
C-dropping except before V	peti(t)	petit V	peti(t) C
Modern French	peti(t)	petit V	peti(t) C

L-final words underwent a very similar change with the vocalization of L before consonants (Clédat 1917; Laks and Le Pesant 2009). As a result of this change, *bel* turned into *beau*, except before vowels, where it retained its original form. The discussion of L-vocalization is simplified here. In reality, the change from [l] to [o] happened over multiple stages, with diphthongs at intermediate steps (Laks and Le Pesant 2009 fn. 2). These diphthongs are reflected in the modern spelling.

(77) Simplified history of liaison for modern day *beau*

Old French	bel	bel V	bel C
C-vocalization except before V	beau	bel V	beau C
Modern French	beau	bel V	beau C

As further evidence of L-vocalization, consider singular-plural pairs like *cheval* ([ʃœval]) and *chevaux* ([ʃœvo]). This alternation follows from the fact that the plural suffix (seen in the spelling as *x* or *s*) was once consonantal, resulting in vocalization in the plural but not the singular.

(78) Vowel-liquid alternations in singular-plural pairs (Laks and Le Pesant 2009)

a. cheval/chevaux, travail/travaux, ciel/cieus

b. bal/baus, portail/portaus, col/cous, rossignol/rossignous, appel/appeaus

For *petit* and *beau*, then, we can trace the form of the liaison form back to historical consonant loss and L-vocalization. So why do these liaison forms happen to resemble the feminine adjectives?

The answer is that French feminine adjectives were once derived from masculine adjectives via suffixation. Feminine gender was marked with a suffix -e, pronounced as a schwa, resulting in masculine-feminine pairs like *petit*[pətit] and *petite*[pətitə]. Once this schwa disappeared, the masculine liaison form and the feminine form became identical.

This schwa is also the reason that feminine adjectives don't undergo liaison. Liaison forms resulted from final C-dropping, and the feminine suffix provided protection against C-dropping. After C-dropping occurred and liaison forms appeared, final schwas (including the feminine suffix) disappeared, resulting in the modern forms.

(79) Simplified history of liaison: feminine *petite*

Old French	[pətitə]	[pətitə] V	[pətitə] C
C-dropping except before V	[pətitə]	[pətitə] V	[pətitə] C
Word-final schwa loss	[pətit]	[pətit] V	[pətit] C
Modern French	[pətit]	[pətit] V	[pətit] C

For comparison, the history of masculine *petit* is below.

(80) Simplified history of liaison: masculine *petit*

Old French	[pətit]	[pətit] V	[pətit] C
C-dropping except before V	[pəti]	[pətit] V	[pəti] C
Word-final schwa loss	[pəti]	[pətit] V	[pəti] C
Modern French	[pəti]	[pətit] V	[pəti] C

We can see the result of these processes in spelling, which reflects earlier pronunciations. Final orthographic *e* and final consonants are unpronounced, due the C- and schwa-dropping, but consonants *are* pronounced if they're followed by an *e*. Generally, French feminine adjectives are spelled with a final unpronounced vowel (the now-lost suffix), and masculine adjectives are spelled with a final unpronounced consonant (the dropped consonant).

As discussed in Morin (1986), final consonant loss alone is not sufficient to explain the entire system. There are a variety of other forces responsible for the rise of liaison, such as analogy, which may have resulted in the loss of liaison for some words, and orthography, which may have resulted in the restoration of some previously unpronounced consonants.

In conclusion, masculine liaison forms resemble feminine forms due to history, and not because feminine forms are being recruited for liaison. Masculine liaison forms resemble feminine because of an Old French gender suffix, together with processes of C-dropping and schwa loss.

4.9 Chapter 4 conclusion

This chapter presented a URC analysis of French liaison, focusing on cases that are typically treated as exceptions. UR constraints provide an analysis for numerals and Ṽ-final words, cases subject to both idiosyncratic defaults and variation. These data are challenging for alternative accounts, in which liaison is the result of epenthesis or floating consonants.

This chapter also explored the typology of UR constraints, showing that only optimizing patterns are possible for Ṽ-final words and numerals. There's no way for UR constraints to usurp the general phonology of a language. If an allomorph is the default, it will be used whenever possible, only abdicating when another UR is able to avoid a violation of a high-ranked markedness constraint.

Like the other case studies, French liaison demonstrates the interaction of PCA and phonological repairs. Both conspire to avoid the same marked structures, although words and speakers differ in their preferred strategies for markedness avoidance. In the case of liaison, some speakers prefer n-epenthesis, and some prefer to use the non-default. Fine-grained differences between these speakers can be captured using weighted UR constraints, evaluated at the same time as repairs.

CHAPTER 5

-(A)LICIOUS AND -(A)THON

5.1 Overview of Chapter 5

In this chapter, I present a case study of the English suffixes *-(a)licious* and *-(a)thon*. Each suffix has two allomorphs – e.g. [əlɪʃɨs] and [lɪʃɨs] – conditioned by phonology. The schwaful allomorph tends to occur after consonants and stressed syllables, and the schwaless allomorph tends to occur after vowels and unstressed syllables.

(1) Two examples of *-(a)licious*

a. That part of town is *oak-alicious*.

[ok-əlɪʃɨs] *[ok-lɪʃɨs]

b. That part of town is *holly-licious*.

[hɑli-lɪʃɨs] *[hɑli-əlɪʃɨs]

As with the other cases in the dissertation, I argue that this is case of PCA, and its phonological conditioning is a result of the general phonological grammar. Speakers recruit existing constraints, like ∗Clash and ∗Hiatus, to decide between [əlɪʃɨs] and [lɪʃɨs]. The alternative, which I argue against, is that phonological conditioning is the result of subcategorization. Under this alternative, phonological conditioning is encoded in the lexicon on a suffix-by-suffix basis, independent of the phonological grammar.

The first half of the chapter focuses on the distribution of *-(a)licious* and *-(a)thon*. I argue that they are suffixes, not blends, and the choice between schwaful and schwaless forms is sensitive to the final segment and stress pattern of the stem. Moreover, I show that *-(a)licious* interacts with the Rhythm Rule, providing another example of the chicken-egg effect. These generalizations come from two sources: data from the Corpus of Global Web-based English (GloWbE) and a judgment experiment.

Along the way, I present a number of arguments for the LWC Hypothesis. Treating the suffixes as the result of the English phonological grammar can account for their acquisition in the face of sparse data, their interaction with phonological rules, and the degree of overlap between allomorphic conditioning, phonotactics, and phonological repairs.

The second half of the chapter provides a URC account (using MaxEnt Harmonic Grammar) of the full set of generalizations. This model has three pieces:

- Phonological conditioning follows from weighted phonological constraints.
- UR selection is evaluated at the same time as phonological processes.
- Preferences between URs come from the relative weights of UR constraints.

UR constraints provide a means to capture the fact that the baseline rate of schwa differs between the two suffixes, and it also provides a framework in which this baseline difference can be learned using existing learning algorithms.

The chapter is outlined as follows. In §5.2, I provide background on *-(a)licious* and *-(a)thon*: their meaning and basic phonological conditioning. In §5.3, I present arguments for LWC Hypothesis. §5.4 argues in favor of the PCA account, against alternatives such as morpheme-specific phonology or blending. In §5.5, I present the results of a corpus search, which demonstrate the distribution of *-(a)licious* and *-(a)thon*, as well as showing that there is sparse evidence for learners with respect to the suffixes' distribution.

In §5.6 and §5.7, I present the results of an experiment that further tests the claim that PCA is conditioned by markedness constraints. In §5.6, the experiment tests stems with phonological shapes that are under-attested in the corpus. These stems behave as predicted by the account with ∗Hiatus and ∗Clash. In §5.7, I present experimental suggesting evidence that *-(a)licious* is sensitive to the Rhythm Rule, supporting both a parallel model and the use ∗Clash.

Finally, in §5.8, I present a MaxEnt model of the experimental results. The model of *-(a)licious* and *-(a)thon* can account for both their common phonological conditioning and their differing preferences with respect to schwa. The weights of the constraints correspond closely to the distribution of words in the English lexicon, suggesting that the same constraints are also active in phonotactics. The section concludes by showing that an English phonotactic grammar by itself cannot account account for the distribution of *-(a)licious* and *-(a)thon*. An additional mechanism like UR constraints is necessary.

5.2 Background

This section provides background on *-(a)licious* and *-(a)thon*: their meaning, phonological distribution, and morphological properties. I show that *-(a)licious* and *-(a)thon* pattern in many ways like well-established English suffixes.

5.2.1 -(a)licious: overview and conditioning

-(a)licious is a productive derivational suffix, which creates adjectives from nouns. Derived adjectives have one of the meanings below.

(2) NOUN-licious (1): Possessing characteristics of NOUN (and this is positive).

(3) NOUN-licious (2): Containing an abundance of NOUN (and this is positive).

Two notes on these definitions. First, *-(a)licious* selects for nouns, but it can also take adjectives, e.g. *sexy-licious*. Adjective-derived *-(a)licious* words are less common, and some speakers even find them ungrammatical. This is supported in corpus results in §5.4. Second, words derived by the suffix always have a positive connotation.

Negative *-(a)licious* words occur very rarely, and perhaps only sarcastically. The only unambiguously negative word I've encountered is *barf-a-licious*.

Here are a few real-world examples, taken from the Corpus of Contemporary American English (COCA: Davies 2008-). COCA is a collection of spoken and written English from 1990–2012.

(4) But her new show, 'Cougar Town' is stirring up a lot of **cougarlicious** controversy. (CNN Showbiz 2009)

(5) …embrace our **body-licious** curves. (People Magazine 2007)

(6) British Columbian back county skiing: It's **tree-licious**! (Skiing 2005)

(7) ER's George Clooney and Noah Wyle play two **hunkalicious** M.D.'s whom Monica and Rachel date. (Entertainment Magazine 2001)

(8) The gourmet concoction, while not much more difficult, is equally **starchilicious**. (Atlanta Journal Constitution 1996)

In these examples, we find both meanings of *-(a)licious*. Back county skiing is *tree-licious* because it's full of trees (but does not possess characteristics of a tree), while George Clooney is *hunkalicious* because he has the characteristics of a hunk (but is not full of hunks). Some cases, e.g. *starchilicious*, are ambiguous between the two meanings.

These examples also show that *-(a)licious* is trendy, and lacks a standardized spelling. Examples are especially common in magazines and TV shows that address popular culture (CNN Showbiz, People, Entertainment, etc.). It can be spelled with a hyphen or without. The schwa is spelled most often with the vowels *a* or *i*, sometimes *o*, and almost never *e*. More notes on spelling can be found in the corpus discussion in §4.4. For the rest of the chapter, I always spell the schwaful form as *-alicious*.

History. The suffix *-(a)licious* is relatively new, having only attained the suffixhood as recently as the 1990s. Zimmer (2006) and Zwicky (2006) discuss its productivity and history on the website Language Log. Zimmer (2006) shows that early uses of *-(a)licious* in the 1940s–1960s took it as a blend component. Blends were often only one segment removed from *delicious*, and described delicious things. Some examples are *tea-licious* (describing tea), *sea-licious* (describing shrimp), and *bee-licious* (describing honey). As shown by the COCA examples above, modern usage of *-(a)licious* allows a more diverse set of stems and meanings. Now, a licious-word needn't be related to food or rhyme with *delicious*.

Zwicky (2010) (in another blog post) names *-(a)licious* and other neologistic suffixes *libfixes*. Libfixes are suffixes that have been *liberated* from their source words, and are bound like suffixes but have meanings similar to compounds. Some other common libfixes are *-gate*, as in *bridgegate*, and *-holic*, as in *workaholic*. Bauer (2006) calls these types of suffixes *splinters*, citing *-(e)teria*, *-(a)nomics*, and *-scape* as examples. According to Bauer, repeated blends with a word result in re-analysis as a morpheme. This seems be the case for *-(a)licious*, which transitioned from a blend component (as in *bee-licious*) to a full-fledged derivational suffix (as in *dog-a-licious*). More arguments that *-(a)licious* is a suffix follow in §5.4.

Phonology. One property of *-(a)licious* that has not received any attention is its phonological conditioning.

Like many derivational suffixes in English, *-(a)licious* is conditioned by the stress pattern of the stem: stems with final stress prefer *-alicious*. This is shown below with more examples taken from the non-fiction portions of COCA. I indicate my judgments for stress with overset numbers: 1 indicates primary stress, 2 indicates secondary stress, and so on. Unstressed syllables are unnumbered.

...σ́-$\underline{\text{a}}$licious	...σ̆-licious
c$\overset{2}{\text{u}}$rve $\underline{\text{a}}\overset{1}{\text{l}}$icious	r$\overset{2}{\text{u}}$by $\overset{1}{\text{l}}$icious
h$\overset{2}{\text{u}}$nk $\underline{\text{a}}\overset{1}{\text{l}}$icious	t$\overset{2}{\text{u}}$rkey $\overset{1}{\text{l}}$icious
st$\overset{2}{\text{a}}$rch $\underline{\text{a}}\overset{1}{\text{l}}$icious	c$\overset{2}{\text{o}}$ugar $\overset{1}{\text{l}}$icious

Table 5.1: Effect of stress, examples from COCA

The type of final segment also plays a role. Stems with final consonants prefer *-alicious*, while stems with final vowels prefer *-licious*. This is shown below with more COCA examples.

...C-$\underline{\text{a}}$licious	....V-licious
curve $\underline{\text{a}}$licious	tree licious
hunk $\underline{\text{a}}$licious	jew licious
low carb $\underline{\text{a}}$licious	ruby licious

Table 5.2: Effect of final segment, examples from COCA

In COCA, the suffix has a third form: *-icious*. This form occurs with L-final stems, as in *bottle-icious*. It's unclear whether this form results from suppletion or is derived from *-licious* via L-deletion, so I won't discuss it at length here.

Optionality. The examples above present an idealized view of *-(a)licious*. In actual use, the suffix is subject to a great deal of optionality. Consonant-final stems tend to take *-alicious*, but don't always, and likewise for final-stressed roots. For example, both *babe-licious* and *babe-alicious* are attested in COCA.

This variation is reflected in speaker intuitions, which are sometimes uncertain, especially for words with conflicting stress and segmental requirements. For example, *cactus* should take *-licious* according to stress requirements, but *-alicious* according to segmental requirements. As a result, many speakers lack a clear preference between *cactus-licious* and *cactus-alicious*, reflected in both the corpus and experimental results.

In the table below, I preview the experimental results from §5.6. These results demonstrate independent effects of final stress and final segment, along with the intermediate status of cactus-type words.

Context	Example	Proportion schwa
	$\text{pol}\overset{2}{\text{i}}\text{ce }\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$	0.91
C-final iamb	>>	>>
	$\text{pol}\overset{2}{\text{i}}\text{ce l}\overset{1}{\text{i}}\text{cious}$	0.09
	$\text{c}\overset{2}{\text{a}}\text{ctus }\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$	0.39
C-final trochee	<	<
	$\text{c}\overset{2}{\text{a}}\text{ctus l}\overset{1}{\text{i}}\text{cious}$	0.61
	$\text{h}\overset{2}{\text{e}}\text{ro }\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$	0.05
V-final trochee	<<	<<
	$\text{h}\overset{2}{\text{e}}\text{ro l}\overset{1}{\text{i}}\text{cious}$	0.95

Table 5.3: Proportions of *-(a)licious* from the experiment in §5.6

To summarize the section, *-(a)licious* is subject to variation, and conditioned by both the final segment and stress of the stem. The next two sections address other English derivational suffixes with a similar distribution, starting with *-(a)thon*.

5.2.2 -(a)thon: overview and conditioning

The suffix *-(a)thon* shares many properties with *-(a)licious*, and I use it throughout the chapter as a point of comparison. *-(a)thon* is a derivational suffix, creating nouns from verbs and nouns. It has two forms: [θɑn] and [əθɑn].

-(a)thon can have the two meanings below.

(9) X-thon (1): An event that involves repeated instances with X or cases of Xing (X=NOUN or VERB)

(10) X-thon (2): A fundraiser to benefit X (X=NOUN)

The phonological conditioning of *-(a)thon* is similar to that of *-(a)licious*. Like *-(a)licious*, it's conditioned by both final stress and final segment. The proportions below come from the experiment in §5.6.

Context	Example	Proportion schwa
	pol$\overset{1}{i}$ce $\underline{a}$th$\overset{2}{o}$n	0.98
C-final iamb	>>	>>
	pol$\overset{1}{i}$ce th$\overset{2}{o}$n	0.02
	c$\overset{1}{a}$ctus $\underline{a}$th$\overset{2}{o}$n	0.71
C-final trochee	>	>
	c$\overset{1}{a}$ctus th$\overset{2}{o}$n	0.29
	h$\overset{1}{e}$ro $\underline{a}$th$\overset{2}{o}$n	0.24
V-final trochee	<<	<<
	h$\overset{1}{e}$ro th$\overset{2}{o}$n	0.76

Table 5.4: Proportions of *-(a)thon* from the experiment in §5.6

There are three main differences between *-(a)licious* and *-(a)thon*. First, *-(a)thon* is more likely to occur with a schwa than *-(a)licious*. This difference holds across all word types, and can be observed in both the corpus and experimental results later in the chapter.

Second, *-(a)licious* takes main stress in its derived words, while *-(a)thon* takes secondary stress. This is shown below for the stem *hero*. Judgments for stress are my own, but have been informally confirmed by at least a dozen English speakers.

(11) Stress differences between *-(a)thon* and *-(a)licious*

a. h$\overset{1}{e}$ro th$\overset{2}{o}$n

b. h$\overset{2}{e}$ro l$\overset{1}{i}$cious

Third, *-(a)thon* is one of many derivational suffixes in English that causes stress to shift rightwards in its stem. The examples below show *-(a)thon* causing rightwards movement of stress, along with the suffixes *-al*, *-ic*, and *-ity*, which exhibit the same behavior. All of these suffixes take secondary stress in derived words.

(12) Examples of stress shift

a.	únderwear	underwéar-athòn
b.	Íceland	Icelánd-athòn
c.	cónsonant	consonánt-al
d.	Íceland	Icelánd-ic
e.	vírgin	virgín-ity

Stress shift is only possible when V-initial *-athon* is used. If *-thon* is used, stress shift is impossible.

(13) Examples of stress shift

a.	úndérwèar	underwéar-athòn	
b.	úndérwèar	úndérwear-thòn	*underwéar-thòn
c.	phónème	phonéme-athòn	
d.	phónème	phóneme-thòn	*phonéme-thòn

This suggests that rightwards stress shift provides a means to satisfy the rhythmic requirements of *-(a)thon*. When *-athon* is used, stress shift applies creating a final-stressed root, the type of stem that *-athon* prefers. However, when *-thon* is used, stress shift is impossible, because such a shift would violate the phonological conditioning of the suffix. Beyond these examples, I don't discuss the stress-shifting behavior of *-(a)thon*, but in §4.7, I present experiment evidence that shows *-(a)licious* interacts with the Rhythm Rule to avoid stress clash in a similar way.

5.2.3 Related suffixes

Although there is no previous work on the phonological conditioning of *-(a)licious* or *-(a)thon*, many other libfixes and suffixes follow a similar distribution.

Siegel (1974)'s description of the suffix *-(e)teria* suggests that it's subject to the same stress conditioning as *-(a)licious*. Just like *-(a)licious*, the schwaful form of *-(e)teria* tends to occur with final-stress stems, and the schwaless form tends to occur with non-final-stress stems. In the examples below, a *(t)* indicates that the *t* is not present in the spelling, and stress has been added.

...σ́+.e.teria	...σ̆+teria
c$\overset{2}{\text{a}}$ke et$\overset{1}{\text{e}}$ria	b$\overset{2}{\text{a}}$sket (t)$\overset{1}{\text{e}}$ria
cl$\overset{2}{\text{e}}$an et$\overset{1}{\text{e}}$ria	ch$\overset{2}{\text{o}}$colate (t)$\overset{1}{\text{e}}$ria
h$\overset{2}{\text{a}}$t et$\overset{1}{\text{e}}$ria	c$\overset{2}{\text{a}}$sket (t)$\overset{1}{\text{e}}$ria
f$\overset{2}{\text{u}}$rnit$\overset{3}{\text{u}}$re et$\overset{1}{\text{e}}$ria	c$\overset{2}{\text{a}}$ndy t$\overset{1}{\text{e}}$ria
dr$\overset{2}{\text{y}}$g$\overset{3}{\text{o}}$ods et$\overset{1}{\text{e}}$ria	r$\overset{2}{\text{a}}$dio t$\overset{1}{\text{e}}$ria

Table 5.5: Siegel (1974): examples of *-teria* and *-eteria*

This suffix is especially relevant since it's a derivational libfix just like like *-(a)licious*. However, the suffix is not contemporary, and younger speakers (born in the 80s and later) lack intuitions about its distribution and meaning. In fact, Siegel (1974)'s examples are discussed in Mencken (1936), who cites even earlier work.

Beyond *-(e)teria*, there are many contemporary libfixes that follow the same pattern. An informal survey of Wiktionary, an open-source dictionary, suggests that all of the suffixes below are similarly conditioned by stress. For nearly all of the suffixes, the alternating vowel is schwa, although some of them are occasionally pronounced with

[o] (*-orama, -ophile, -onomics*), and *-(ma)geddon* has a CV syllable that alternates. More examples, along with meanings from Wiktionary, are included in the appendix.[1]

(14) Alternating libfixes that are similar to *-(a)licious* and *-(a)thon*

-(o)rama	-(ma)geddon	-(o)phile
-(i)riffic	-(i)verse	-(a)holic
-(o)gram	-(a)pedia	-(i)vore
-(a)saurus	-(o)nomics	

There are also libfixes with a single fixed form and no alternating vowel. All of these begin with a consonant.

(15) Non-alternating libfixes

-gate	-tastic	-zilla

Non-alternating libfixes like *-gate* and *-tastic* come from source words in which the libfix is preceded by a consonant, while the alternating ones like *-(a)holic* come from source words with a vowel before the suffix. This seems to be a good predictor of whether a libfix will alternate, and a full list of source words is in the appendix.

Outside of libfixes, there are many well-established derivational suffixes in English that obey similar phonological conditioning. One that particularly resembles *-(a)licious* is *-(e)ry*. The suffix has two forms [ɹi] and [əɹi]: [əɹi] occurs after stressed syllables, and [ɹi] after unstressed ones.

(16) Stress conditioning of *-(e)ry*

a. villianry — víllian-ry

b. chickenry — chícken-ry

[1] A growing list of libfixes can be found on Arnold Zwicky's blog (http://arnoldzwicky.org/category/morphology/libfixes/). His list includes many of the ones here, along with observations about libfixes in the wild.

c. dentistry déntist-ry

d. comicry cómic-ry

e. brewery bréw-ery

f. quippery qúip-ery

g. clownery clówn-ery

The suffix *-ery* also resembles *-athon* with respect to stress shift. In the examples below, *-ery* causes stress to shift to the final syllable, resulting in surface forms that obey the phonological requirements of *-(e)ry*.

(17) *-ery* after compounds

a. pósthoc posthóck+ery

b. búllshit bullshít+ery

c. ásshat asshátt+ery

d. ássclown assclówn+ery

e. dóuchebag douchebágg+ery

The phonological conditioning of other derivational suffixes is discussed in §3.2 with respect to hiatus avoidance and §5.3 with respect to stress clash avoidance, and even more cases of phonologically-conditioned derivation can be found in Raffelsiefen (2004) and Plag (1999).

5.3 Driven by ∗Clash and ∗Hiatus

Given the distribution of *-(a)licious* and *-(a)thon*, the natural question is where phonological conditioning comes from. I consider two possibilities: conditioning is the result of language-wide constraints (the LWC Hypothesis: §2.4.1); or conditioning is the result of subcategorization. Each of these possibilities is sketched below. In this section, I focus on *-(a)licious*, but all of the argumentation applies equally to *-(a)thon*.

(18) The LWC Hypothesis: the distribution of *-(a)licious* is phonologically optimizing. It's the result of a ranking of pre-existing markedness constraints like ∗Clash and ∗Lapse.

(19) SubH: the distribution of *-(a)licious* is the result of phonological subcategorization. The phonological contexts for *-(a)licious* are lexically listed.

As with the other cases in the dissertation, I argue for the LWC Hypothesis.

The LWC Hypothesis. Under the analysis here, the phonological grammar of English conditions *-(a)licious*. Three constraints in particular are responsible.

(20) ∗Clash

Assign one violation for every sequence of two stressed syllables.

(21) ∗Lapse

Assign one violation for every sequence of two unstressed syllables.

(22) ∗Hiatus

Assign one violation for every sequence of two vowels.

∗Clash and ∗Lapse capture the generalization that *-(a)licious* optimizes rhythm, avoiding sequences of consecutive stressed or unstressed syllables. In the examples below, forms with alternating rhythm are judged as better than forms with clashes and lapses.

(23) Examples with perfect rhythm

σσ́+σσ́	police-alicious
	police-athon
σ́σ+σ́σ	cactus-licious

(24) Examples with a stress clash or lapse

σσ́+σ́σ *police-licious

σ́σ+σσ́ ?cactus-alicious

∗Hiatus captures the generalization that allomorphy avoids VV sequences, as in **hero-alicious* and **hero-athon*. As the experimental results will show, speakers are especially sensitive to hiatus between a lax vowel and a full vowel, which follows from the English constraint ∗ə.V from Chapter 2.

Subcategorization. Under the alternative account, all phonological conditioning results from subcategorization frames. For example, a subcategorization frame requires *-alicious* to combine with stress-final, consonant-final stems, while *-licious* occurs elsewhere.

(25) *-alicious* ↔ C ___

(26) *-alicious* ↔ σ́ ___

(27) *-licious* elsewhere

Under this account, language learners must acquire suffix-specific selectional requirements. Any resemblance between alternations, phonotactics, and suffixal selectional requirements is a coincidence, although diachrony can be used to explain similarities across suffixes (see Berg 2011 for an example).

Differences between the accounts. Under the LWC Hypothesis, phonological constraints on PCA are completely independent of the lexicon. Their effects should emerge regardless of the suffix at hand, and the same constraints hold outside of suffixation, in phonotactics and alternations.

The support for the LWC Hypothesis is repeated below (from §2.4.1). I show that all of these predictions hold for *-(a)licious*.

(28) The LWC Hypothesis is supported when PCA-conditioning constraints are active elsewhere in the same language.

a. They condition other cases of PCA.

b. They condition phonotactics.

c. They condition repairs.

In this chapter, I consider two more kinds of support for the LWC Hypothesis.

(29) The LWC Hypothesis is also supported when:

a. There's insufficient data to learn the affix's distribution.

b. There's no historical explanation for the affix's distribution.

Since a speaker recruits the existing phonological grammar to decide between suffixes, he doesn't need to actually learn a suffix's particular phonological requirements. Furthermore, we expect similarities between suffixes, since they're all conditioned by the same constraints. We don't need to look to history for explanations of cross-suffix similarity.

There's one final requirement for any account that assumes language-wide constraints. Since everything follows from a single grammar, there must be some consistent ranking or weighting of constraints for all cases.

(30) Requirement of the LWC Hypothesis

There is a consistent constraint ranking for PCA and repairs.

In the URC account of *-(a)licious* and *-(a)thon* in §5.8, I show that it's possible to account for the distribution of both suffixes with a single weighting of markedness constraints. Moreover, I show that English phonotactics are consistent with the model's weights of ∗Clash, ∗Hiatus, and ∗Lapse, even though the constraint weights were determined using only the *-(a)licious* and *-(a)thon* data.

In the next sections, I consider each piece of support for the LWC Hypothesis.

5.3.1 PCA-conditioning constraints are active elsewhere in the same language

The constraints *Hiatus, *Clash, and *Lapse show effects throughout English.

As shown in §3.2, hiatus is avoided throughout English, including PCA with *a(n)* and a number of hiatus-conditioned repairs, such as glottal stop epenthesis and vowel reduction. I won't repeat the data here.

The rhythmic constraints *Clash and *Lapse also show effects across English. Rhythmic constraints condition a large number of cases of grammatical variation:

- derivation with the suffixes *-ese*, *-al*, *-eer*, *-ee*, *-ette*, *-ize*, and *-ify* (Raffelsiefen 1999)
- the dative alternation, *give John the book* vs. *give the book to John* (Anttila, Adams, and Speriosu 2010)
- the genitive alternation, *the car's wheel* vs. the *wheel of the car* (Shih et al. 2015)
- optional *to* (Wasow, Greene, and Levy 2012)
- optional *that* (Lee and Gibbons 2007)
- word order in conjoined NPs (McDonald et al. 1993)

English also has a phonological repair that enforced rhythmic alternation. The Rhythm Rule, discussed later in this chapter, moves a word's stress in order to avoid stress clash.

Under the LWC Hypothesis, similarities between *-(a)licious*, *-(a)thon*, and these other alternations follow from the fact that all of the cases are conditioned by the same set of phonological constraints. All of these diverse processes conspire to satisfy the same constraints.

Under subcategorization, if there are other affixes that are subject to the same conditions, it's because they happen to have similar subcategorization frames.

5.3.2 There's no historical explanation for the affix's distribution

Why would so many suffixes have the same subcategorization frame? The most straightforward answer is that cross-suffix similarity follows from historical change. Many cases of PCA are the result of shared sound change, such as French liaison in §4.8 and the historical resemblence in English between *a*/*an*, *my*/*mine*, and *thy*/*thine* (Berg 2011).

While a historical account is available for cases like French liaison, no such account is available for libfixes. Libfixes are relatively novel and uncommon, and libfixes that have appeared during different periods of time, such as *-(e)teria* and *-(a)licious*, obey the same set of constraints.

5.3.3 There's insufficient data to learn the affix's distribution

Speakers who learn the distribution of *-(a)licious* must do so with very sparse data. In the 2 billion word corpus discussed in §4.4, most words with *-(a)licious* occur only once, and the most common *-(a)licious* words have the same phonological shape.

Despite this, speakers agree on the distribution of *-(a)licious* in the judgment experiment. If speakers don't learn the distribution of *-(a)licious* through observation, how do they learn it? The answer under LWC Hypothesis is that speakers simply extend their existing phonology to the new suffixes. All a speaker needs to learn is that there are two forms, *-licious* and *-alicious*, and the phonological grammar handles the rest.

5.4 Arguments for PCA

Throughout the dissertation, I treat the choice between *-licious* and *-alicious* as an instance of PCA. Under this account, *-licious* and *-alicious* have separate URs, and the choice between URs is conditioned by phonology.

(31) Multiple UR account: $\left/\begin{matrix}\text{əlɪʃɨs}\\ \text{lɪʃɨs}\end{matrix}\right/ \rightrightarrows \begin{bmatrix}\text{əlɪʃɨs}\\ \text{lɪʃɨs}\end{bmatrix}$

The alternative is that *-licious* and *-alicious* are derived from a single UR through epenthesis or deletion.

(32) Single UR account with [ə]-epenthesis: /lɪʃɨs/ → $\begin{bmatrix}\text{əlɪʃɨs}\\ \text{lɪʃɨs}\end{bmatrix}$

(33) Single UR account with [ə]-deletion: /əlɪʃɨs/ → $\begin{bmatrix}\text{əlɪʃɨs}\\ \text{lɪʃɨs}\end{bmatrix}$

In this section, I argue against both single UR accounts, along with the alternative that *-(a)licious* is the result of blending. Although this section focuses on *-(a)licious*, these arguments apply equally to *-(a)thon*.

5.4.1 Not deletion or epenthesis

The best argument against a single UR account is that schwa alternations are limited to subset of English suffixes.

If schwa were the result of a general process of epenthesis, we would expect it at every morpheme boundary in English, given the right phonological context. The suffixes below have no schwa, even with final-stressed, consonant-final stems. If the schwa in *police-alicious* is epenthetic, the same epenthesis rule should apply in *police-tastic*.

(34) Suffixes that never occur with a schwa, regardless of context

a. -wise:

police-wise   cactus-wise   *police-a-wise

b. -gate:

police-gate   cactus-gate   *police-a-gate

c. -zilla:

police-zilla   cactus-zilla   *police-a-zilla

d. -tastic:

police-tastic   cactus-tastic   *police-a-tastic

If the alternation were the result of deletion, we'd expect schwa deletion in the contexts that prefer the schwaless *-licious*. The suffixes below always occur with a schwa, even with unstressed V-final stems. These are the stems that strongly disprefer schwa in *-athon* and *-alicious*.

(35) Suffixes that always occur with schwa, regardless of context

a. -able:

delayable	carryable	*carry'ble (*[kæɹibl̩])

b. -ability:

delayability	carryabiliity	*carry'bility (*[kæɹibɪlɨɾi])

5.4.2 Not a minor rule

Another possibility is that schwa is the result of morpheme-specific epenthesis or deletion. Under this account, *-(a)thon* and *-(a)licious* both exhibit the same type of schwa alternation because they are subject to the same phonological processes.

This can account for some of the things that are coincidence in the PCA account. For example, most libfixes have an alternating schwa. Under morpheme-specific epenthesis, the reason the alternating vowel is always schwa is that the schwa is the epenthetic vowels.

There are three challenges for an account with a minor rule or morpheme-specific epenthesis.

First, hiatus- and clash-avoidance are not specific to the suffixes *-(a)thon* and *-(a)licious*. Using a minor rule or a morpheme-specific markedness constraint misses the fact that clash and hiatus are avoided across *all* of English (see §3.6 for similar arguments for *a* and *an*).

Second, hiatus is resolved in English through other mechanisms, such as ʔ-epenthesis. It's difficult to create a ranking that favors ʔ-epenthesis in general, but ə-deletion in the case of *-alicious* and *-athon* (again, see §3.6 for an example with *a* and *an*).

Third, the rate of schwa differs between *-(a)licious* and *-(a)thon* (§4.4.3). This means that we need either two separate morpheme-specific rules/constraints, or some way to limit the rate of epenthesis/deletion for one of the suffixes. One possibility is frequency-conditioned deletion, but this doesn't seem plausible. In cases of frequency-conditioned deletion, such as schwa deletion in English (*astronomy*), more frequent words are more likely to undergo deletion (Hooper 1976). In the experimental results later in the chapter, subjects rated *-(a)thon* as more frequent than *-(a)licious* in both perception and production, consistent with the corpus counts. Based on this, we expect more deletion and less schwa for *-athon* than *-alicious*, contrary to the observed pattern in the data.

5.4.3 Not a blend

A final possibility is that *-(a)licious* is the product of blending. Under this analysis, *cactus-licious* is a combination of the words *cactus* and *delicious*.

(36) Examples of common blends

a. smoke+fog = smog

b. motor+hotel = motel

c. breakfast+lunch = brunch

There are three common properties of blends, all of which are contradicted by many modern *-(a)licious* words. The properties of blends come from Plag (2003).

(37) Properties of blends from Plag (2003)

a. Blends are semantically compositional, involving meanings of both components.

b. Blends are more likely between words of the same syntactic category.

c. Blends resemble the prosody of their component words.

d. Blends are formed by combining subparts of two words.

According to Plag (2003), the semantics of blends resembles that of copulative compounds, such as *actor-director* and *writer-journalist*. In a blend like *boatel* (from *boat*+*hotel*), both components contribute meaning: a *boatel* is both a *boat* and *hotel*. However, a word created with *-(a)licious* needn't relate to deliciousness, in terms of either sexiness or tastiness. For most speakers, something that is *puppy-licious* is not delicious in any sense of the word.

(38) I went to the pound, and boy was it puppy-licious. (the pound had lots of puppies, and it was great)

Blend-like semantics does hold for early usages of *-(a)licious*, before it became a suffix. As noted earlier, licious-words in the 1940s–60s typically related to food and drink. Such words are possible today, but so are words like *puppy-licious*.

Since both parts contribute meaning, blends are typically formed from words of the same syntactic category, e.g. two nouns or two adjectives. This is not the case for *-(a)licious* – which actually disprefers adjectives (§5.5). This is a weaker argument, however, since early *-licious* blends also occurred with nouns.

The next property of blends is that they resemble the prosody of their component words. For example, blends tend to be no longer than the longer of their two components (Plag 2003). This is not the case for words derived with *-(a)licious*, which are typically longer than both the stem and *delicious*. This holds for all of the disyllabic stems discussed in this chapter (*turkey-licious*, *cougar-licious*), which are at least four syllables long. Again, this requirement held of early uses of *-(a)licious*, which tended to only contain vowel-final monosyllabic stems: *tea-licious*, *bee-licious*, *sea-licious*.

There are other prosodic requirements in blending (see Arndt-Lappe and Plag 2013 for example), although the literature is subject to a lot of disagreement. The easiest way to see the prosodic differences between *-(a)licious* and true blends is to compare them directly. In the examples below, I give attested blends between monosyllabic words and trisyllabic words. The trisyllabic words have the same stress pattern as *delicious*, but in the derived blends, schwa is disfavored.

(39) Attested blends

a. mock + martini = mocktini, *mock-a-tini

b. gay + gestapo = gaystapo, *gay-a-stapo

c. man + bikini = mankini, *man-a-kini

In the equivalent licious-words, the schwa is required.

(40) *-(a)licious* words

a. curve-a-licious, *curve-licious

b. hunk-a-licious, *hunk-licious

c. starch-alicious, *starch-licious

As a final example of prosodic differences, consider *delightful* and *delicious*. Both are adjectives with the same stress pattern. According to my own intuitions, blends with *delightful* don't take a schwa, while licious-words prefer one. There are a few wrinkles here. V-final words like *tea* pattern identically for both *delightful* and *delicious*, and some blends with *delightful* seem impossible (marked with a question mark), especially for polysyllabic words.

(41) *delightful* and *delicious*

a. dog: *dog-lightful*, *dog-alicious*

b. tea: *tea-lightful*, *tea-licious*

c. hunk: *hunk-lightful*, *hunk-alicious*

d. babe: *babe-lightful*, *babe-alicious*

e. police: ?*police-lightful*, *police-alicious*

f. cactus: ?*booty-lightful*, *booty-licious*

The final property of blends is that they are commonly formed by concatenating subparts of two words. For example, *brunch* is formed from the onset of *breakfast* and the rhyme of *lunch*. In the corpus results, the majority (310/340) of licious-words are formed by taking a full, untruncated stem and adding *-licious* or *-alicious*.

It should be noted, however, that there are *-licious* words that seem to resemble blends. About 10% of the licious-words in the corpus contain a truncated root. An example is *coalicious*, from *coalition* and *licious*. This word obeys the prosodic conditions for blends described above. The fact that words like this are still used suggests that *-licious* is currently leading a double life, transitioning from full blend component (as it was in the 1960s) to full suffix.

The conclusion is that licious-words tend to be very different from blends. If they are blends, as has been suggested, then they are blends that pattern differently with respect to semantics, syntax, and phonology. While it's possible that there are two types of blends, ones like *smog* and ones like *booty-licious*, it's clear that latter type are more suffix-like along every dimension.

5.5 Corpus data

In this section, I use corpus data to show that *-(a)licious* and *-(a)thon* are used productively to derive new words, and the choice between allomorphs is influenced by both segmental and prosodic factors. These findings are replicated in the experiment presented later in the chapter, providing two independent, converging sources of evidence.

Given the corpus data alone, the exact prosodic factors that condition *-(a)licious* are unclear, and some stem shapes are under attested. If the corpus data are representative of a speaker's day-to-day language experience, it's unclear how speakers know the patterning of *-(a)licious*, if not through their existing phonological grammar.

5.5.1 Corpus methods for -(a)licious

The corpus search was conducted over the Corpus of Global Web-Based English (GloWbE:Davies 2013), a 1.9-billion-word corpus representing 20 different English-speaking countries. Since GloWbE is a corpus of web-based English, it includes user names, restaurant names, website names, etc., types of words which lend themselves to formation with *-(a)licious*.

I use type counts rather than token counts. Each different stem is counted only once, regardless of its number of tokens. If a stem occurs with both *-alicious* and *-licious*, it's counted once for each. Given how many items are proper names, token counts for *-(a)licious* and *-(a)thon* in GloWbE are not informative: the frequency of a blog name has more to do with its popularity than phonological shape. Moreover, most licious-words only occur once in the corpus.

The data were collected as follows. A search for words ending in *licious* yielded 437 different licious-words after initial exclusions.

(42) Initial exclusions:

a. Typos (e.g. *relicious* for *religious*)

b. Existing words (e.g. *cilicious*, *silicious*, *delicious*)

c. Spelling variants (multiple spellings counted only once, e.g. *babe-ilicious, babeolicious, babe-a-licious*)

Again, each licious-word was only counted once. I used the criteria below to determine whether two words were spelling variants. Coding was done by hand.

(43) Criteria for identifying stems

a. Words that differ only in their choice of *-(a)licious* vowel or hyphenation are counted as having the same stem

(i) *babe-a-licous*, *babe-o-licious*, *babe-alicious*, *babeolicious*, *babe-ilicious* are all counted as one stem – *babe*

b. Compound stems and non-compound stems are counted as having the same stem

(i) *YMC-book-alicious* and *book-alicous* are counted as one stem – *book*

(ii) *Pretty-boy-swagga-licious* and *swagga-licious* are counted as one stem – *swagga*

After the initial exclusions, there were 437 words. Out of these words, 127 more were excluded.

(44) The following were excluded:

a. 50 words with L-final stems (e.g. *xmlicious*, *tentpolicious*)

b. 30 words treated as blends, where part of the stem isn't present in the *-(a)licious* word (e.g. *Ferg-alicious* from *Fergie*)

c. 30 words whose stems couldn't be identified given the context (e.g. *vivalicious*, *yumbolicious*, *vogonalicious*)

d. 17 ambiguous stems (e.g. *bellicious* - *bell* or *belly*?)

L-final. Words with L-final stems were excluded, since they can take the third allomorph *-icious*. For an L-final stem like *bubblicious*, it's impossible to determine if the suffix is *-licious* or *-icious* based on spelling alone.

Blends. If only part of the stem was present, a word was considered a blend and excluded. For example, *cavalicious* is a blend between *cavalier* and *delicious*. Determining stemhood required checking the context. These are listed in the appendix.

Only 30/437 words were counted as blends. All of the remaining licious-words include a full stem.

Unidentifiable and ambiguous stems. Some words are ambiguous between multiple parses. For example, *lanalicious* is compatible with both the parses *Lana-licious* and *LAN-alicious*. The same is true for *owlicious* (owl-icious or ow-licious) and *bootilicious* (boot-alicious or booty-licious). Some of these stems can be disambiguated by context, e.g. if the topic of discussion is LAN parties and not Lana. Some can be disambiguated with punctuation, capitalization, or spelling.

Spelling. With respect to spelling, licious-words behave consistently, especially in hyphen placement. In the corpus, a hyphen may occur either: before a suffix (*babe-alicious*); both before a suffix and after the suffix's vowel (*babe-a-licious*); but never solely after a suffix's vowel (no words like *babea-licous*). A spelling of *booti-licious* supports the parse of booty+licious.

Final set of words. After all exclusions, there were 310 different licious-words. For each word, the stem is identifiable, complete, unambiguous, and does not end in L. Each stem was hand-coded for part of speech, final stress, final consonant, and number of syllables. In polysyllabic words, which were all disyllabic, only final *primary* stress was counted as final stress.

5.5.2 Distribution of -licious and -alicious

In the discussion of the corpus results, I use the stems below as category exemplars. A police-type stem has final stress and a final consonant, just like *police*.

Stem type	Stress	Final segment
hero	non-final	vowel
café	final	vowel
cactus	non-final	consonant
police	final	consonant

Table 5.6: Classification of stems

The results are summarized below. This table presents the proportion of the schwaful allomorph *-alicious* by phonological context. N is the total number of different stems of each type. For example, there are 31 licious-words with stems like *cactus*, with non-final stress and a final consonant.

Stem type	Proportion schwa	N
hero	0.00	113
café	0.11	19
cactus	0.21	31
police	0.78	147

Table 5.7: Distribution of licious-words by stem type (N=310)

The proportions from the table are reproduced in the graph below.

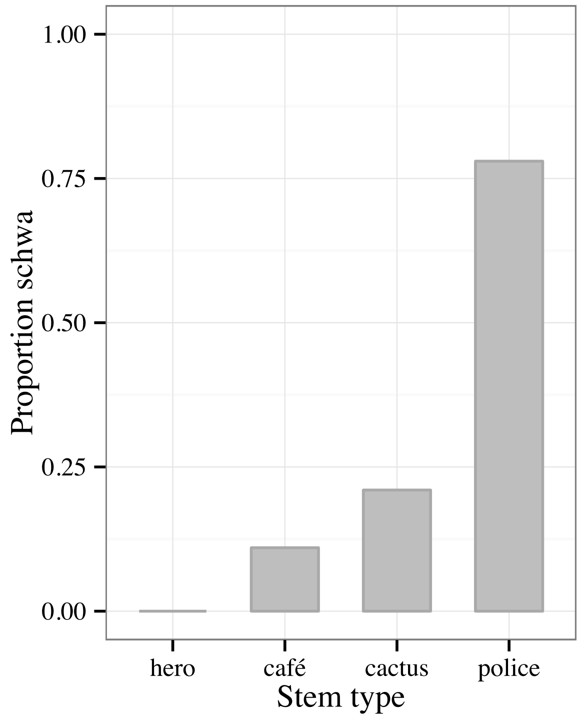

Figure 5.1: Proportion of stems with *-alicious* in the corpus GlOWbE

The table and graph above show effects of both final segment and final stress. Stems ending in consonants take *-alicious* more than stems ending in vowels (compare *cactus* and *hero*), and stems with final stress take *-alicious* more than stems with non-final stress, as long as they match in final segment (compare *cactus* and *police*). Cactus-type stems are between hero-type and police-type stems. This follows from the fact that cactus-type stems are subject to competing phonological demands.

The effects of stress and final segment are independent. As shown below, final segment has an effect after controlling for final stress. For each cell, the proportion out of the total stems is presented in parentheses. Among stems with final stress, C-final stems occur with *-alicious* proportionately more often than V-final stems. The results of Fisher's exact test are presented in the table captions. Fisher's exact is used here because of the small counts in some cells.

	C-final	V-final
-licious	33 (0.20)	17 (0.10)
-alicious	114 (0.69)	2 (0.01)

Table 5.8: Final-stressed *-(a)licious* stems: effect of final segment (N=166, p<0.001)

Likewise, stress has an effect after controlling for final segment. Among C-final stems, final-stress stems occur with *-alicious* proportionately more often than non-final-stress stems.

	Final stress	Non-final stress
-licious	33 (0.19)	24 (0.13)
-alicious	114 (0.65)	7 (0.04)

Table 5.9: C-final *-(a)licious* stems: effect of stress (N=178, p<0.001)

In later sections, I present similar results for *-(a)thon*, and the basic pattern of *-(a)licious* is replicated in a judgment experiment.

5.5.3 Distribution of -(a)licious stems

This section considers the distribution of stems in the corpus data. There are three main points:

- *-(a)licious* is a productive suffix.
- *-(a)licious* selects for nouns over adjectives and verbs.
- *-(a)licious* is under attested with some stem shapes, especially C-final trochees like *cactus*.

The first two points support the treatment of *-(a)licious* as a productive English suffix. The last point motivates the experiment presents later in the chapter, and supports the LWC Hypothesis.

Productivity. I use *productivity* here in the sense of Baayen (1992): the propensity of a suffix to be used in the creation of new words. The productivity of *-(a)licious* is evidenced by its large number of *hapaxes*, words that occur only once in the corpus. The number of hapaxes reflects how often a suffix is used in coining, and factors heavily into numerical measures of productivity. Of all stems (types), more than half are hapaxes, and out of the total number of tokens, more than a fifth are hapaxes.

(45) Hapax, type, and token counts for *-(a)licious*

a. Number of types = 310

b. Number of tokens = 905

c. Number of hapaxes = 182

Baayen's (1992) *P* quantifies an affix's productivity. *P* is the ratio of the total hapaxes to the number of tokens.

(46) Calculation of *P* (Baayen 1992)

a. $P = n1/N$

b. n1 = number of hapaxes

c. N = total number of tokens

The *P* of *-(a)licious* is 0.201 ($P = 182/905$). This is high relative to other English affixes: the only affix with a higher *P* is *-like*. *P* values for the affixes below come from the appendix of Hay and Baayen (2002).

Affix	*P*
anti-	0.082
counter-	0.054
non-	0.071
-like	0.381
-proof	0.055
super-	0.084

Table 5.10: English affixes where *P* >0.05

Although *-(a)licious* is amenable to coining, there are still a small number of established *-(a)licious* words. The word *booty-licious* occurs 87 times in the corpus (with 3 different spellings), accounting for about 10% of tokens. The six most common *-(a)licious* words are below, listed in descending order of frequency.

(47) Six most common *-(a)licious* words

a. booty-licious

b. diva-licious

c. jersey-licious

d. summer-licious

e. taco-licious

f. yummy-licious

Together, these six words account for over a quarter of *-(a)licious* tokens.

Selectional restrictions. The claim that *-(a)licious* selects for nouns over other syntactic categories finds support in the corpus. As shown in the table below, 88% of stems are nouns or proper nouns.

	Adjective	Noun	Proper Noun	Verb	Unknown
Count	34	195	48	8	25
Proportion	0.11	0.63	0.15	0.03	0.08

Table 5.11: Distribution of stems across different parts of speech (N=310)

A few notes on the syntactic categories above. Stems were coded by hand. Stems with the syntactic category *Unknown* are ambiguous, e.g. *queer*, *extra*, *nom*. *Queer* can be either an adjective or noun in the attested word *queer-licious*. Color words, which make up a handful of stems, are coded as adjectives. In §5.4, the syntactic categories of stems are used to argue against the analysis of licious-words as blends.

Phonological properties of stems. The second half of this section looks at the distribution of stress, final consonants, and syllable counts in the stems from the corpus. Many of these properties are not orthogonal, especially final stress and number of syllables. Given the overlap between the properties, it's difficult to determine the exact phonological conditioning of the suffix. Additionally the phonological distribution of stems in the corpus does not match the distribution of nouns in the English lexicon. Some stems, especially C-final trochees like *cactus*, are under attested.

These shortcomings are part of the motivation for the experiment in §4.6, which controls for syllable count, and collects judgments for C-final trochees.

Syllable count, stress, and final segment. Complicating the description in earlier sections, the number of syllables is almost perfectly correlated with stress. Stems are either monosyllables or trochees; only 2% of stems are iambs.

	1 syllable	2 syllables
final stress	160 (0.52)	6 (0.02)
non-final stress	N/A	143 (0.46)

Table 5.12: Distribution of stress and syllable count in *-(a)licious* stems (N=310)

In the analysis of the corpus data, then, syllable count and stress are interchangeable as predictors.

Surprisingly, there are no trisyllabic or longer stems in the corpus. Overall, stems are evenly divided between one and two syllables. 52% of stems are monosyllabic, and 48% are disyllabic. The lack of longer stems suggests that *-(a)licious* may be subject to a size constraint, especially given that longer stems are well-attested with *-(a)thon*, as shown in the next section.

In addition to the correlation between syllable count and stress, there is a strong correlation between final segment and stress. Stems with final stress are much more likely to end in a consonant, while stems with non-final stress are much more likely to end in a vowel. Final-stress here means final *primary* stress.

	C-final	V-final
final stress	147 (0.47)	19 (0.06)
non-final stress	31 (0.10)	113 (0.36)

Table 5.13: Distribution of final segment and stress in *-(a)licious* stems (N=310)

Stems tend to be C-final with final stress (e.g. *police*, *dog*) or V-final trochees (e.g. *hero*). There are few V-final, final-stressed stems (e.g. *café*, *Joe*) or C-final trochees (e.g. *cactus*).

How does this compare to English? The counts below estimate the distribution of nouns in the English lexicon. These counts come from the list of words in the CMU pronouncing dictionary (Weide 1993). To estimate the frequency of these words, I use frequency counts from the film subtitle corpus SUBTLEX-US (Brysbaert, New, and Keuleers 2012). A word is excluded if it doesn't occur in SUBTLEX-US.

For a fair comparison, I only consider English nouns that are possible *-(a)licious* stems, according to the criteria below. Since L-final stems were excluded from the corpus search, they're excluded here as well.

(48) A noun is included if:

a. Dominant part of speech in SUBTLEX-US is noun

b. 1–2 syllables

c. Not plural

d. Doesn't end in L – including both consonantal L and syllabic L

The table below shows the distribution of stress and syllable count for the 1,000 most frequent nouns that meet the criteria above, given frequencies in SUBTLEX-US. Words that are annotated with final secondary stress in CMU are in the non-final stress group.

	1 syllable	2 syllables
final stress	486 (0.49)	46 (0.05)
non-final stress	N/A	468 (0.47)

Table 5.14: Distribution of 1,000 most frequent nouns in the English lexicon, meeting criteria above (N=1000)

Comparing these to the *-(a)licious* stems in the corpus, we find that the distribution is nearly identical. The correlation in the corpus between final stress and syllable count likely reflects the distribution of nouns in the lexicon.

	1 syllable	2 syllables
final stress	0.52 ~ 0.49	0.02 ~ 0.05
non-final stress	N/A	0.46 ~ 0.47

Table 5.15: Comparison of of *-(a)licious* stems (L) and English nouns from SUBTLEX-US (R)

One place where the SUBTLEX-US counts and *-(a)licious* corpus differ is the distribution of final consonant and final stress. The SUBTLEX-US counts are below.

	C-final	V-final
final stress	493 (0.49)	39 (0.04)
non-final stress	331 (0.33)	137 (0.14)

Table 5.16: Distribution of 1,000 most frequent nouns in the English lexicon, meeting criteria above.

A comparison with the *-(a)licious* stems follows.

	C-final	V-final
final stress	0.47 ~ 0.49	0.06 ~ 0.04
non-final stress	0.10 ~ 0.33	0.36 ~ 0.14

Table 5.17: Comparison of of *-(a)licious* stems (L) and 1,000 most frequent English nouns in SUBTLEX-US (R)

In the *-(a)licious* corpus, we find fewer C-final stems with non-final stress (*cactus*) and more V-final stems with non-final stress (*hero*).

If we look at all nouns in the English lexicon meeting the criteria, and not just the 1,000 most frequent, the number of *cactus* type words increases, widening the gap between *-(a)licious* stems and the English lexicon.

	C-final	V-final
final stress	2904 (0.29)	402 (0.04)
non-final stress	4856 (0.49)	1715 (0.16)

Table 5.18: Distribution of all nouns in SUBTLEX-US meeting criteria above (N=9877)

	C-final	V-final
final stress	0.47 ~ 0.29	0.06 ~ 0.04
non-final stress	0.10 ~ 0.49	0.36 ~ 0.16

Table 5.19: Comparison of of *-(a)licious* stems (L) and all English nouns in SUBTLEX-US (R)

A possible source of this difference is avoidance: speakers stay away stems like *cactus*. C-final trochees require *-alicious* on one hand (due to being C-final), and *-licious* on the other (due to having non-final stress). Cases of avoidance driven by phonological uncertainty are well-documented, e.g. for Spanish in Albright (2003).

As discussed in §4.3.3, the lack of *-(a)licious* stems may make learning the its distribution difficult. The majority of stems only occur once in the corpus, and cactus-type stems are additionally rare. Although cactus-type stems are under attested, speakers treat them as expected when they do occur. The 31 cactus-type stems in the corpus demonstrate exactly the phonological conditioning we'd expect given the phonological requirements of *-(a)licious*, and subjects reproduce nearly the exact same distribution in the experiment.

5.5.4 Corpus methods for -(a)thon

A corpus search for *-(a)thon* was carried out using the same methods as were used for *-(a)licious*, except L-final stems were included in the analysis. There were 336 distinct words with -*(a)thon* after exclusions. Since -*(a)thon* is not the focus of this chapter, and its status as suffix is less controversial, I devote much less discussion here to its distribution.

5.5.5 Distribution of -thon and -athon

The stem types for -*(a)thon* are the same. They're repeated below.

Stem type	Stress	Final segment
police	final	consonant
cactus	non-final	consonant
café	final	vowel
hero	non-final	vowel

Table 5.20: Classification of stems

Like -*(a)licious*, there are independent effects of both final stress and final segment. The data for -*(a)thon* are presented in the table and graph below.

	Proportion schwa	N
police	0.98	244
cactus	0.71	56
café	1.00	7
hero	0.24	29

Table 5.21: Distribution of thon-words by stem type (N=336)

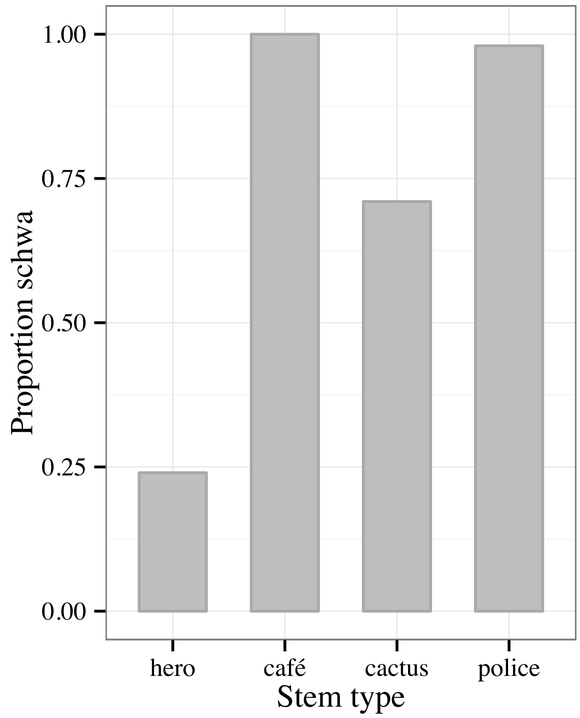

Figure 5.2: Proportion of stems with *-athon* in the corpus GlOWbE

Like *-(a)licious*, schwa in *-(a)thon* is most likely in police-type stems, and least likely in hero-type stems. Cactus-type stems are between police- and hero-type stems. Stems like *café* run contrary to the general pattern, possibly due to their rarity. There are only 7 café-type stems in the *-(a)thon* corpus, and all have a schwa.

The first table shows the effect of stress among for C-final stems. Stress-final stems occur with schwa proportionately more often than non-stress-final stems. The results of Fisher's exact test are reported in the caption.

	Final stress	Non-final stress
-thon	5 (0.02)	16 (0.05)
-athon	239 (0.80)	40 (0.13)

Table 5.22: C-final stems: effect of stress (N=300, $p<0.001$)

There is also an effect of final segment after controlling for stress and syllable count. Among polysyllabic stems with non-final stress, C-final stems occur with *-athon* proportionately more often than V-final stems.

	C-final	V-final
-thon	16 (0.19)	22 (0.26)
-athon	40 (0.47)	7 (0.08)

Table 5.23: Non-final-stress stems: effect of final segment (N=85, $p<0.001$)

In short, *-(a)thon* is conditioned by the same phonological factors as *-(a)licious*.

5.5.6 Distribution of -(a)thon stems

This section considers the phonological properties of *-(a)thon* stems. Many of the issues that are present for *-(a)licious* stems in the corpus are less severe for *-(a)thon*. In general, the stems that take *-(a)thon* show much greater variety in their phonological shape.

Compared to *-(a)licious*, *-(a)thon* exhibits more diversity in the prosodic shapes of its stems, occurring with stems up to five syllables long.

Syllable count	1	2	3	4	5
final stress	222	25	3	1	0
non-final stress	N/A	60	20	4	1

Table 5.24: Prosodic shapes of stems with *-(a)thon* (N=336)

Because of this greater variety in stem shapes, it's possible to control for syllable count when determining the effect of stress. This is not the case for *-(a)licious*, whose stems overlapped perfectly in syllable count and stress pattern.

Some long stems are exemplified below. Of these, many are derived nouns, which occur often with *-(a)thon*.

(49) Examples of long stems with *-(a)thon*

a. misinterpret

b. misunderstanding

c. procrastination

d. substitute

e. barcelona

f. exaggeration

Although *-(a)thon* occurs with long stems, the majority (66%) are monosyllabic. This is another point of difference with *-(a)licious*, whose stems are equally split between one and two syllables.

The table below presents the distribution of stems with respect to final segment and stress pattern. Most stems for *-(a)thon* are C-final monosyllables.

	C-final	V-final
final stress	244 (0.73)	7 (0.02)
non-final stress	56 (0.16)	29 (0.09)

Table 5.25: Distribution of stem shapes that occur with *-thon* and *-athon* (N=336)

The distribution of stems for *-(a)thon* roughly follows the distribution of nouns in the English lexicon. In both the stems and lexicon, cactus-type words are more frequent than hero-type words.

	C-final	V-final
final stress	493 (0.49)	39 (0.04)
non-final stress	331 (0.33)	137 (0.14)

Table 5.26: Distribution of 1,000 most frequent 1-2 syllable nouns in the English lexicon

Although cactus-type stems are not as under attested for *-(a)thon* as they are for *-(a)licious*, they still seem underrepresented (33% in English vs. 16% in *-(a)thon*). This is likely due to the fact that most *-(a)thon* stems are monosyllabic (with final stress), resulting in an inflation of C-final, final stress stems.

5.5.7 Differences between -(a)thon and -(a)licious

Overall, *-(a)thon* and *-(a)licious* pattern in similar ways, but there is one consistent difference: regardless of the phonological context, schwa is more likely in *-(a)thon* than *-(a)licious*. This can be seen in the graph below, which compares the corpus results for the two suffixes.

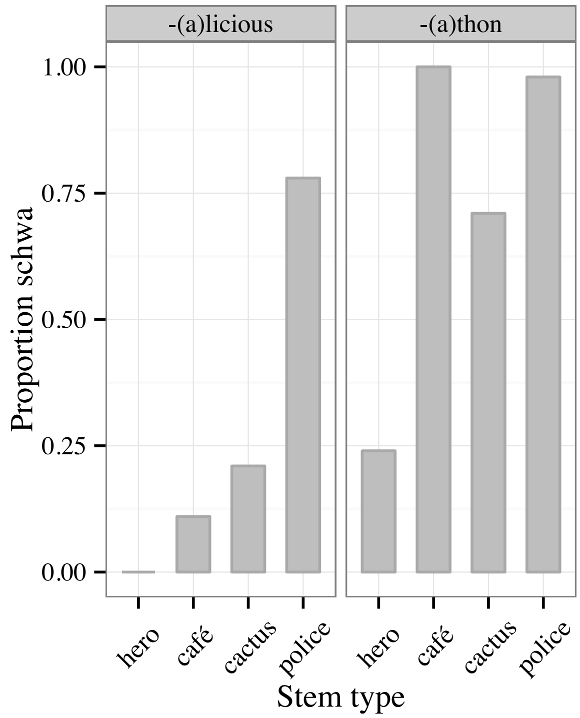

Figure 5.3: Proportion of stems with *-alicious* (L) and *-athon* (R) in the corpus GlOWbE

The preference for *-athon* appears again in the experiment, in which subjects choose *-athon* more often than they choose *-alicious*. This difference holds for most items and subjects.

I treat the difference between *-(a)thon* and *-(a)licious* as a result lexical variation. There's no phonological motivation for the difference. Instead, speakers simply learn that schwa is more likely for *-(a)thon*. In §5.8, I provide a URC account that can model this difference using UR constraints.

One question for the lexical variation account is whether learners have enough evidence to learn that schwa is more likely in *-(a)thon* than *-(a)licious*. This is especially important given the claim that phonological conditioning of *-(a)thon* and *-(a)licious* is difficult to learn from sparse evidence.

Even if a speaker sees only a few words with *-(a)thon* and *-(a)licious*, she'll likely encounter this difference. In the corpus, the most common *-(a)thon* words occur with a schwa, and the most common *-(a)licious* words occur without one.

The six most common *-(a)licious* words are below. These words make up more than a quarter of *-(a)licious* tokens in the corpus, and all occur without a schwa.

(50) Six most common *-(a)licious* words

a. booty-licious
b. diva-licious
c. jersey-licious
d. summer-licious
e. taco-licious
f. yummy-licious

On the other hand, the seven most common *-(a)thon* words all contain a schwa. These words account for more than half of *-(a)thon* tokens in the corpus.

(51) Seven most common *-(a)thon* words

a. hack-athon
b. walk-athon
c. read-athon
d. blog-athon
e. swim-athon
f. spend-athon
g. dance-athon

If a learner sees an *-(a)thon* word, it probably contains a schwa, and if a speaker sees an *-(a)licious* word, it's probably schwaless.

In the corpus data, speakers exhibit knowledge of this asymmetry when creating new words with *-(a)licious* and *-(a)thon*, and experimental subjects do so when judging whether a licious- or thon-word is better with or without a schwa.

5.5.8 Summary of corpus results

There are three main findings from the corpus study.

First, *-(a)licious* and *-(a)thon* are used creatively to derive new words. In the corpus, there are over 300 different words with *-(a)licious* and over 300 with *-(a)thon*. The majority of these words only occur once.

Second, these suffixes are conditioned both by the final segment and stress pattern of the stem. These findings are replicated in the experiment in next section.

Finally, *-(a)thon* is more likely to occur with a schwa than *-(a)licious* across all phonological contexts. This finding is also replicated in the experiment. The difference between *-(a)thon* and *-(a)licious* follows from the most frequent words with each suffix. The most frequent *-(a)thon* words contain a schwa, while the most frequent *-(a)licious* words are schwaless.

5.6 Experiment part 1: ∗Clash and ∗Hiatus

In this section, I present the results of a judgment experiment on *-(a)licious* and *-(a)thon*.

The experiment is presented in two parts. In part 1, I discuss the items testing whether there are independent effects of final segment and final stress. In part 2, I discuss the items that test whether PCA interacts with the Rhythm Rule. Although presented separately, the items are from the same experiment, with the same methods, participants, and materials.

5.6.1 Methods

Subjects. The experiment was conducted online using Ibex.[2] Subjects were recruited through word-of-mouth and social media, and were not reimbursed in any way. Data were included for the 109 subjects who indicated that they were native English speakers and from the U.S.

Materials. Subjects were presented with *-licious* and *-alicious* variants of a noun, and asked to choose the form they would say, along with indicating their confidence as *definitely* or *probably*. They did the same for other nouns with *-thon* and *-athon*. Choices were presented in English orthography, with a single hyphen between the stem and the suffix. The presentation of the schwaful variant on the right or left side of the screen was random. A screen capture of the experiment in progress is below.

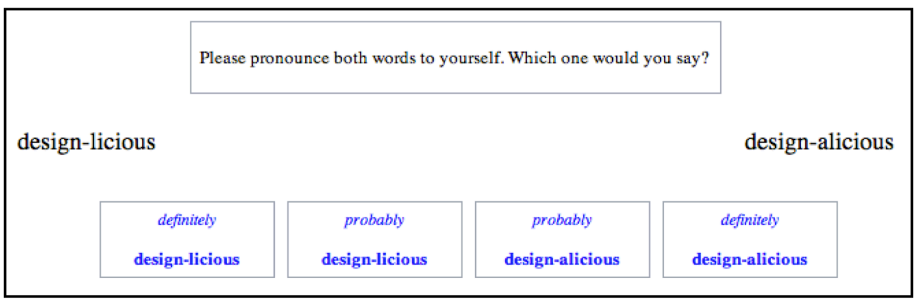

Figure 5.4: A screen capture of the experiment in progress

The experiment tested 50 different stem nouns, varying in stress pattern and final segment. Nouns belonged to one of five different categories, presented below. The numbers in the stress context column represent the stress pattern of the noun: 1 is a primary-stressed syllable; 2 is secondary-stressed syllable; and 0 is an unstressed syllable. A list of items is included in the appendix.

---

[2] http://spellout.net/ibexfarm/

Stem-type	Stress	Final segment
police-type	01	consonant
thirteen-type	21	consonant
cactus-type	10	consonant
hero-type	10	vowel
underwear-type	102	consonant

Table 5.27: Experimental conditions

None of the experimental stems occur in the corpus.

The first three contexts were included to test the effects of final stress and Rhythm Rule (RR), discussed in §4.6. The *thirteen* and *police* stems contrast RR-eligible (stress: 21) and RR-ineligible stems (stress: 01). The list of police-type nouns and the list of thirteen-type nouns were balanced with respect to frequency and final consonant. Cactus-type stems were included to test the basic stress-conditioning of *-(a)licious* and *-(a)thon*. V-final nouns like *hero* were included to test the segmental conditioning of the suffixes. They match cactus-type words with respect to stress, differing in only final segment.

The experiment also contained secondary-stress-final nouns like *underwear*, to test the effect of final secondary stress, and the difference between weak (secondary-primary) and strong (primary-primary) stress clashes. These words aren't discussed much here, since the data are subject to a number of confounds: many speakers show variation between 102 and 201 patterns (límousìne vs. lìmousíne), *-athon* is able to shift stress in underwear-type words (§4.2.2), and *-(a)licious* may be subject to a size constraint, only occurring with stems shorter than three syllables (§5.5.3).

The experiment contained 30 fillers. Like the test items, all fillers compared schwaful and schwaless variants of words derived with *-(a)thon* and *-(a)licious*. The fillers were included to distract from the prosodic conditioning by providing diversity in stress contexts, and also to balance the number of V-final words. They contained a mix of different final consonants and stress contexts, and all were trisyllabic. Ten fillers were presented from each category below. The results for these words were not analyzed in detail, but I include results in Appendix B.

Stem-type	Stress	Final segment
japanese-type	201	consonant
acoustic-type	010	consonant
alaska-type	010	vowel

Table 5.28: Phonological contexts of fillers

Each subject saw every stem once (including fillers), paired with either *-(a)thon* or *-(a)licious*. This makes 80 judgments (80 stems), presented in random order. For each subject, half of the judgments were for *-(a)thon*, and half were for *-(a)licious*, and stem-suffix pairings were counterbalanced across subjects.

5.6.2 Results

In this section, I present the results for all stems, except thirteen-type words, which are discussed in the section on the Rhythm Rule (§4.7).

Response times. Given that the experiment was conducted over the internet, response time cutoffs were used to ensure that subjects weren't clicking without reading. The mean response time was 2172 ms, which seems reasonable given that subjects were asked to pronounce both forms of the word. Responses were excluded from analysis if they were less than two standard deviations below the log-transformed mean response time: only responses above 294 ms were considered.

Results for -(a)licious. The table below reports the mean proportion of schwaful responses for *-(a)licious* stems.

Stem type	Context	Proportion *-alicious*
police-type	01 C-final	0.93
cactus-type	10 C-final	0.45
hero-type (all)	10 V-final	0.07

Table 5.29: Table of means for *-(a)licious*

The results for hero-type, cactus-type, and police-type words are presented in the graph below. In this graph, we see the same order as the corpus data. C-final iambs (*police*) are most likely to take *-alicious*, while V-final trochees (*hero*) are least. C-final trochees (*cactus*) are between.

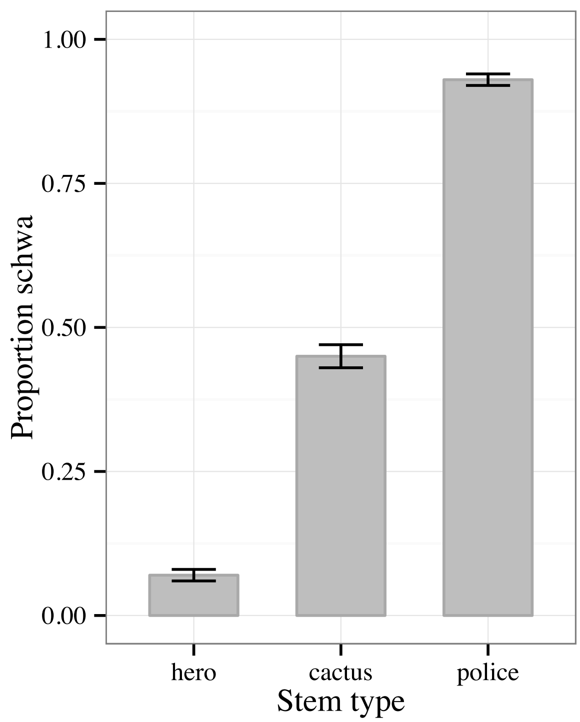

Figure 5.5: Proportion of *-alicious* responses in judgment experiment

The hero-type stems can be further divided based on their final vowel. Six of the stems end in full vowels (*chili*, *cookie*, *hero*, *jackie*, *menu*, *zero*), and four end in schwa (*china*, *cuba*, *drama*, *russia*). The full vowel stems are more likely to take -*alicious* than the schwa stems (0.09 vs. 0.04). This mirrors the stronger dispreference for lax-vowel–vowel sequences found in the rest of English (§3.2).

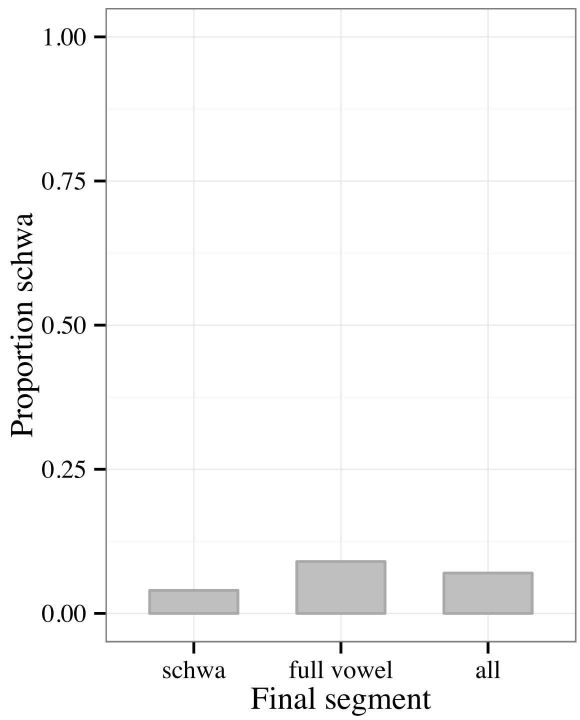

Figure 5.6: Proportion of *-alicious* responses for *hero*-type words

Chi-square tests (with Yates correction) were performed on the contrasts of theoretical interest: final vs. non-final stress, V-final vs. C-final, and so on. The results are in the table below.

Contrast	Groups compared	Chi-square (d.f.)	p-value
final • non-final stress	police • cactus	222.37 (1)	p<0.001
final V • final C	hero • cactus	122.15 (1)	p<0.001
final schwa • final full vowel	hero • hero	3.94 (1)	p<0.05

Table 5.30: Chi-square tests for *-(a)licious*

The tests above show that both final segment and final stress condition *-(a)licious*. The schwaful form is more likely with final-stress stems (*police*) than non-final-stress stems (*cactus*). In addition, *-alicious* is less likely with V-final stems (*hero*) than C-final stems (*cactus*). Among V-final stems, *-alicious* is more likely after a full vowel than a schwa.

Results for -(a)thon. The mean proportions of schwa responses for *-(a)thon* are presented in the table below. Overall, there were more schwaful responses for *-(a)thon* than *-(a)licious*, mirroring the differences found in the corpus data.

Stem type	Context	Proportion *-athon*
police-type	01 C-final	0.99
thirteen-type	21 C-final	0.98
cactus-type	10 C-final	0.79
hero-type (all)	10 V-final	0.32

Table 5.31: Table of means for *-(a)thon*

The results for *-(a)thon* follow the same pattern as *-(a)licious*. V-final trochees (like *hero*) prefer *-thon*, while C-final iambs (like *police*) prefer *-athon*. Again, C-final trochees (*cactus*) are between.

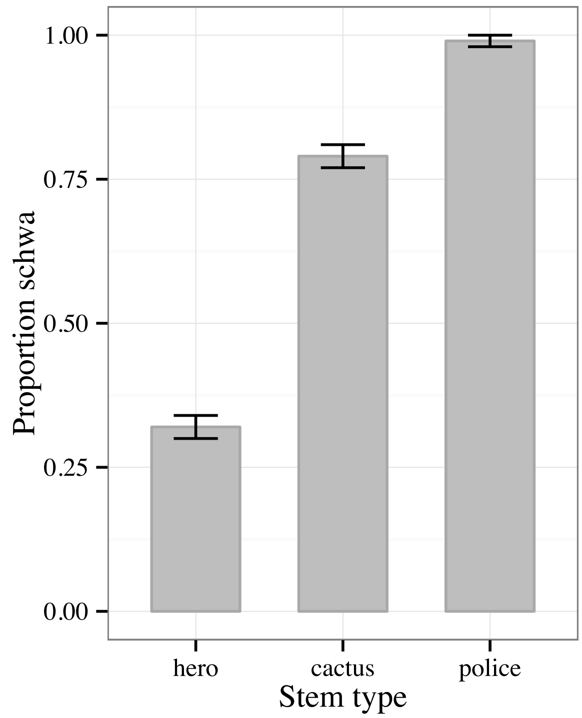

Figure 5.7: Proportion of *-athon* responses in judgment experiment

The difference between full V-final and schwa-final stems is even more noticeable with *-(a)thon*. Full vowel-final stems are more likely to take *-athon* than the schwa-schwa stems (0.48 vs. 0.10)

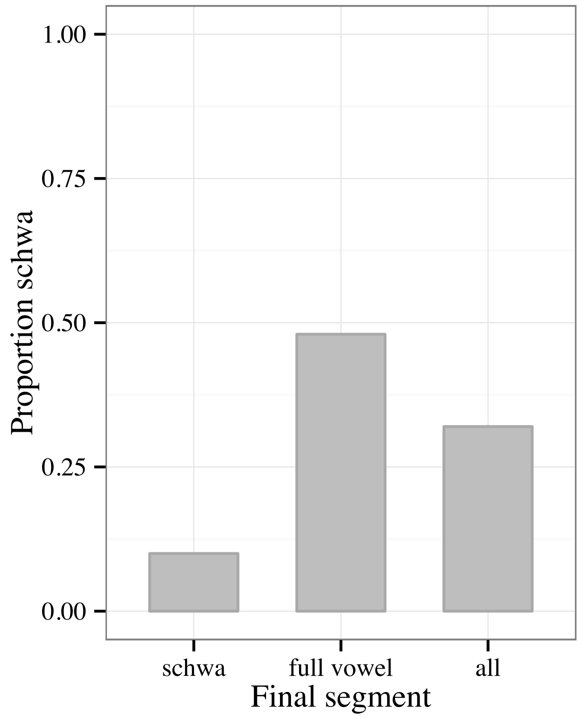

Figure 5.8: Proportion of *-athon* responses for *hero*-type stems

Chi-square tests were performed for each comparison of interest. These tests show a significant effect of stress and final segment, and a significant effect of type of final vowel.

Contrast	Groups compared	Chi-square (d.f.)	p-value
final • non-final stress	police • cactus	102.74 (1)	p<0.001
final V • final C	hero • cactus	165.34 (1)	p<0.001
final schwa • final full vowel	hero • hero	88.8 (1)	p<0.001

Table 5.32: Chi-square tests for *-(a)thon*

5.6.3 Optionality

Recall that in addition to collecting data on schwa vs. no schwa, the experiment asked subjects to rate their confidence in their answers as *definitely* or *probably*. The graphs below show that subjects are more likely to rate an answer as ‘definitely’ when it’s closer to categorical, either 0.00 or 1.00. In other words, when the population is split on whether a stem should take *-alicious* or *-licious*, each individual is less sure of his or her answer. This is shown for both *-(a)licious* and *-(a)thon* below. In these graphs, each point is a stem, fillers included. Recall that each subject only saw each stem once.

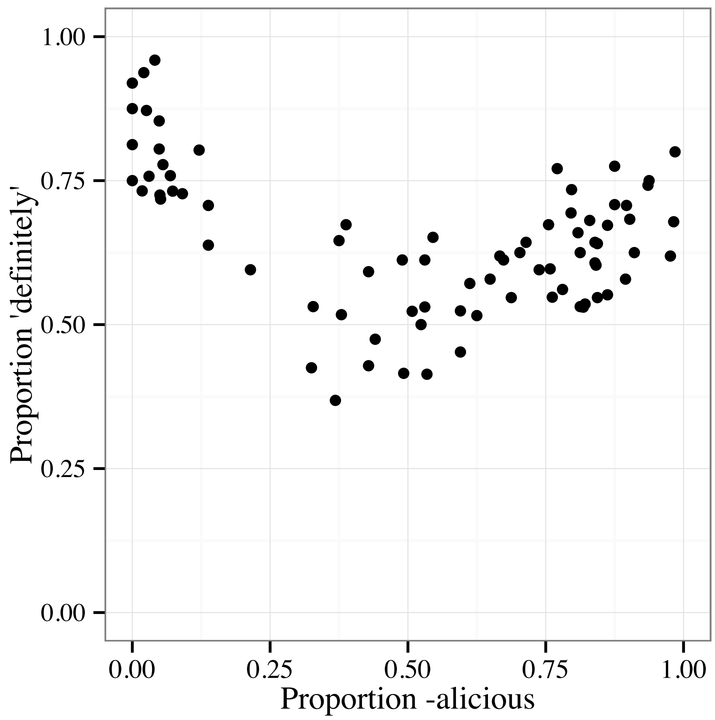

Figure 5.9: Proportion of *-alicious* responses by confidence, grouped by stem

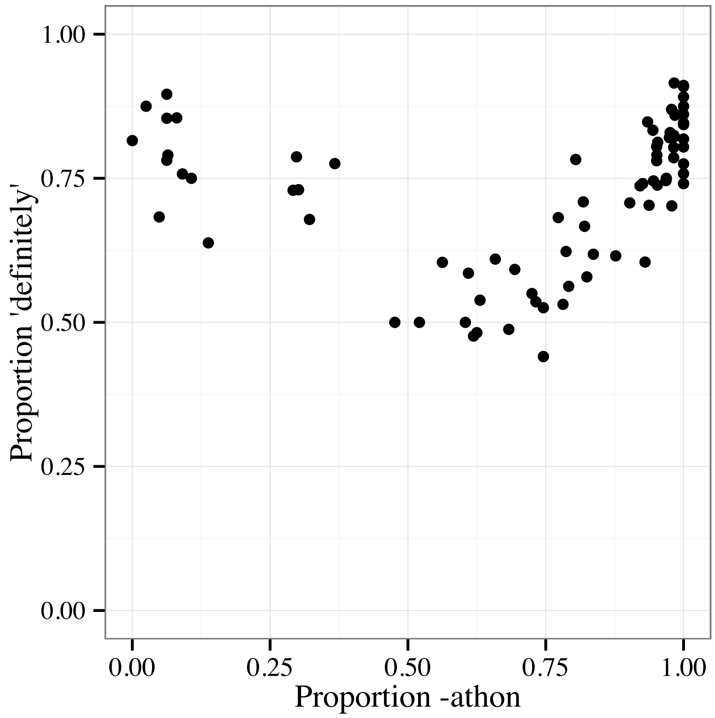

Figure 5.10: Proportion of *-athon* responses by confidence, grouped by stem

The graph for *-(a)licious* is asymmetric: subjects are more confident for *-licious* responses than *-alicious* responses. This suggests that subjects are aware of the difference between the suffixes with respect to schwa. A schwaless response is more likely with *-(a)licious* than *-(a)thon*, so subjects are more likely to answer *definitely -licious* than *definitely -alicious*.

The graph below collapses the two previous graphs. It shows that as the distance from 50% increases, subjects become more confident in their individual responses.

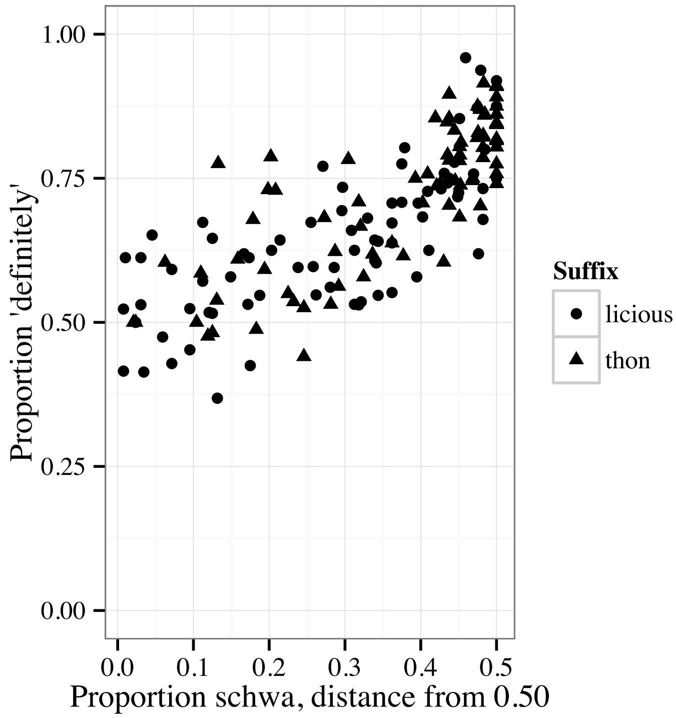

Figure 5.11: Proportion of schwa by confidence, grouped by stem

The graph above is important because the presence of intraspeaker variation isn't apparent from the corpus data. With the exception of *babe-alicious*, nearly no stems occur with both schwaful and schwaless suffixes in the corpus. The experimental results, on the other hand, clearly show that *-(a)licious* and *-(a)thon* are subject to intraspeaker variation, and not simply a result of averaging across speakers.

5.6.4 Comparison of -(a)thon and -(a)licious

Like the corpus search, the experiment finds that both suffixes obey similar conditioning, but schwa is more likely in *-(a)thon* than *-(a)licious*.

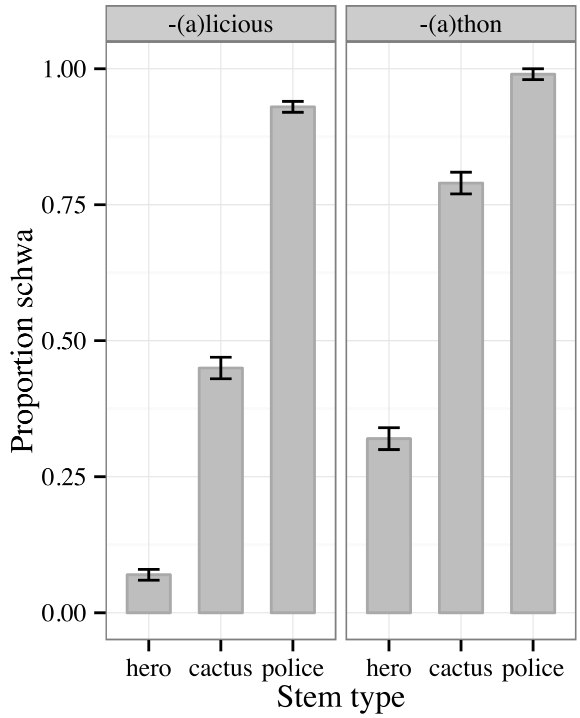

Figure 5.12: Proportion of *-alicious* (L) and *-athon* (R) responses in judgment experiment

This difference between *-(a)thon* and *-(a)licious* is consistent across both items and subjects. Schwa is more likely in *-(a)thon* than *-(a)licious* for 78 out of 80 stems.[3] The graph below shows the proportion schwa for each suffix. Each point is a stem, and points above the dotted diagonal line have a higher proportion of schwa in *-(a)thon* than *-(a)licious*.

[3]The exceptions are fillers *korea* and *gorilla*, possibly due to the liquids.

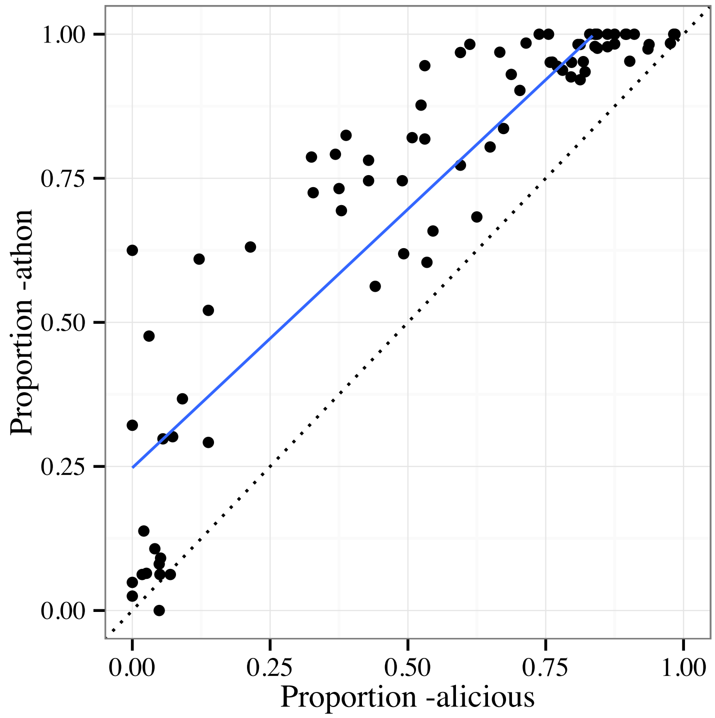

Figure 5.13: Proportion of schwa for each suffix, grouped by stem. Solid line is line of best fit (slope=0.90, adjusted r^2= 0.82). Dotted line shows values where proportions of *-alicious* and *-athon* are equal

This graph also shows that for each stem, the proportion of schwa in *-(a)licious* is strongly correlated with the proportion of schwa in *-(a)thon*, r(78)=0.91, $p<0.001$. If a stem is likely to take *-alicious*, it's also likely to take *-athon*.

A similar graph for the 109 subjects is below. Only 12/109 participants use schwa more often in *-(a)licious* than *-(a)thon*. These are the points below the dotted line.

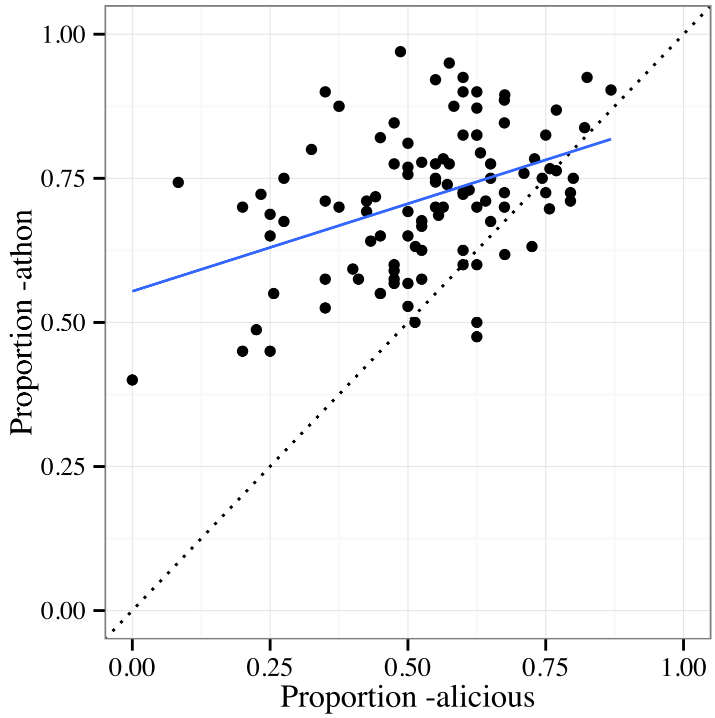

Figure 5.14: Proportion of schwa for each suffix, grouped by subject. Solid line is line of best fit (slope=0.30, adjusted r^2= 0.16). Dotted line shows values where proportions of *-alicious* and *-athon* are equal

For each subject, there is a weak but significant correlation between use of *-alicious* and use of *-athon*, r(109)=0.41, p<0.001. Speakers who use schwa more often with one suffix are more likely to use schwa with the other.

5.6.5 Summary and comparison with corpus

In summary, the experiment finds independent effects of final segment and final stress for both suffixes, along with a difference between the overall rates of schwa in *-(a)licious* and *-(a)thon*.

The experiment mirrors the findings of the corpus study, despite the lack of overlap between the stems in the corpus and the stems in the experiment. The replication of the corpus findings is most important for cactus-type stems, which are under attested in the corpus. Cactus-type stems only occur in 31 licious-words, all of which only occur once in GlOWbE (out of 1.9 billion words). The convergence of these two types of data supports the claim that speakers really do know the distribution of *-(a)licious* and *-(a)thon*, even in the face of sparse learning data.

The graphs below compare the corpus and experiment.

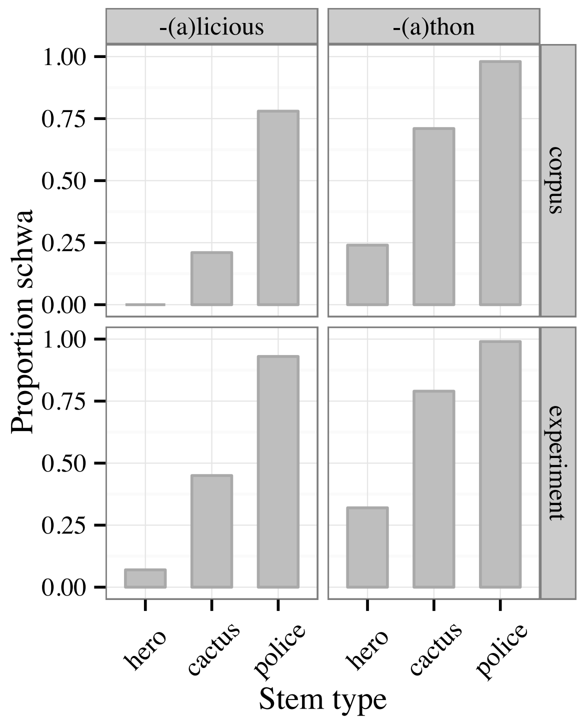

Figure 5.15: Comparison of experimental and corpus results for *-(a)licious* and *-(a)thon*

For both suffixes, schwa is more likely in the experiment than the corpus, but otherwise, the results look very similar.

5.7 Experiment part 2: the Rhythm Rule

In this section, I present the rest of the experimental results. These results provide another example of the chicken-egg effect, supporting a parallel model morphophonology. The Rhythm Rule must paradoxically apply both before and after the form of the suffix is chosen.

(52) Chicken-egg effect in *-(a)licious* and the Rhythm Rule

a. The Rhythm Rule is triggered by the suffix chosen

b. The suffix chosen depends on whether the Rhythm Rule can apply

To capture these facts, UR selection must have lookahead to the output of phonological rules like the RR. This is possible in URC because UR selection and repairs are evaluated together in the candidate set.

In the following sections, I review the Rhythm Rule and stress clash, and then discuss the rest of the experimental results.

5.7.1 Clash and the Rhythm Rule

The Rhythm Rule (RR) is a phonological repair that resolves stress clash by retracting stress to an earlier syllable. It has been discussed extensively in earlier work, such as Liberman and Prince (1977), Prince (1983), Hayes (1984) and many others (see Tilsen 2012 for an overview). I remain noncommittal with respect to the formulation of RR, whether it's prominence transfer, accent deletion, node relabeling, or something else. Instead, I focus on the requirements for its application, which are generally agreed on in the literature.

In the examples below, stress is represented on the metrical grid, useful for visualizing the requirements and restrictions of RR application (Liberman and Prince 1977; Selkirk 1984; Nespor and Vogel 1986). Syllables with more grid marks are perceived as relatively more prominent. *Relative* and *perceived* are important here. Since decreasing the prominence of a syllable results in an increase for the other syllables, the grid may not straightforwardly represent quantitative measures of prominence (e.g. duration, pitch).

When two consecutive syllables have grid marks at the same level, a stress clash occurs. In the examples below, a clash occurs in *Di^{2}ane Cha^{1}mbers* but not *Christi^{2}ne McVi^{1}e*.

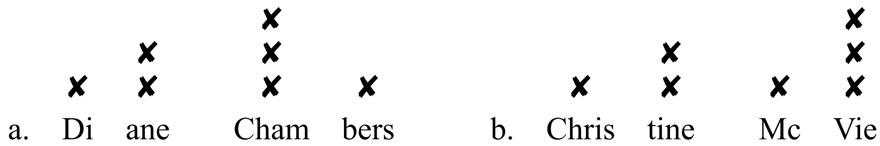

Figure 5.16: Stress clash: *Diane Chambers* vs. *Christine McVie*

Stress clash is resolved in these cases by reducing the prominence of the first clashing syllable (the second syllable in *Diane*). This causes an increase in the relative prominence of the first syllable. In the example below, the grid mark of the second syllable of *Diane* retracts to an earlier syllable. [4]

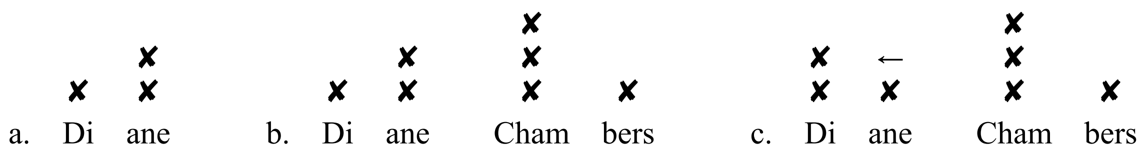

Figure 5.17: *Diane Chambers*: Rhythm Rule applies

In order for RR to apply, the clash must be preceded by a syllable with secondary stress. In terms of the grid, a grid mark must have a landing site for retraction, and a syllable with schwa doesn't count.

[4]Experimental studies (Horne 1993; Tilsen 2012), however, show that absolute prominence of the first syllable is similar in (b) and (c).

			✘					✘	
		✘	✘			✘	↚	✘	
	(ə)	✘	✘	✘		(ə)	✘	✘	✘
a.	Ma	lone	Cham	bers	c.	Ma	lone	Cham	bers

Figure 5.18: *Malone-Chambers*: Rhythm Rule cannot apply

There are a few notable issues with RR, that are often omitted from the classic description above. Because of these issues, when RR fails to apply, it's difficult to say why. First, RR is a variable process, and the exact likelihood of its application isn't known. Grabe and Warren (1995) find that speakers retract stress about 85% of the time in clash contexts in a production experiment. Second, it's been recently suggested that RR requires production planning. In an experiment, Tilsen (2012) finds that RR effects can be observed in prepared speech, when speakers have already read the sentences, but not in unprepared speech, when speakers are reading the sentences for the first time. Finally, RR fails to apply with certain lexical items, and exceptions differ across speakers Bolinger (1981). For example, the word *obese* does not undergo RR, even in clashing contexts.

For the experiment, there are two things to remember: RR resolves stress clash by retracting stress, and stress retraction is only possible if there is a secondary stress earlier in the word.

5.7.2 Predictions of a parallel model for *-(a)licious*

Recall that *-(a)licious* carries main stress in the word it derives. For example, main stress falls on *licious* in *t*$\overset{2}{u}$*rkey-l*$\overset{1}{i}$*cious*. This means that *-licious* is able to trigger RR when it occurs with a stem such as *th*$\overset{2}{i}$*rt*$\overset{1}{e}$*en*. This is shown on the grid below.

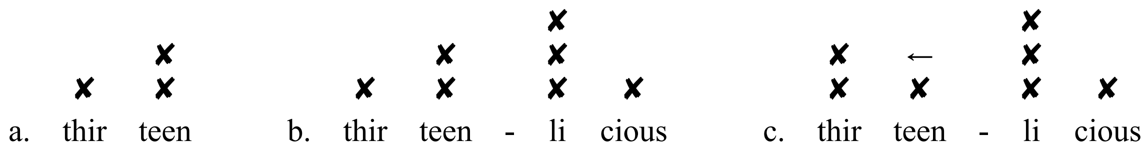

Figure 5.19: *thirteen-licious*: Rhythm Rule applies

RR is still subject to the restrictions outlined in the previous section. It won't apply with a word like *police*, since stress is unable to shift to the initial schwaful syllable.

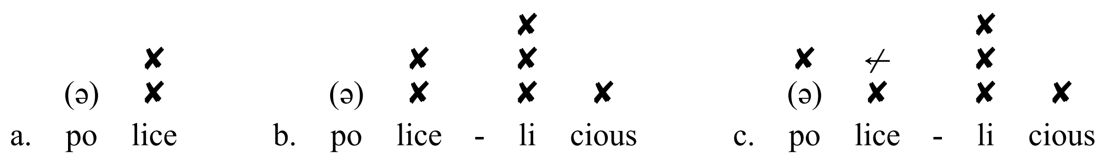

Figure 5.20: *police-licious*: Rhythm Rule cannot apply

The fact that *-licious* is able to trigger RR in some stems (*thirteen*) but not others (*police*) provides a way to distinguish parallel and derivational models.

Parallel model. In a parallel model like URC, all combinations of suffix and RR application are considered together in the candidate set (§2.4.3).

For a word like *thirteen*, there are four relevant candidates. In the candidates below, the first two have undergone RR, and the second two have not. In the set below, there are candidates that avoid a stress clash.

(53) Candidate set for *thirteen-(a)licious*

a. $\text{th}\overset{3}{\text{i}}\text{rt}\overset{2}{\text{e}}\text{en-l}\overset{1}{\text{i}}\text{cious}$ violates ∗Clash

b. $\text{th}\overset{3}{\text{i}}\text{rt}\overset{2}{\text{e}}\text{en-}\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$ satisfies ∗Clash

c. $\text{th}\overset{2}{\text{i}}\text{rt}\overset{3}{\text{e}}\text{en-l}\overset{1}{\text{i}}\text{cious}$ shifted stress via RR, satisfies ∗Clash

d. $\text{th}\overset{2}{\text{i}}\text{rt}\overset{3}{\text{e}}\text{en-}\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$ shifted stress via RR, satisfies ∗Clash

For a word like *police*, in which RR cannot apply, only one clashless candidate is viable. The candidates with shifted stress are ruled out by the restrictions on the application of RR. In *police*, the only way for a speaker to avoid a stress clash is the schwaful allomorph *-alicious*.

(54) Candidate set for *police-(a)licious*

a. $\text{pol}\overset{2}{\text{i}}\text{ce-l}\overset{1}{\text{i}}\text{cious}$ violates ∗Clash

b. $\text{pol}\overset{2}{\text{i}}\text{ce-}\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$ satisifies ∗Clash

c. *$\text{p}\overset{2}{\text{o}}\text{lice-l}\overset{1}{\text{i}}\text{cious}$ shifted stress ruled out by RR restrictions

d. *$\text{p}\overset{2}{\text{o}}\text{lice-}\underline{\text{a}}\text{l}\overset{1}{\text{i}}\text{cious}$ shifted stress ruled out by RR restrictions

In the parallel model, there are three ways to avoid ∗Clash for *thirteen-(a)licious*, but only one way for *police-(a)licious*. Assuming a speaker takes advantage of these extra options, a thirteen-type stem should take *-licious* more often than a police-type stem.

This prediction isn't unique to URC. Any model which simultaneously considers different URs and phonological repairs will share it. Nearly every OT account of PCA has this property, and derivational models can have limited parallelism as well (see §2.4).

Derivational models. In many derivational models of morphophonology, UR selection occurs either before or after phonology, but never at the same time. This holds for nearly every account in Distributed Morphology (e.g. Embick 2010), and some accounts in derivational OT, such as Wolf (2008)'s OT-CC account, and any account in Harmonic Serialism that assumes UR selection is an operation (e.g. Wolf 2014.)

If UR selection is evaluated separately from phonological operations, there should be no difference between *police* and *thirteen*. If phonology happens first, then RR doesn't apply, since it's triggered by the suffix. If suffix selection happens first, then the suffix doesn't have access to the output of RR. Either way, all words with final stress will prefer *-licious* and *-alicious* to the same degree, regardless of whether they undergo RR.

This prediction only holds so long as there is no other way to distinguish *police*- and thirteen-type stems. Imagine, for instance, a subcategorization frame for *-alicious* that prefers stress-final stems with a preceding secondary stress (such as *thirteen*). This subcategorization frame could capture a difference between *police* and *thirteen*, but there are three reasons to doubt it. First, this subcategorization frame perfectly mirrors the conditions on RR, duplicating a phonological rule in the lexicon. Second, it refers to non-local phonological context, for instance, a secondary stress somewhere earlier in the word. Subcategorization frames are generally taken to be local, for instance, in Paster (2009). Third, if the corpus results are any indication, there's practically no evidence for such a subcategorization frame for language learners. In the corpus results in §5.5, less than 1% of the stems that occur with *-(a)licious* have final stress with a preceding secondary stress.

A second prediction for the parallel account. While a parallel account predicts a difference between *police* and *thirteen* for *-(a)licious*, this difference should disappear for *-(a)thon*. Unlike *-(a)licious*, *-(a)thon* takes secondary stress in the words it derives, as in *$\overset{1}{\text{c}}$actus-th$\overset{2}{\text{o}}$n* (cf. *$\overset{2}{\text{c}}$actus-l$\overset{1}{\text{i}}$cious*). Since *-(a)thon* takes secondary stress, it won't trigger RR.

As shown below, main stress isn't retracted from main-stress syllables: RR applies in *antique armchair*, but not the compound *antique dealer*.

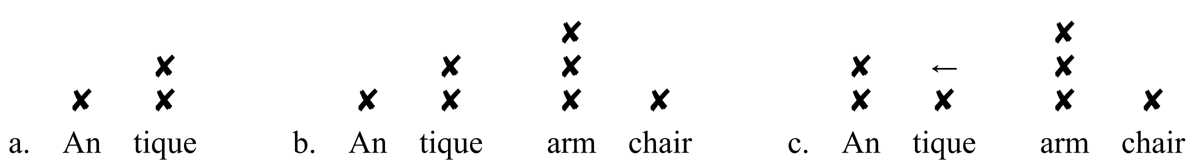

Figure 5.21: *antique armchair*: Rhythm Rule applies

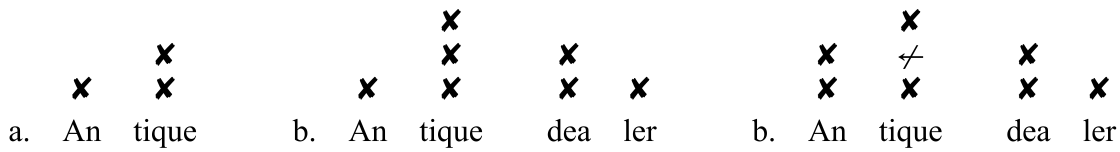

Figure 5.22: *antique dealer*: Rhythm Rule cannot apply

The failure of RR with *-thon* is shown below. Since the syllable *teen* carries main stress in *thirt*$\overset{1}{e}$*en-th*$\overset{2}{o}$*n*, RR cannot apply.

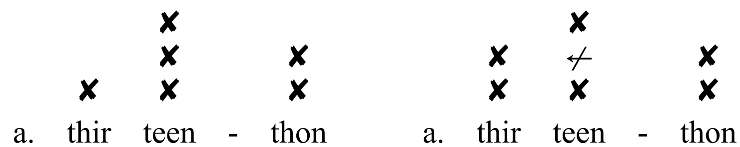

Figure 5.23: *thirteen-thon*: Rhythm Rule cannot apply

In a parallel model, the choice between a schwaful or schwaless suffix being chosen is directly linked to RR eligibility. For a suffix like *-licious*, which triggers RR, there should be a difference between RR-eligible stems like *thirteen* and RR-ineligible stems like *police*. For a suffix like *-thon*, which never triggers RR, there should be no difference.

A derivational model, on the other hand, predicts no relationship between RR-eligibility and suffix selection. If such a relationship exists, it's a coincidence, and must be accounted for with subcategorization frames that differentiate *thirteen* and *police*, in addition to *-(a)licious* and *-(a)thon*.

5.7.3 Experimental results

The table below presents the experimental results for *-(a)licious*, with thirteen-type stems added. As mentioned in the materials section, police-type and thirteen-type stems were balanced with respect to lexical frequency and place/manner of the final segment. The results for thirteen-type are consistent with the parallel model. As predicted, RR-eligible stems (*thirteen*) are more likely to appear with *-licious* than RR-ineligible stems (*police*) (chi square= 38.60, df= 1, p<0.001).

Stem type	Context	Proportion *-alicious*
police-type	01 C-final	0.93
thirteen-type	21 C-final	0.80
cactus-type	10 C-final	0.45
hero-type	10 V-final	0.07

Table 5.33: Table of means for *-(a)licious*

The graph below shows all four stem types.

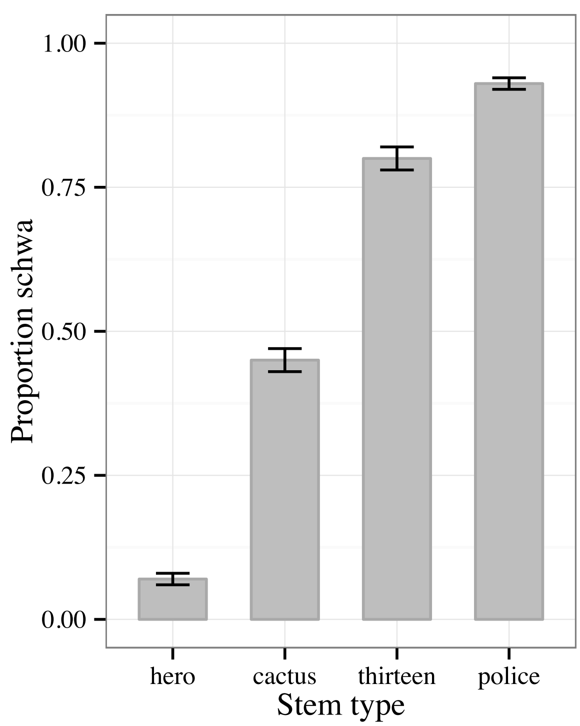

Figure 5.24: Proportion of *-alicious* responses in judgment experiment, thirteen-type stems included

Here's another way to think about these results: stems like *thirteen* are sometimes pronounced with retracted stress as a result of RR, behaving like *cactus*, and sometimes pronounced with unretracted stress, behaving like *police*. This puts them between cactus-type and police-type stems with respect to schwa.

The difference between thirteen-type and police-type stems disappears for *-(a)thon*. With *-(a)thon*, there is no significant difference between RR-eligible and RR-ineligible words (chi square = 0.64, df = 1, p = 0.42). This is consistent with the parallel model, which only predicts an effect of RR for suffixes that trigger it.

The results for *-(a)thon* are below.

Example	Context	Proportion *-athon*
police-type	01 C-final	0.99
thirteen-type	21 C-final	0.98
cactus-type	10 C-final	0.79
hero-type	10 V-final	0.29

Table 5.34: Table of means for *-(a)thon*, thirteen-type stems included

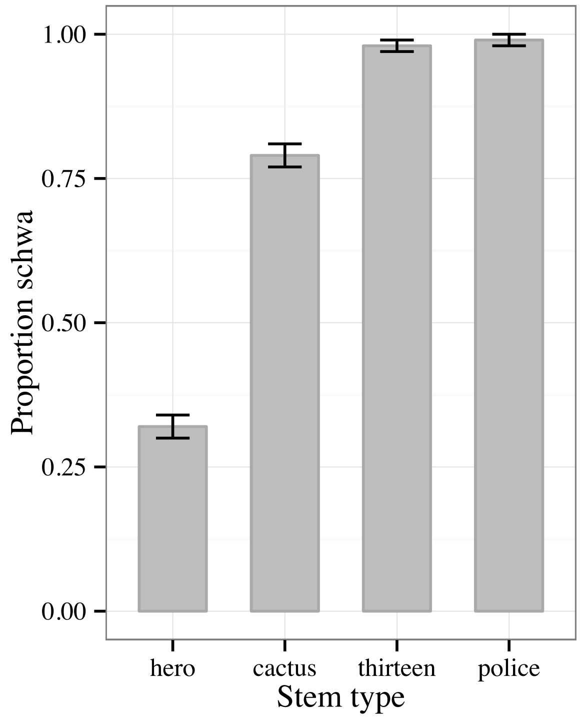

Figure 5.25: Proportion of *-athon* responses in judgment experiment, thirteen-type stems included

While significant overall, RR-elibigility doesn't have an effect for every subject. Not every subject shows a difference between *thirteen* and *police*, but of the subjects who do, most show a difference in the predicted direction.

For *-(a)licious*, the predicted difference between police-type and thirteen-type stems holds for 44% of subjects, while 46% show no difference, and the remaining subjects show in the opposite direction. In the table below, I divide subjects by geographic region, based on their self-reported location, and the regional divisions in the R dataset of state divisions (R Core Team 2013).[5] The effect is about the same across regions, although the vast majority of the opposite-pattern responders are in the Northeast.

[5] For more information, see 'state.name' and 'state.region' in R, and the helpfile 'state'.

	Midwest	Northeast	Northwest	South	West	Total
More schwa with police-type	13	14	4	13	4	48
No difference	9	19	5	10	8	51
More schwa with thirteen-type	1	7	0	0	2	10

Table 5.35: Number of speakers who show a differences between police-type and thirteen-type stems for *-(a)licious*

Regional information is included because Southern English tends to shift stress to the initial syllable of nouns, e.g. *úmbrella*, *chínese*, especially when there's a preceding secondary stress. This can't explain the intermediate status of *thirteen*, though, since many non-shifting dialects show a difference in the expected direction.

It's unclear what separates the speakers who show an effect of RR from those that do not. As discussed earlier in this section (§5.7.1), there are many explanations for failure to apply RR. Speakers may differ in whether they pronounce the words aloud first, speakers may differ in their mastery and familiarty with the suffixes, and – most likely – speakers may differ in their rate of RR application. The likelihood of RR application has not been extensively studied, nor have interspeaker differences in its application.

While about half of the subjects show an effect of RR in *-(a)licious*, nearly no subjects show a difference between police-type and thirteen-type stems for *-(a)thon*. The subjects who do show a difference are split with respect to which stem is better.

	Midwest	Northeast	Northwest	South	West	Total
4 More schwa with police-type	0	2	1	1	0	4
No difference	23	36	8	21	12	100
More schwa with thirteen-type	0	2	0	1	2	5

Table 5.36: Number of speakers who show a difference between police-type and thirteen-type stems for *-(a)thon*

All of these data show that speakers treat RR-eligible and RR-ineligible stems differently, and this difference disappears for *-(a)thon*. To further support the differences between *-(a)thon* and *-(a)licious*, I present the results of a mixed effects regression model in the next section, which finds a significant interaction between RR-eligibility and suffix.

The rest of this section addresses confounds and common objections to the results above, based on feedback from various audiences and three anonymous reviewers. The answer to most objections can be found in the interaction between RR-eligibility and suffix. Any property of the stems that could be used to explain the difference between thirteen-type and police-type stems cannot account for the lack of difference in *-(a)thon*. If some property makes thirteen-type stems favor *-licious*, that same property should make them favor *-thon*.

A ceiling effect. One potential complication is that the proportions for *-(a)thon* are close to 1.0. The lack of difference for *-(a)thon* could be due to a ceiling effect.

The difference between *-(a)licious* and *-(a)thon* holds when we move away from the ceiling. This is possible by binning the responses differently. Recall that subjects indicated their confidence as *definitely* or *probably*, in addition to choosing a suffix.

If we look at the proportion of *definitely -athon* responses, the rate of schwa drops to 0.72 for police-type stems and 0.70 for thirteen-type stems, but the size of the difference remains the same: 0.02. This difference is not significant in a chi-square test (chi-square = 0.41, d.f. = 1, p = 0.52).

Moving away from ceiling, we still find a difference for *-(a)licious*. Subjects chose *definitely -alicious* 53% of the time for police-type stems, and 45% of the time for thirteen-type stems, a significant difference (chi-square = 14.53, d.f. = 1, p < 0.001).

Interspeaker variation. The results for thirteen-type words are complicated by interspeaker variation with respect to secondary stress. As pointed out in Cooper and Eady (1986), many words that undergo RR (such as *thirteen*) are pronounced with initial stress even in non-RR contexts, at least for some speakers. The experimental findings could be dismissed as a result of this variation: some speakers say *thirteen* with initial stress, some with final, and the mixture of these speakers puts it between *cactus* and *police*.

I offer two responses to this objection.

First, if thirteen-type words vary between pronunciations, there's no reason why they'd vary with *-(a)licious* but not with *-(a)thon*.

Second, the difference between police-type and thirteen-type responses is not dependent on one or two items subject to variation. For *-(a)licious*, every police-type stem takes schwa at higher rate than every thirteen-type stem, and likewise for thirteen-type and cactus-type stems. There is no overlap between stem-types with respect to the proportion of schwa. For *-(a)thon*, there is a great deal of overlap: police-type and thirteen-type stems take schwa at the same rates. A full list of proportions by stem can be found in the appendix.

Spelling. A final confound is spelling. The items were presented with a hyphen between the stem and suffix, but it's possible that subjects interpreted a schwa where none was intended, for example, the *e* in *police-licious*. There are three reasons that spelling is nothing to worry about here. First, conditions don't differ too much with respect to their number of final *e*'s: 8/10 thirteen-type stems end in *e*, while 6/10 police-type stems do. Second, all thirteen-type stems have lower rates of *-alicious* than all police-type stems. Even if we disregard *e*-final stems, the effect of RR remains. Finally, spelling can't explain why the effect of RR is present in *-(a)licious*, but disappears with *-(a)thon*.

5.7.4 Regression model

To see if there was an interaction between RR-eligibility and suffix, results were analyzed using a mixed-effects logistic regression model. The analysis was performed using the lme4 package (Bates et al. 2013) in R (R Core Team 2013). The independent variable was schwa vs. no schwa.

The model included predictors for stress pattern (Non-Final), RR-eligibility (rr), suffix (Suffix), and the interaction of RR-eiligbility and suffix. The coding of these is discussed below.

The model did not include a predictor for final segment, and hero-type stems were excluded. A model with hero-type stems failed to converge with a full set of random slopes. This may be because all of the V-final items in the experiment have final stress. As a result, many combinations of final segment, RR-eligibility, and stress are missing from the data.

Stress pattern. The different stress contexts were coded as a 3-level factor, ordered in the direction predicted by the parallel model. This three-way contrast was divided into two predictors using Helmert coding: Non-Final for non-final stress and rr for Rhythm Rule.

Level	Stress pattern	NON-FINAL	RR	stem types
Level 1	10	+2	0	cactus
Level 2	21	−1	+1	thirteen
Level 3	01	−1	−1	police

Table 5.37: Contrasts for NON-FINAL and RR

NON-FINAL compares Level 1 with higher levels (10 vs. 21 and 01), while RR compares Level 2 with higher levels (21 vs. 01). RR has no effect in cactus-type stems, since they have a value of 0.

Suffix. The contrasts for SUFFIX are below.

Context	SUFFIX	Examples
-(a)licious	+1	cactus-(a)licious, police-(a)licious, etc.
-(a)thon	−1	cactus-(a)thon, police-(a)thon, etc.

Table 5.38: Contrasts for SUFFIX

Interaction RR x SUFFIX. The model included an interaction term for RR and SUFFIX. The values for each condition are show below. Note that RR x SUFFIX cancels out RR for *-(a)thon*, but heightens the difference between *police* and *thirteen* for *-(a)licious*. Like RR , RR x SUFFIX has no effect in cactus-type stems.

	RR x SUFFIX	RR	SUFFIX
thirteen-licious	+1	+1	+1
cactus-licious	0	0	+1
police-licious	−1	−1	+1
thirteen-thon	−1	+1	−1
cactus-thon	0	0	−1
police-thon	+1	−1	−1

Table 5.39: Interaction term RR x SUFFIX

Model and results. The model included predictors for stress pattern (NON-FINAL), Rhythm Rule eligibility (RR), suffix (SUFFIX), and the interaction term RR x SUFFIX. The model also included random intercepts for Subject and Item, in addition to random slopes by Subject for all predictors, including the interaction term.[6]

The results of the model are presented below. Effects with a Z value greater than 2 or less than –2 are significant. In the table below, a positive estimate (β) indicates that as the predictor increases, the likelihood of the schwaful variant (*-alicious* or *-athon*) increases. A negative one indicates that the likelihood of the schwaful variant decreases as the factor increases. In other words, positive means more schwa, and negative means less.

[6]The regression equation in R: Response ~ NON-FINAL + RR*SUFFIX + (1 + NON-FINAL + RR*SUFFIX | Subject) + (1|Item); family=binomial; link=logit

	β	SE	z value	p value
(Intercept)	2.01	0.18	16.08	
NON-FINAL	-1.05	0.08	−12.78	<0.001
RR	-0.22	0.17	-1.24	0.21
SUFFIX	-1.14	0.10	-11.70	<0.001
RR x SUFFIX	-0.60	0.15	-3.93	<0.001

Table 5.40: Logistic regression results

All of the predictors included in the model were significant, except for RR.

NON-FINAL: The negative value shows that non-final-stress stems are more likely to occur with *-licious* and *-thon* than *-alicious* and *-athon*. In other words, stress-final stems are more likely to occur with a schwaful suffix.

SUFFIX: The negative value of the factor SUFFIX shows that words with *-(a)licious* are less likely to occur with schwa than words with *-(a)thon*.

RR x SUFFIX: The significant interaction between RR and SUFFIX shows that RR-eligibility has a greater effect in words derived with *-(a)licious* than in words derived with *-(a)thon*. The negative value means that RR-eligible stems with *-(a)licious* are less likely to take schwa than we'd expect given the effects of RR or SUFFIX alone.

The result for RR x SUFFIX is the one most of interest here: the effect of RR-eligibility is dependent on suffix. This can be seen in the mean proportions from the experiment: there is a large large difference between RR and non-RR stems for *-(a)licious*, but only a marginal difference for *-(a)thon*.

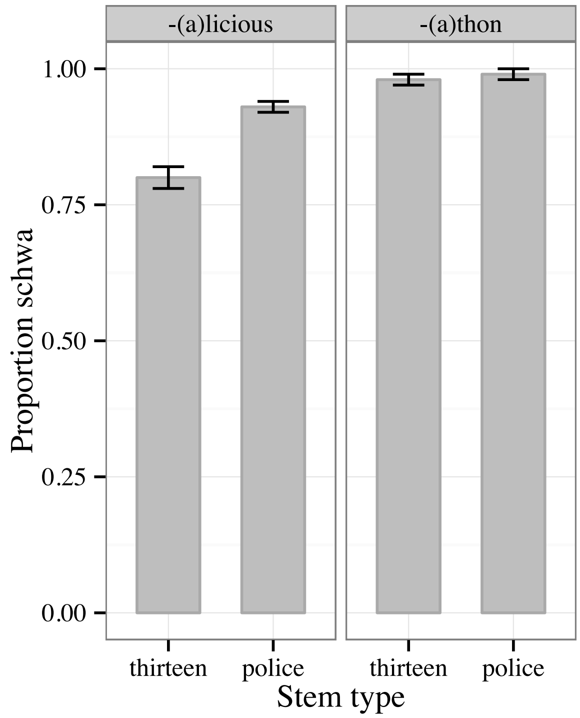

Figure 5.26: Proportion of schwa responses for thirteen-type and police-type stems from experiment

It's this interaction that provides support for a parallel model. In the parallel model, the choice of suffix is closely tied to whether or not RR can apply. RR will only have an effect with suffixes that can trigger it. For a suffix that can't trigger RR (like *-(a)thon*), there should be no difference between RR-eligible stems (*thirteen*) and RR-ineligible ones (*police*).

5.7.5 Metrical consequences

In addition to providing an argument for language-wide constraints, the experimental results demonstrate that clash in English is a gradient phenomenon.

Recall that the *-alicious* form of the suffix is used to avoid a stress clash, as shown below.

					✘						✘	
		✘			✘				✘		✘	
	ə	✘		ə	✘	✘		ə	✘		✘	✘
a.	po	lice	-	a	li	licious	b.	po	lice	-	li	licious

Table 5.41: *police-alicious* avoids clash

In the examples above, a schwaful syllable is able to intervene between two stressed syllables, acting as a buffer against clash. The fact that there is a clash in (b) but not (a) is consistent with the typical formulation of clash, such as Hammond (1992) below.

(55) Clash: two x's adjacent on two contiguous rows.

A stress clash results when there are two adjacent grid marks on the same level, and two adjacent grid marks on the level below or above that. A clash does *not* occur when there is an intervening grid mark on an adjacent lower level.

The problem is that that schwa doesn't count as a buffer against stress clash in other cases. In the example below, a stress clash occurs between two non-adjacent syllables with schwa between them. RR here is only possible if schwa doesn't count as an intervener with respect to stress clash.

				✘						✘	
		✘		✘	✘		✘	←		✘	✘
	✘	✘	ə	✘	✘		✘	✘	ə	✘	✘
a.	Tai	pei	A	ssa	ssins	b.	Tai	pei	A	ssa	ssins

Table 5.42: Taipei Assassins: stress clash across schwa

One answer is that schwa itself doesn't project onto the grid, which also accounts for the failure of RR to retract stress onto a syllable with a schwa. Under the classic definition of clash, schwa is unable to prevent a clash if it doesn't project on the grid.

This raises a new problem: schwa counts as an intervener with respect to PCA, but not with respect to RR. It must project on the grid in *police-alicious*, but not in *Taipei Assassins*.

The solution is that schwa is a weak intervener. The buffer provided by schwa is not enough to prevent the RR from applying, as above, but it is enough to prefer *-alicious* over *-licious* in PCA. It's not as good as a syllable with a full vowel, but it's better than nothing.

The evidence for the status of schwa as weak intervener is presented below. Hayes (1984) reports that words with one vowel between clashes are more likely to undergo RR than words with two vowels between cashes. Many of the two vowel words contain a schwa. For the one- and two-vowel clashes to be different, schwa must be present on the grid, at least in some form.

(56) Disyllabic stress intervals clash less than monosyllabic stress intervals – words on the right resist Rhythm Rule relative to those on the left (Hayes 1984)

a.	Mississippi Mabel	Minneapolis Mike
b.	Punxatawny Pete	Passaconaway Pete
c.	analytic thought	analytical thought
d.	diacritic markings	diacritical markings
e.	the Passamaquoddy verb	the Potawatomi verb
f.	Alabama relatives	Alabama connections
g.	European history	European historian
h.	Oklahoma congressman	Oklahoma congressional district
i.	two thousand one	two thousand and one

Further evidence for schwa as weak intervener comes from Tilsen (2012), who reports the results of a production experiment on RR. The experiment finds that speakers resolve stress clash using RR, at least in prepared speech. The interesting thing is that the non-clash contexts in Tilsen (2012) are contain words with schwa as an intervener (e.g. *gazelle*). Speakers are less likely to resolve clash in *Japanese gazelle* than *Japanese gecko*. If schwa didn't project onto the grid, then we'd expect no difference between the clash in *gazelle* and the clash in *japanese gecko*, contrary to Tilsen (2012)'s findings.

5.8 MaxEnt model of experimental results

The goal of this section is a probabilistic model that can capture the phonological conditioning of *-(a)thon* and *-(a)licious*. The target generalizations:

- Overall, schwa is more likely in *-(a)thon* than *-(a)licious*.
- *-(a)thon* and *-(a)licious* are conditioned by final segment and final stress.
- Full vowel-final stems (*hero*) take schwaful allomorphs more than schwa-final stems (*soda*).
- *-(a)licious* interacts with the Rhythm Rule.

A successful model captures the generalizations above, and comes close to matching the probabilities from the experiment.

In this section, all of the generalizations above follow from the interaction of weighted constraints in a MaxEnt grammar (see §3.7). Phonological conditioning comes from markedness constraints, while the difference in baseline rates for *-athon* and *-alicious* comes from UR constraints. Moreover, the model is able capture the probabilities for both *-(a)licious* and *-(a)thon* with a single weighting of constraints, as required by the LWC Hypothesis.

The model's weights are found using well-understood learning algorithms. Since learning defaults is as simple as learning a constraint weighting, no extra machinery is required. All the learner needs is constraints, violations, URs, and the probabilities for each type of licious-word and thon-word.

At the end of the chapter, I show that the model found for *-(a)licious* and *-(a)thon* is consistent with English phonotactics, suggesting that learners have enough data from phonotactics to acquire the markedness weights in the model. In this way, *-(a)licious* and *-(a)thon* data provide a window into English phonology. A model fit only with the experimental data is consistent with a model fit over the entire English lexicon.

5.8.1 Constraints and violations

I use the four markedness constraints below, discussed in §5.3.

(57) ∗CLASH

Assign one violation mark for every sequence of two stressed syllables.

(58) ∗LAPSE

Assign one violation mark for every sequence of two unstressed syllables.

(59) ∗HIATUS

Assign one violation mark for every sequence of two vowels.

(60) ∗ə.V

Assign one violation mark for every sequence of two vowels, where the left vowel is lax.

In addition, I use two constraints for RR. The first militates against RR application, under the assumption the stress is present in URs.

(61) FAITH(STRESS)

Assign one violation mark for every stressed vowel in the input that corresponds to a stressless vowel in the output.

The second is a constraint that enforces two conditions on RR. The first condition prevents retracting stress to a schwaful syllable, e.g. retracting stress to the first syllable in *police*. The second condition prevents retracting a main stress in a phrase, e.g. retracting stress from *antique* in *antique armchair*, or from *thirteen* in *thirteen-licious*.

These two conditions are inviolable in English, so they're grouped together in a single constraint for ease of presentation.

(62) RR RULES

Assign one violation for every UR-SR pair that violates at least one condition on RR. The conditions are: (1) if schwa in the input, then stressless in the output. (2) if main stress in the input, then stressed in the output.

Finally, there are four UR constraints, two for *-(a)licious* and two for *-(a)thon*. For arguments that these suffixes are cases of PCA and need multiple URs, see §5.4.

(63) UR = /əlɪʃəs/

(64) UR = /lɪʃəs/

(65) UR = /əθɑn/

(66) UR = /θɑn/

The tableau below shows the violations for the four types of stem with *-(a)licious*. I don't consider unfaithful mappings, such as candidates with epenthesis and deletion.

	*Clash	*Lapse	*ə.V	*Hiatus	Faith(Stress)	RR Rules	UR = /lɪʃəs/	UR = /əlɪʃəs/
pol$\overset{2}{i}$ce-al$\overset{1}{i}$cious							−1	
pol$\overset{2}{i}$ce-l$\overset{1}{i}$cious	−1							−1
p$\overset{2}{o}$lice-al$\overset{1}{i}$cious (RR)		−1			−1	−1	−1	
p$\overset{2}{o}$lice-l$\overset{1}{i}$cious (RR)					−1	−1		−1
thirt$\overset{2}{e}$e-al$\overset{1}{i}$cious							−1	
chin$\overset{2}{e}$se-l$\overset{1}{i}$cious	−1							−1
th$\overset{2}{i}$rteen-al$\overset{1}{i}$cious (RR)		−1			−1		−1	
th$\overset{2}{i}$rteen-l$\overset{1}{i}$cious (RR)					−1			−1
cactus-alicious		−1					−1	
cactus-licious								−1
hero-alicious		−1		−1			−1	
hero-licious								−1
soda-alicious		−1	−1	−1			−1	
soda-licious								−1

Table 5.43: Constraint violations for *-(a)licious*

Before moving on, let's consider what's these constraints and violations predict. In MaxEnt, the probability assigned to a candidate is proportional to the exponential of its weighted constraint violations.

Given the candidates and violations above, *soda-alicious* will always be less likely than than *hero-alicious*. The schwaless forms of both will always have the same harmony score, but *soda-alicious* will always have a lower harmony score than *hero-alicious* (as long as the constraint weights aren't zero). As a result of this lower harmony score, it will take up less of the probability distribution.

Likewise, *hero-alicious* will be less probable than *cactus-alicious*, regardless of weights. The violations of *hero-alicious* are a superset of those of *cactus-alicious*, while the *-licious* forms have the same violations.

In summary, we expect *soda-licious* to be more likely than *hero-licious*, and *hero-licious* to be more likely than *cactus-licious*. This is a straightforward consequence of the constraints of English, and holds for any set of non-zero, non-negative weights.

The violations for *-(a)thon* are below. There are two places where they differ from *-(a)licious*. First, *-(a)thon* subject to a different set of UR constraints. Second, since *-(a)thon* takes secondary stress in derived words, RR is blocked. This can be seen in the two violations of RR RULES in boxes below. Because of these violations, *police-(a)thon* and *thirteen-(a)thon* have identical violation profiles, and are predicted to always have the same probabilities.

	*Clash	*Lapse	*ə.V	*Hiatus	Faith(Stress)	RR Rules	UR = /θɑn/	UR = /əθɑn/
pol$\overset{1}{i}$ce-ath$\overset{2}{o}$n							−1	
pol$\overset{1}{i}$ce-th$\overset{2}{o}$n	−1							−1
p$\overset{1}{o}$lice-ath$\overset{2}{o}$n (RR)		−1			−1	−1	−1	
p$\overset{1}{o}$lice-th$\overset{2}{o}$n (RR)					−1	−1		−1
thirt$\overset{1}{e}$en-ath$\overset{2}{o}$n							−1	
thirt$\overset{1}{e}$en-th$\overset{2}{o}$n	−1							−1
th$\overset{1}{i}$rteen-ath$\overset{2}{o}$n (RR)		−1			−1	$\boxed{-1}$	−1	
th$\overset{1}{i}$rteenth$\overset{2}{o}$n (RR)					−1	$\boxed{-1}$		−1
cactus-athon		−1					−1	
cactus-thon								−1
hero-athon		−1		−1			−1	
hero-thon								−1
soda-alicious		−1	−1	−1			−1	
soda-licious								−1

Table 5.44: Constraint violations for *-(a)thon*

As with *-(a)licious*, *soda-thon* will always be more likely than *hero-thon*, and *hero-thon* will always be more likely than *cactus-thon*, regardless of constraint weights

5.8.2 Constraint weights

The target probabilities for the MaxEnt-HG model are repeated below, taken from the experiment. Note that hero-type words have been subdivided into *hero* (full V final) and *soda* (schwa final).

	p(alicious)	p(athon)
police	0.93	0.99
thirteen	0.80	0.98
cactus	0.45	0.79
hero	0.09	0.48
soda	0.04	0.10

Table 5.45: Target probabilities from experiment

The learner is provided with these probabilities, along with the candidates and constraint violations from the last section. The learner is supplied with the correct URs, but isn't provided with any other information, such as which form is the default or the strength of the default.[7]

The objective of the learner is to find a set of weights that maximizes the probability of observed forms. To find such a set of weights, I used the MaxEnt Grammar Tool (Wilson and George 2008). Weights were started at 0, and to prevent weights from climbing too high, an L2 (Gaussian) prior was used (Tychonoff and Arsenin 1977), with $sigma^2$ of 10,000.

The learned weights are in the table below.

[7]As mentioned, I provide the correct URs and abstract from hidden structure learning, but see (Pater et al. 2012) for an implementation using UR constraints, in which the learner must learn URs at the same time as learning alternations and defaults.

Constraint	Weight	Constraint	Weight	Constraint	Weight
*Clash	2.66	RR Rules	16.56	ur = -athon	2.61
*ə.V	1.81	Faith(Stress)	1.40	ur = -thon	0.45
*Hiatus	1.50			ur = -alicious	0.85
*Lapse	0.85			ur = -licious	0.50

Table 5.46: Learned constraint weights

The table below shows the probabilities for each candidate in the learned grammar. The learned grammar closely matches the target probabilities. More importantly, it captures all of the target generalizations: schwa is more likely for *-(a)thon* across contexts; stress and final segment play a role in suffix selection; and RR-eligible stems are more likely to take *-licious* than RR-ineligible stems.

The grammar captures the pattern for *-(a)licious* and *-(a)thon* with only faithfulness, markedness, and UR constraints. There are no constraints specifically for defaulthood, and there are no morphologically-specific markedness or faithfulness constraints.

	-(a)licious		-(a)thon		
	Target	Learned	Target	Learned	
pol$\overset{2}{\text{i}}$ce-al$\overset{1}{\text{i}}$cious	0.93	0.95	0.99	0.99	pol$\overset{1}{\text{i}}$ce-ath$\overset{2}{\text{o}}$n
pol$\overset{2}{\text{i}}$ce-l$\overset{1}{\text{i}}$cious	0.07	0.05	0.01	0.01	pol$\overset{1}{\text{i}}$ce-th$\overset{2}{\text{o}}$n
p$\overset{2}{\text{o}}$lice-al$\overset{1}{\text{i}}$cious (RR)	0.00	0.00	0.00	0.00	p$\overset{1}{\text{o}}$lice-ath$\overset{2}{\text{o}}$n (RR)
p$\overset{2}{\text{o}}$lice-l$\overset{1}{\text{i}}$cious (RR)	0.00	0.00	0.00	0.00	p$\overset{1}{\text{o}}$lice-th$\overset{2}{\text{o}}$n (RR)
thirt$\overset{2}{\text{e}}$en-al$\overset{1}{\text{i}}$cious	0.80	0.71	0.98	0.99	thirt$\overset{1}{\text{e}}$en-ath$\overset{2}{\text{o}}$n
thirt$\overset{2}{\text{e}}$en-l$\overset{1}{\text{i}}$cious	0.00	0.04	0.02	0.01	thirt$\overset{1}{\text{e}}$en-th$\overset{2}{\text{o}}$n
th$\overset{2}{\text{i}}$rteen-al$\overset{1}{\text{i}}$cious (RR)	0.00	0.09	0.00	0.00	th$\overset{1}{\text{i}}$rteen-ath$\overset{2}{\text{o}}$n (RR)
th$\overset{2}{\text{i}}$rteen-l$\overset{1}{\text{i}}$cious (RR)	0.20	0.16	0.00	0.00	th$\overset{1}{\text{i}}$rteen-th$\overset{2}{\text{o}}$n (RR)
cactus-alicious	0.45	0.38	0.79	0.79	cactus-athon
cactus-licious	0.55	0.62	0.21	0.21	cactus-thon
hero-alicious	0.09	0.12	0.48	0.45	hero-athon
hero-licious	0.91	0.88	0.52	0.55	hero-thon
soda-alicious	0.04	0.02	0.10	0.12	soda-athon
soda-licious	0.96	0.98	0.90	0.88	soda-thon

Table 5.47: Target and learned probabilities for MaxEnt model of *-(a)licious* and *-(a)thon*

Below, I go through the constraint weightings responsible for each generalization.

Overall, -athon is more likely than -alicious. The weights of the UR constraints capture the differences in baselines between *-(a)thon* and *-(a)licious*. For both suffixes, the default is the schwaful form, shown by the fact that the schwaful form has a higher weight. The degree of defaulthood differs across the two suffixes: for *-(a)thon*, there is large difference between the weight of UR =-athon and UR =-thon, making the schwaful form a strong default. For *-(a)licious*, the weights of the UR constraints are much closer, resulting in a weaker preference for the schwaful form. As a result, *-athon* is more likely than *-alicious* overall, consistent with the experimental and corpus data.

The suffixes are conditioned by final segment and final stress. In the learned grammar, ∗Clash and ∗Hiatus ensure that *police* occurs most with the schwaful form, and *hero* occurs most with the schwaless form. *Cactus* is between *hero* and *police*, since neither ∗Clash nor ∗Hiatus are at stake; outside of the UR constraints, the only reason to use a schwaless suffix is to avoid a violation of ∗Lapse, which has a lower weight. Note that effects hold for both suffixes, since both suffixes obey the same weighting of markedness constraints.

Full vowel-final stems take schwa more than schwa-final ones.*Soda-alicious* and *soda-athon* are strongly dispreferred by the grammar. Each incurs violations of both ∗ə.V and ∗Hiatus. *Hero-alicious* and *-athon*, on the other hand, only violate ∗Hiatus.

-(a)licious interacts with the Rhythm Rule. The interaction of RR and *-(a)licious* follows from the weighting of Clash over Faith(Stress). This interaction is only possible because RR and suffix allomorphy are considered in parallel. The difference between *-(a)licious* and *-(a)thon* comes from the high weight of RR Rules, which prevents retraction from primary stressed syllables (as in *thirteen-thon*).

For *thirteen*, the grammar assigns some probability to *-licious* without RR and *-(a)licious* with RR. The reason is the lack of general RR data in the learning data. The grammar has no way to know that RR only applies to resolve stress clash, or that it applies whenever there's a clash. Despite this, the grammar matches the observed distribution if we collapse over RR and non-RR candidates: 0.20 for *thirteen-licious* and 0.80 for *thirteen-alicious*.

Further predictions. The model here makes some further, testable predictions.

Given the weights of ∗Clash, ∗Lapse, and ∗Hiatus, every alternating suffix in English (*-(o)rama*, *-(a)holic*, *-(e)teria*, etc.) should occur most often with schwa in stems like *police* and least often with schwa in stems like *hero*. This is assuming we control for other constraints, like those against segmental identity (segmental OCP).

This prediction follows from the fact that allomorphic variation is the result of the phonological grammar. While UR constraints can make a schwaful form more or less likely across the entire set of contexts, there is no way for a UR constraint to make a schwaful form more likely with *hero* than *cactus*, or more likely with *cactus* than *police*.

The constraint weights also predict that stress-final, vowel-final words, like *café*, will be between *cactus*- and police-type words. In *café*-type words, ∗CLASH and ∗HIATUS have competing demands for suffixation. For *café*, ∗CLASH prefers *-alicious* and *-athon*, while ∗HIATUS prefers *-licious* and *-thon*. Under the learned grammar, ∗CLASH is higher weighted than ∗HIATUS, so we expect more *café-alicious* than *café-licious*. Unfortunately, *café*-type words aren't well-attested in the corpus, and weren't tested in the experiment.

Given the constraint weights, RR will apply about 78% of the time in a phrase like *thirteen men*.

	Harmony	Exp(H)	Proportion
thirtéén men (no RR)	−2.66	0.07	22%
thírteen men (RR)	−1.40	0.27	78%

Table 5.48: Model's predictions for Rhythm Rule application

This isn't so far from what's observed in production experiments. Grabe and Warren (1995) report that stress clash is resolved about 85% of the time in a production experiment.

5.8.3 Relationship to English phonotactics

The model from the last section succeeds in capturing the distribution of *-(a)licious* and *-(a)thon*, and the weights were fitted using only the probabilities for licious- and thon-words. As discussed earlier in the chapter, speakers don't have much evidence for the distribution of the two suffixes, and they certainly don't have access to the exact probabilities for each type of word. As a result, the fitting of the model isn't representative of how speakers actually acquire the phonological conditioning of the suffixes.

Under the LWC Hypothesis, allomorphy follows from the regular English phonological grammar. Speakers acquire the weights of markedness and faithfulness constraints in the course of acquisition of English, and the weights of UR constraints follow later.

This section shows that the weights found for *-(a)licious* and *-(a)thon* match the weights we expect in the English phonological grammar. There are two types of evidence discussed here: raw counts from the English lexicon; and the weights of constraints in Hayes' (2012) phonotactic grammar. Both support the weights of the markedness constraints found by the model, even though the model's weights were determined exclusively from the distribution of *-(a)licious* and *-(a)thon.*

I finish the section by considering whether phonotactics alone are sufficient to account for the distribution of the suffixes. Recall that the suffixes have different phonological properties, especially with respect to stress. Perhaps these stress differences are responsible for the greater preference for schwa in *-(a)thon*.

While English phonotactics can explain a lot of the phonological conditioning, they cannot account for the differences captured by UR constraints: that schwa is more likely in *-(a)thon* than *-(a)licious*.

Target generalizations. The weights learned in the last section are repeated below.

Constraint	Weight	Constraint	Weight
∗Clash	2.66	RR Rules	16.56
∗ə.V	1.81	Faith(Stress)	1.40
∗Hiatus	1.50		
∗Lapse	0.85		

Table 5.49: Constraint weights from suffix model

Lexical counts. The weights above are reflected in the distribution of words in the English lexicon. Across English words, the constraints above with higher weights are less likely to be violated.

This is shown in the table below, which presents the number of words that violate each constraint in the CMU pronouncing dictionary (Weide 1993). The counts only consider words that are at least three syllables long, since shorter words are unable to violate ∗Lapse. I also exclude words that don't occur at least once in SUBTLEX-US, a corpus of English subtitles (Brysbaert and New 2009). Since any word that violates ∗ə.V also violates ∗Hiatus, the weights of the two constraints are combined in the first row.

Constraint	Weight in model	Number of violators (% of total words)
∗ə.V and ∗Hiatus	3.31 $= 1.81 + 1.50$	16 (<1%)
∗Clash	2.66	1,597 (8%)
∗Hiatus (but not ∗ə.V)	1.50	2,792 (13%)
∗Lapse	0.85	8,702 (41%)

Table 5.50: Number of 3+ syllable words that violate each constraint in CMU, out of 20,988 words.

Consistent with the constraint weights, the counts demonstrate that clashes are worse than lapses, and hiatus is worse when the left vowel is lax. The relationship between the constraint weights and proportion of violators in CMU is shown in the graph below. The graph plots the proportion of words in CMU that violate each constraint against the constraint weights. The weights are transformed by making them negative and applying the exponential function. Recall that the same function is used in MaxEnt Harmonic Grammar to convert harmony scores into probabilities.

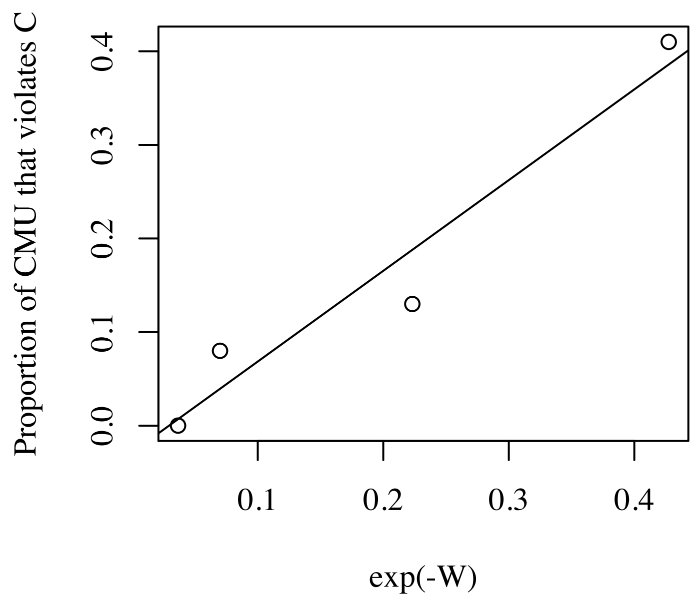

Figure 5.27: Exponentiated negative weight of each constraint vs. the proportion of 3+ syllable words in CMU that violate the constraint

Phonotactic grammar. The constraint weights learned for *-(a)licious* and *-(a)thon* also line up with those of an English phonotactic grammar: the BLICK grammar of Hayes (2012). Like the model presented in the last section, the BLICK grammar uses weighted constraints in MaxEnt Harmonic Grammar. The grammar includes more than 200 constraints, both machine learned and hand-picked from the literature by Hayes.

The weights of these constraints were discovered using a large list of English words from the CMU pronouncing dictionary.

There are two reasons to use the BLICK grammar over others. First, all of BLICK's constraint weights are available online, in addition to software that calculates the harmony of any English word transcribed in IPA.[8] Second, unlike many other phonotactic grammars of English, BLICK considers stress, and contains a full set of stress constraints, including *CLASH.

The weights of the relevant constraints are presented below, along with the descriptions from the BLICK file. One important consideration is that the BLICK grammar contains many constraints (upwards of 200), and it has many versions of constraints against hiatus, stress lapse, and stress clash. This means the general anti-hiatus and anti-lapse constraints are competing with more specific versions, and as a result, sometimes have lower weights. I include both general and specific versions of hiatus and stress constraints below.

As mentioned above, the weights in BLICK line up with the model of the suffix data. The lowest-weighted constraints from the suffix grammar have no weight in BLICK, either because they have a weight of zero (*HIATUS) or because they weren't included in the BLICK grammar (*LAPSE). The highest weighted constraints from the suffix grammar – *ə.V and *CLASH – both have relatively high weights in BLICK. Word-medial clashes are especially bad in BLICK, since they violate both a constraint against general stress clash, and a more specific constraint against medial stress clash.

[8] www.linguistics.ucla.edu/people/hayes/BLICK/

Suffix grammar		BLICK grammar		
Constraint	Weight	Weight	Constraint	Description from BLICK
∗ə.V	1.81	6.53	∗[-tense][+syllabic]	Hiatus with lax vowel on left.
		4.27	∗[+low][+syllabic]	Hiatus with low vowel on left.
∗Hiatus	1.50	0.00	∗[+syllabic][+syllabic]	Hiatus in general.
		1.87	∗[+stress][+syllabic]	Hiatus is worse when one vowel is stressed (here, the first of the two).
		0.67	∗[+syllabic][+stress]	Hiatus is worse when one vowel is stressed (here, the second of the two).
∗Clash	2.66	1.90	∗[+stress][+stress]	*Clash.
		1.07	∗[-wd. bound.][+str][+str]	Clash in other than initial position.
∗Lapse	0.85	N/A	N/A	BLICK only has initial, 3-syllable, and 4-syllable lapse.

Table 5.51: comparison of weights from suffix grammar and BLICK grammar

To better see the interaction of these constraints, I give the harmonies for some candidates below. These harmonies come from the constraints in the table above. Neither UR constraints from the suffix grammar nor the rest of the constraints from BLICK are included. For both sets of constraints, *soda-athon* is less likely then *hero-athon*, and *cactus-athon* is less likely than *police-athon*. The place where the grammars differ is *hero-athon* and *cactus-athon*. BLICK lacks both general ∗Hiatus and ∗Lapse, so these two forms have equal probabilities.

Word	H given suffix grammar	H given BLICK constraints
hero-athon	−2.35 (−0.85 + −1.50)	0
hero-thon	0	0
soda-athon	−3.16 (−1.81 + −1.50 + −0.85)	−6.53
soda-thon	0	0
police-athon	0	0
police-thon	−2.66	−2.97 (−1.90 + −1.07)
cactus-athon	−0.85	0
cactus-thon	0	0

Table 5.52: Harmonies given both grammars

While the phonotactic grammar captures the two target generalizations from this section, it's unable to distinguish *-(a)licious* from *-(a)thon*. Contrary to the phonotactic grammar, schwa is more likely with *-(a)thon* than *-(a)licious*, both in the corpus and across nearly all experimental items and subjects.

In the table below, I present the penalty scores for V-final stems, calculated using the entire BLICK grammar. The probabilities are calculated using the harmony score of each candidate, which is equal to the negative penalty score. The probability is the exponentiated harmony, normalized across the candidate set. The inputs for the BLICK grammar are included at the end of the section.

Word	Penalty score	Probability
sofa-thon	11.83	99%
sofa-athon	18.36	<1%
sofa-licious	1.69	99%
sofa-alicious	8.22	<1%
hero-thon	8.13	50%
hero-athon	8.13	50%
hero-licious	4.59	50%
hero-alicious	4.59	50%

Table 5.53: Probabilities from BLICK grammar weights: V-final stems

In the table above, the probabilities are the same for both *-(a)thon* and *-(a)licious* versions of stems, contrary to the expected pattern. Although *-thon* and *-athon* words have a higher penalty score (and lower harmony score), the difference in penalty scores is the same for *soda-(a)licious* and *soda-(a)thon*, resulting in the same difference in probabilities. The lower harmony of *-(a)thon* words comes from the fact that *-(a)thon* words have final stress, which is penalized n the grammar.

The probabilities for C-final stems are below. Unlike the V-final stems above, some C-final stems do show a difference in the expected direction. For example, *cactus-athon* is more likely than *cactus-alicious*. This is because *s-l* sequences are disfavored in the phonotactic grammar. However, the difference disappears for nasal-final stems like *balloon*. In the experimental results, differences between *-(a)thon* and *-(a)licious* hold regardless of the final consonant.

Word	Penalty score	Percent
cactus-thon	5.52	29%
cactus-athon	4.63	71%
cactus-licious	0.27	50%
cactus-alicious	0.27	50%
police-thon	8.72	2%
police-athon	4.87	98%
police-licious	4.29	5%
police-alicious	1.31	95%
balloon-thon	7.95	5%
balloon-athon	4.98	95%
balloon-licious	4.41	5%
balloon-alicious	1.44	95%

Table 5.54: Probabilities from BLICK grammar weights: C-final stems

In summary, while the phonotactic grammar can capture the differences between stems, such as *police* and *cactus*, its unable to account for the differences between -*(a)thon* and -*(a)licious*. In the URC MaxEnt model, this difference comes from UR constraints, which capture differences in the baseline rate of schwa.

Appendix. Here are the inputs to the BLICK Grammar Tool, which were used to calculate the probabilities above.

Word	Input for BLICK	Penalty
sofa-thon	S OW1 F AH0 TH AA2 N	11.83
sofa-athon	S OW1 F AH0 AH0 TH AA2 N	18.36
hero-thon	HH IY1 R OW0 TH AA2 N	8.13
hero-athon	HH IY1 R OW0 AH0 TH AA2 N	8.13
cactus-thon	K AE1 K T AH0 S TH AA2N	5.52
cactus-athon	K AE1 K T AH0 S AH0 TH AA2N	4.63
police-thon	P AH0 L IY1 S TH AA2 N	8.72
police-athon	P AH0 L IY1 S AH0 TH AA2 N	4.87
balloon-licious	B AH0 L UW2 N L IH1 SH AH0 S	4.11
balloon-alicious	B AH0 L UW2 N AH0 L IH1 SH AH0 S	1.44
sofa-licious	S OW2 F AH0 L IH1 SH AH0 S	1.69
sofa-alicious	S OW2 F AH0 AH0 L IH1 SH AH0 S	8.22
hero-licious	HH IY2 R OW0 L IH1 SH AH0 S	4.59
hero-alicious	HH IY2 R OW0 AH0 L IH1 SH AH0 S	4.59
cactus-licious	K AE2 K T AH0 S L IH1 SH AH0 S	0.27
cactus-alicious	K AE2 K T AH0 S AH0 L IH1 SH AH0 S	0.27
police-licious	P AH0 LIY2 S L IH1 SH AH0 S	4.29
police-alicious	P AH0 LIY2 S AH0 L IH1 SH AH0 S	1.31
balloon-licious	B AH0 L UW2 N L IH1 SH AH0 S	4.11
balloon-alicious	B AH0 L UW2 N AH0 L IH1 SH AH0 S	1.44

Table 5.55: Inputs and penalty scores for BLICK grammar

5.9 Chapter 5 conclusion

This chapter provided an in-depth case study of *-(a)licious* and *-(a)thon*, using both corpus and experimental data. These suffixes support the claim that PCA is driven by language-wide constraints, in a parallel model of phonology and morphology. The suffixes *-(a)licious* and *-(a)thon* are conditioned by ∗Clash and ∗Hiatus, constraints that are synchronically active and well-motivated in English. The conclusion is that speakers extend their existing grammatical knowledge to new suffixes, choosing the forms of the suffix that avoid stress clash and hiatus.

The argument for parallelism comes from the interaction of suffix selection and the Rhythm Rule (RR). Stems that can avoid a clash by undergoing RR are less likely to occur with *-alicious*, the clash-avoiding form of the suffix. The connection between suffix selection and RR is further supported by differences between *-(a)licious* and *-(a)thon*. Suffixes that can trigger RR show a difference between RR-eligible and RR-ineligible stems, while suffixes that cannot trigger RR show none. These interactions require UR selection to have lookahead to repairs.

Finally, the suffixes are best modeled with UR constraints. URC in MaxEnt is able to model variation, its constraint weights can be learned using existing learning algorithms, and it's able to capture differences between the baseline rates of *-(a)licious* and *-(a)thon*. Moreover, the model's learned weights are reflected in the English lexicon and phonotactics.

Conclusion

The goal of this thesis was to answer two unresolved questions in PCA.

(67) Phonological conditioning

When UR selection is phonologically-conditioned, how is phonological conditioning encoded?

(68) Lookahead to repairs

If the choice of a UR creates a phonological context that conditions the application of some process or "repair" (like epenthesis or deletion), does UR selection take these repairs into account?

I argued that PCA is driven by language-wide phonological constraints, and emerges from the general phonological grammar. With respect to language-wide constraints, I presented data showing that PCA is driven by independently motivated constraints: *a(n)* is driven by ∗ə.V, French liaison is driven by ∗HIATUS and *HIATUS(Ṽ.V), and *-(a)licious* is driven by ∗CLASH, ∗HIATUS, and others. In all of these cases, the same constraints used in the analysis of PCA play a role elsewhere in repairs or phonotactics, and a single ranking of constraints is possible for both repairs and PCA. For *-(a)licious*, the grammar found for the suffix closely matches the distribution of the English lexicon, even though speakers acquire the suffix with sparse data.

The fact that PCA is driven by language-wide constraints finds further support in the interaction of repairs and PCA, both of which conspire to avoid the same marked structures. Based on evidence from the same case studies, the conclusion is that UR selection sometimes has lookahead to repairs. Each case study had at least one instance of the chicken-egg effect, and parallelism played an important role throughout, allowing the model to capture preferences between PCA and repairs.

The account developed to model these two answers – URC – expands on previous OT accounts of PCA by introducing rankable UR constraints.

UR constraints can be ranked to capture defaults, and no additional default-specific machinery is required. Since defaulthood follows from the constraint-based grammar, both learnability and variation can be handled with existing learning algorithms and models of variation. In Chapter 3, I showed that URC can be used to model interspeaker variation with respect to preferences between *a*, *an*, and ʔ-epenthesis. In Chapter 4, I showed the same for preferences between forms of different Ṽ-final words. And in Chapter 5, I provided experimental support showing different baselines for *-(a)licious* and *-(a)thon*, along with a URC model of the results.

APPENDIX A: Libfixes

This appendix provides more libfixes that resemble -*(a)licious* and -*(a)thon*.

Other suffixes. Many suffixes follow the same pattern as -*(a)licious*, having both a schwaful and schwaless form, which are conditioned by stress. Like -*licious*, many have only recently achieved suffixhood.

Since some of these suffixes aren't included in traditional dictionaries, all of the definitions and the majority of the examples here are from Wiktionary, an open source dictionary, accessed in 2013.

This list isn't complete. There are more suffixes, which seem to follow a similar distribution but lack sufficient examples to be included (e.g., *(a)pocalypse*, *(o)mania*, *(o)crat*).

Suffix	Definition	Examples
-(a)licious	n/adj→ adj, Used to form intensified adjectives indicating deliciousness, from nouns and adjectives	sexalicious bootylicious
-(e)teria	n→ n, a self-service establishment that sells/serves the stem noun (not in Wiktionary)	shoe-eteria buffeteria
-(a)thon	n/v→ n, Used to form words meaning a greatly extended period of any activity, usually for the purpose of fundraising	insultathon Bieberthon
-(a)holic	n/v→ n, Denotes addiction to the substance or activity of the stem word.	sexaholic wikiholic
-(a)palooza	n→ n, 1. Forms the name of a promotional event such as a presentation. 2. Emphasizes or exaggerates the element of a situation.	Patriot-Act-a-palooza giggle palooza

Suffix	Definition	Examples
-(ma)geddon	n→ n, A disaster involving the stem word (not in Wiktionary)	snowmageddon moneygeddon
-(o)phile	n→ n/adj, Forming nouns and adjectives meaning ‘loving’ and ‘friendly’, or ‘lover’ and ‘friend’	Japanophile fashionphile
-(a)saurus	n→ n, Denoting something having the qualities of a dinosaur	snorasaurus coffeesaurus
-(a)riffic	n/adj→ adj, Used to form intensified adjectives from nouns and adjectives.	pimp-a-riffic Bieber-riffic
-(i)verse	n→ n, Forming compounds nouns denoting the fictional world of a given character, television series etc.	Trekiverse Buffyverse
-(o)rama	v/n→ n, Used to form, from one noun, a second, meaning ‘wide view of’ the first, or (with ironic reference to the preceding sense) ‘surfeit of’, ‘overattention to’, or ‘exaggerated praise of’ the first.	fez-o-rama Potter rama

Suffix	Definition	Examples
-(o)nomics	n→ n, Used, with a combining form to form nouns meaning the economics of a specified person or state.	Bushonomics Reaganomics
-(o)gram	v/n→ n, Something written, drawn or otherwise recorded. (My definition: message delivered via X)	kissogram candygram
-(a)pedia	n→ n, A specialized encyclopaedia about the prefix or a general encyclopedia in the structure of the prefix.	Bulbapedia Potterpedia
-(i)vore	n→ n, An animal, identified by their kind of diet.	insectivore localvore
-(o)phobe	n→ n, Used to form nouns denoting a person who hates or despises a specific thing.	pornophobe homophobe

I've omitted some non-alternating libfixes from this list, such as *-gate* and *-tastic*. These are discussed in the next section of the appendix.

Source words. All of these libfixes come from backformation: an English word or blend is reanalyzed with a suffix.

The fact that some libfixes have a schwaful counterpart and others lack one follows from the source word of the libfix. The table below shows that all of the words that have an alternating vowel come from a word containing a vowel directly before the libfix.

It can also be observed that the stress pattern of the suffix matches the stress pattern in the source word. For example, *(a)palooza* and *(o)phile* take secondary stress, just like their source words. The other cases are for the most part very regular. As expected, final syllables do not take primary stress.

Suffix	Source word	Suffix’s stress	Suffix	Source word	Suffix’s stress
-(a)lícious	delícious	primary	-(a)ríffic	teríffic	primary
-(e)téria	càfetéria	primary	-(i)vèrse	únivèrse	secondary
-(a)thòn	márathòn	secondary	-(o)ráma	pànoráma	primary
-(a)hólic	àlcohólic	primary	-(o)nómics	èconómics	primary
-(a)palóóza	Lòllapalóóza	primary	-(o)gràm	télegràm	secondary
-(ma)géddon	àrmagéddon	primary	-(a)pédia	encyclopédia	primary
-(o)phìle	pédophìle	secondary	-(i)vòre	hérbivòre	secondary
-(a)sáurus	bròntosáurus	primary	-(o)phòbe	cláustrophòbe	secondary
-tástic	fantástic	-tástic	wátergàte	secondary	gàte
-zílla	gòdzílla	primary			

APPENDIX B: -(a)licious experiment

This appendix contains materials and the results for the experiment in Chapter 5.

List of items from -(a)licious experiment. The experimental items are below, sorted by condition, with stress context in parentheses. Note some variation in pronunciation, especially for trisyllabic words.

(69) cactus-type words (10)

a. acid

b. basket

c. decade

d. gossip

e. magic

f. necklace

g. office

h. patrick

i. pirate

j. secret

(70) police-type words (01)

a. balloon

b. cologne

c. debate

d. design

e. estate

f. grenade

g. japan

h. maroon

i. parade

j. police

(71) thirteen-type words (21)

a. antique

b. berlin

c. brunette

d. caffeine

e. champagne

f. chinese

g. concrete

h. corvette

i. routine

j. thirteen

(72) hero-type words (10)

a. chili

b. china

c. cookie

d. cuba

e. drama

f. hero

g. jackie

h. menu

i. russia

j. zero

(73) acoustic-type words (010)

a. acoustic

b. adhesive

c. apprentice

d. ceramic

e. deposit

f. detective

g. electric

h. exhibit

i. explosive

j. objective

(74) alaska-type words (010)

a. alaska

b. antenna

c. aroma

d. banana

e. bikini

f. gorilla

g. korea

h. nevada

i. piano

j. spaghetti

(75) japanese-type words (201)

a. afternoon

b. halloween

c. japanese

d. magazine*

e. cigarette*

f. souvenir

g. tambourine

h. violin

i. volunteer

j. pioneer

(* indicates a word that is also pronounced 102)

(76) underwear words (102)

a. alphabet

b. dinosaur

c. exercise

d. honeymoon

e. hurricane

f. limousine*

g. nicotine

h. silverware

i. underwear

j. valentine

(* indicates a word that is also pronounced 201)

Full results for -(a)licious experiment. This appendix presents the full results of the experiment in Chapter 5, including fillers and individual proportions for the stems of interest.

Stem type	-(a)licious	-(a)thon	Final C/V	Stress pattern
acoustic	0.50 (0.02)	0.69 (0.02)	C	010
alaska	0.03 (0.01)	0.13 (0.01)	V	010
cactus	0.45 (0.02)	0.79 (0.02)	C	10
thirteen	0.80 (0.02)	0.98 (0.01)	C	12
hero	0.07 (0.01)	0.30 (0.02)	V	10
japanese	0.78 (0.02)	0.96 (0.01)	C	201
police	0.93 (0.01)	0.99 (0.01)	V	01
underwear	0.73 (0.02)	0.94 (0.01)	C	102

Table 5.56: Proportion schwa for each stem type (standard errors in parentheses)

Stem type	Schwa?	-(a)licious	-(a)thon
acoustic	no schwa	273	162
	schwa	270	362
alaska	no schwa	496	458
	schwa	17	70
cactus	no schwa	294	107
	schwa	242	405
chinese	no schwa	106	11
	schwa	424	490
hero	no schwa	481	372
	schwa	37	160
japanese	no schwa	105	16
	schwa	375	438
police	no schwa	36	7
	schwa	480	504
underwear	no schwa	154	34
	schwa	424	537

Table 5.57: Response counts

hero-type	p(ə)	cactus-type	p(ə)	thirteen-type	p(ə)	police-type	p(ə)
chili	0.29	acid	0.82	antique	0.94	balloon	0.98
china	0.08	basket	0.69	berlin	0.98	cologne	0.98
cookie	0.37	decade	0.93	brunette	1.00	debate	1.00
cuba	0.06	gossip	0.78	caffeine	1.00	design	1.00
drama	0.14	magic	0.73	champagne	0.98	estate	0.95
hero	0.61	necklace	0.84	chinese	0.98	grenade	1.00
jackie	0.48	office	0.78	concrete	1.00	japan	0.97
menu	0.52	patrick	0.82	corvette	0.98	maroon	0.98
russia	0.09	pirate	0.72	routine	0.98	parade	1.00
zero	0.62	secret	0.79	thirteen	0.98	police	1.00
mean	0.32	mean	0.79	mean	0.98	mean	0.99
low	0.06	low	0.69	low	0.94	low	0.95
high	0.62	high	0.93	high	1.00	high	1.00

Table 5.58: Proportion schwa for each *-(a)thon* stem

hero-type	p(ə)	cactus-type	p(ə)	thirteen-type	p(ə)	police-type	p(ə)
chili	0.14	acid	0.39	antique	0.77	balloon	0.88
china	0.05	basket	0.38	berlin	0.86	cologne	0.98
cookie	0.09	decade	0.69	brunette	0.83	debate	0.90
cuba	0.03	gossip	0.32	caffeine	0.84	design	0.98
drama	0.02	magic	0.38	champagne	0.73	estate	0.90
hero	0.12	necklace	0.67	chinese	0.76	grenade	0.98
jackie	0.03	office	0.43	concrete	0.74	japan	0.94
menu	0.14	patrick	0.51	corvette	0.84	maroon	0.94
russia	0.05	pirate	0.33	routine	0.80	parade	0.91
zero	0.00	secret	0.37	thirteen	0.81	police	0.88
mean	0.07	mean	0.45	mean	0.80	mean	0.93
low	0.00	low	0.32	low	0.73	low	0.88
high	0.14	high	0.69	high	0.86	high	0.98

Table 5.59: Proportion schwa for each *-(a)licious* stem

Recall that the experiment asked subjects to rate their confidence in their responses. We can use this information to bin the responses differently. In Chapter 4, I use this alternative binning to argue against a ceiling effect. The table below shows the proportion of *definitely* schwa out of all responses.

	-(a)licious	-(a)thon
acoustic	0.22	0.35
alaska	0.01	0.08
cactus	0.22	0.40
chinese	0.45	0.70
hero	0.04	0.15
japanese	0.36	0.64
police	0.53	0.72
underwear	0.35	0.60

Table 5.60: Proportion of *definitely* schwa

The two tables below present the counts used to calculate the proportions above. The first table shows the counts for *definitely* schwa.

	-(a)licious	-(a)thon
acoustic	148	229
alaska	7	43
cactus	138	261
chinese	296	409
hero	20	90
japanese	226	348
police	346	426
underwear	259	416

Table 5.61: Counts for *definitely* schwa

The second table shows the counts for all other responses (definitely schwaless+ probably schwaless+probably schwa)

	-(a)licious	-(a)thon
acoustic	395	295
alaska	506	485
cactus	398	251
chinese	234	92
hero	498	442
japanese	254	106
police	170	85
underwear	319	155

Table 5.62: Counts for *definitely* schwaless+*probably* schwaless+*definitely* schwaless

BIBLIOGRAPHY

Ågren, John. 1973. Etude sur quelques liaisons facultatives dans le français de conversation radiophonique: fréquences et facteurs.

Albright, Adam. 2003. A quantitative study of Spanish paradigm gaps. In G. Garding and M. Tsujimura, editors, *WCCFL 22 Proceedings*. Cascadilla Press, Somerville, MA, pages 1–14.

Anttila, Arto, Matthew Adams, and Michael Speriosu. 2010. The role of prosody in the English dative alternation. *Language and Cognitive Processes*, 25(7-9):946–981.

Apoussidou, Diana. 2007. *The Learnability of Metrical Phonology*. Ph.D. thesis, University of Amsterdam.

Arndt-Lappe, Sabine and Ingo Plag. 2013. The role of prosodic structure in the formation of English blends. *English Language and Linguistics*, 17(03):537–563.

Baayen, Harald. 1992. Quantitative aspects of morphological productivity. In *Yearbook of morphology 1991*. Springer, pages 109–149.

Bates, Douglas, Martin Maechler, Ben Bolker, and Steven Walker. 2013. *lme4: Linear mixed-effects models using Eigen and S4*. R package version 1.0-5.

Bauer, Laurie. 2006. Compounds and Minor Word-formation Types. *The handbook of English linguistics*, page 483.

Berg, Thomas. 2011. A diachronic frequency account of the allomorphy of some grammatical markers. *Journal of Linguistics*, 1(1):1–34.

Bobaljik, Jonathan David. 2012. *Universals in comparative morphology: Suppletion, superlatives, and the structure of words*, volume 50. MIT Press.

Boersma, Paul. 2001. Phonology-semantics interaction in OT, and its acquisition. In Robert Kirchner, Joe Pater, and Wolf Wikely, editors, *Papers in Experimental and Theoretical Linguistics: Proceedings of the Workshop on the Lexicon in Phonetics and Phonology*. Department of Linguistics, University of Alberta, Edmonton.

Boersma, Paul. 2007. GLAsuccessratevar.praat. Available from http://www.fon.hum.uva.nl/paul/gla/. Script for Praat software.

Bolinger, Dwight. 1981. *Two kinds of vowels, two kinds of rhythm*. Indiana University Linguistics Club Publications, Bloomington, IN.

Bonami, Olivier, Gilles Boyé, and Jesse Tseng. 2004. An integrated approach to French liaison.

Bonet, Eulàlia. 2004. Morph insertion and allomorphy in Optimality Theory. *International Journal of English Studies*, 4:73–104.

Bonet, Eulàlia, Maria-Rosa Lloret, and Joan Mascaró. 2003. Phonology-morphology conflicts in gender allomorphy: A unified approach.

Bonet, Eulàlia, Maria-Rosa Lloret, and Joan Mascaró. 2007. Allomorph selection and lexical preferences: Two case studies. *Lingua*, 117(6):903–927.

Booij, Geert. 1998. Phonological output constraints in morphology. *Phonology and morphology of the Germanic languages*, 386:143.

Britain, David and Sue Fox. 2009. The regularization of the hiatus resolution system in British English: A contact-induced 'vernacular universal'. *Vernacular universals and language contacts: Evidence from varieties of English and beyond. London: Routledge*, pages 177–205.

Bruneau, Charles. 1931. *Manuel de phonétique pratique*. Éditions Berger-Levrault.

Brysbaert, Marc and Boris New. 2009. Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, 41(4):977–990.

Brysbaert, Marc, Boris New, and Emmanuel Keuleers. 2012. Adding part-of-speech information to the SUBTLEX-US word frequencies. *Behavior research methods*, 44(4):991–997.

Bybee, Joan. 2001. *Phonology and Language Use*. Cambridge University Press.

Bye, Patrik. 2008. Allomorphy: Selection, not optimization. In Sylvia Blaho, Patrik Bye, and Martin Krämer, editors, *Freedom of Analysis*. Mouton de Gruyter, pages 64–92.

Carstairs, Andrew. 1988. Some implications of phonologically conditioned suppletion. In Geert Booij and Jaap van Marle, editors, *Yearbook of Morphology*. Foris, Dordrecht, pages 67–94.

Charette, Monik. 1991. *Conditions on phonological government*. Cambridge University Press.

Chomsky, Noam and Morris Halle. 1968. *The Sound Pattern of English*. Harper and Row, New York.

Clark, Herbert H and Jean E Fox Tree. 2002. Using uh and um in spontaneous speaking. *Cognition*, 84(1):73–111.

Clédat, Léon. 1917. *Manuel de phonétique et de morphologie historique du français*. Librairie Hachette.

Conway, Gilbert. 1878. *A Treatise on Versification*. Longmans, Green and Company.

Cooper, William E and Stephen J Eady. 1986. Metrical phonology in speech production. *Journal of Memory and Language*, 25(3):369–384.

Côté, Marie-Hélène. 2005. Le statut lexical des consonnes de liaison. *Langages*, 158(2):66–78.

Côté, Marie-Hélène. 2012. French liaison. *M. van OOSTENDORP, C. Ewen, EH et RICE, K., éditeurs: Companion to phonology*, pages 2685–2710.

Craig, Holly K, Connie A Thompson, Julie A Washington, and Stephanie L Potter. 2003. Phonological features of child African American English. *Journal of Speech, Language, and Hearing Research*, 46(3):623–635.

Crisma, Paola. 2007. Were they 'dropping their aitches'? A quantitative study of h-loss in Middle English. *English Language and Linguistics*, 11(01):51–80.

Dangeau, LC. 1694/1754. Essais de grammaire (1694). *Opuscules sur la langue françoise*.

Davidson, Lisa and Daniel Erker. 2014. Hiatus resolution in American English: the case against glide insertion. *Language*, 90(2):482–514.

Davies, Mark. 2008-. The Corpus of Contemporary American English: 450 million words, 1990-present.

Davies, Mark. 2013. Corpus of Global Web-Based English: 1.9 billion words from speakers in 20 countries.

De Jong, Daan. 1988. *Sociolinguistic Aspects of French Liaison*. Doctoral dissertation, Vrije Universiteit Amsterdam.

De Jong, Daan. 1994. La sociophonologie de la liaison orléanaise. *French Generative*.

Delattre, Pierre. 1947. La liaison en français, tendances et classification. *The French Review*, 21(2):148–157.

Delattre, Pierre. 1966. Les dix intonations de base du français. *French review*, pages 1–14.

Dell, Francois. 1970. *Les regles phonologiques tardives et la morphologie derivationnelle du francais*. Ph.D. thesis, MIT, Cambridge, Mass.

Dell, Francois. 1973. *Les regles et les sons*. Hermann, Collection Savoir, Paris.

Dell, Francois. 1985. A propos de Svantesson, J.-O., Kammu Phonology and Morphology. *Cahiers de linguistique Asie Orientale*, 14:259–275.

Dolbey, Andrew. 1997. Output optimization and cyclic allomorph selection. In *Proceedings of the 15th West Coast Conference on Formal Linguistics*, pages 97–112, Stanford: CSLI.

Durand, Jacques and Chantal Lyche. 2008. French liaison in the light of corpus data. *Journal of French Language Studies*, 18(01):33–66.

Embick, David. 2010. *Localism versus Globalism in Morphology and Phonology*. MIT Press, Cambridge, Massachusetts.

Embick, David and Rolf Noyer. 2001. Movement operations after syntax. *Linguistic inquiry*, 32(4):555–595.

Encreve, Pierre. 1988. *La Liaison avec et sans Enchainement: Phonologie Tridimensionelle*. Seuil, Paris.

Féry, Caroline. 2004. Liaison and syllable structure in French. Unpublished manuscript, Potsdam.

Fougeron, Cécile, Jean-Philippe Goldman, Alicia Dart, Laurence Guélat, and Clémentine Jeager. 2001. Influence de facteurs stylistiques, syntaxiques et lexicaux sur la réalisation de la liaison en français. *Actes de TALN*, 2001:173–182.

Fowler, Henry Watson. 1994. *A dictionary of modern English usage*. Wordsworth Editions.

Fox Tree, Jean E and Herbert H Clark. 1997. Pronouncing “the” as “thee” to signal problems in speaking. *Cognition*, 62(2):151–167.

Fromkin, Victoria. 1973. The non-anomalous nature of anomalous utterances. *Speech errors as linguistic evidence*, pages 215–242.

Fukazawa, Haruka. 1997. A correspondence theoretic approach to Japanese vocabulary strata. In *Proceedings of MALC (Mid-America Linguistics Conference)*.

Gaatone, David. 1978a. Forme sous-jacente unique ou liste d’allomorphes? (a propos des consonnes de liaison en français). *Linguistics*, 16(214):33–54.

Gaatone, David. 1978b. Phonologie abstraite et phonologie concrète: A propos de h-aspire en francais. *Lingvisticae Investigationes*, 2:3–22.

Garellek, Marc. 2012. Glottal stops before word-initial vowels in American English: distribution and acoustic characteristics. *UCLA Working Papers in Phonetics*, 110:1–23.

Garofolo, John S, Lori F Lamel, William M Fisher, Jonathon G Fiscus, David S Pallett, and NL Dahlgren. 1986. The DARPA TIMIT acoustic-phonetic continuous speech corpus CDROM. CDROM, NIST.

Gick, Bryan. 2002. The American intrusive l. *American Speech*, 77(2):167–183.

Gillespie, Stuart, David Hopkins, Jacob Tonson, and John Dryden. 2008. *Examen poeticum, 1693*. Dryden-Tonson Miscellanies, 1684-1709: With a New Introduction, Biographical Directory, and Reader's Guides. Routledge.

Gimson, Alfred Charles and Alan Cruttenden. 2001. *Gimson's pronunciation of English*. Oxford University Press.

Godfrey, J., E. Holliman, and J. McDaniel. 1992. SWITCHBOARD: Telephone speech corpus for research and development. In *Proceedings of ICASSP 92*, pages 517–520, San Francisco.

Goldwater, Sharon and Mark Johnson. 2003. Learning OT constraint rankings using a maximum entropy model. In Jennifer Spenader, Anders Eriksson, and Östen Dahl, editors, *Proceedings of the Workshop on Variation within Optimality theory*. Stockholm University, pages 111–120.

Gougeheim, Georges. 1938. *Système grammatical de la langue française*. Bibliothèque du "Français moderne".

Gouskova, Maria and Luiza Newlin-Łukowicz. 2013. Phonological selectional restrictions as sublexical phonotactics. *Ms. NYU.*

Grabe, Esther and Paul Warren. 1995. Stress shift: do speakers do it or do listeners hear it. *Connell & Arvaniti (1995)*, pages 95–110.

Grammont, Maurice. 1914. *Traité pratique de prononciation française*. Delagrave.

Grevisse, Maurice. 1994. Le Bon Usage, 13th edition. *A. Goosse, Louvain-la-Neuve: Duculot*.

Guzzo, Siria, David Britain, and Sue Fox. 2007. From L2 to ethnic dialect: hiatus resolution strategies across the generations in Bedford Italian English. *Essex Research Reports in Linguistics*.

Halle, Morris and Alec Marantz. 1993. Distributed Morphology. In Kenneth Hale and Samuel Jay Keyser, editors, *The View from Building 20. Essays in Honor of Sylvain Bromberger*. MIT Press, Cambridge, Mass.

Halle, Morris and Alec Marantz. 1994. Some key features of Distributed Morphology. In Andrew Carnie and Heidi Harley, editors, *MIT Working Papers in Linguistics 21: Papers on Phonology and Morphology*. MIT Working Papers in Linguistics, Cambridge, MA, pages 275–288.

Hammond, Michael. 1992. Eurhythmy or Clash in the English Rhythm Rule. *Coyote Papers: Working Papers in Linguistics from AZ.*

Hay, Jennifer and Harald Baayen. 2002. Parsing and productivity. *Editors: Geert Booij*, page 203.

Hayes, Bruce. 1984. The phonology of rhythm in English. *Linguistic Inquiry*, 15:33–74.

Hayes, Bruce. 1990. Precompiled phrasal phonology. In Sharon Inkelas and Draga Zec, editors, *The Phonology-Syntax Connection*. University of Chicago Press, Chicago, pages 85–108.

Heselwood, Barry. 2006. Final schwa and R-sandhi in RP English. *Leeds Working Papers in Linguistics and Phonetics*, 11:78–95.

Hooper, Joan. 1976. Word frequency in lexical diffusion and the source of morphophonological change. In W. Christie, editor, *Current progress in historical linguistics*. Amsterdam: North Holland., pages 96–105.

Horne, Merle. 1993. The phonetics and phonology of the rhythm rule in post-focal position. *PHONUM*, 2.

Hsu, Brian. 2013. Constraining exceptionality as prosody-morphology mismatch: a study of French nasal vowels. In *Proceedings of CLS 49*, Chicago: Chicago Linguistic Society.

Inkelas, Sharon and Draga Zec. 1993. Auxiliary reduction without empty categories: a prosodic account. *Working Papers of the Cornell Phonetics Laboratory*, 8:205–253.

Inkelas, Sharon and Cheryl Zoll. 2007. Is Grammar Dependence Real? A Comparison between Cophonological and Indexed Constraint Approaches to Morphologically Conditioned Phonology. *Linguistics*, 45(1):133–171. CD: LINGBP.

Jurafsky, Daniel, Alan Bell, Eric Fosler-Lussier, Cynthia Girand, and William D Raymond. 1998. Reduction of English function words in switchboard. In *ICSLP*, Citeseer.

Kager, René. 1996. On affix allomorphy and syllable counting. In Ursula Kleinhenz, editor, *Interfaces in phonology*. Akademie Verlag, Berlin, pages 155–171.

Kaye, Jonathan and Jean Lowenstamm. 1984. De la syllabicite. In F. Dell, D. Hirst, and J.-R. Vergnaud, editors, *Forme sonore du language: structure des representations en phonologie*. Hermann, Paris, pages 123–159.

Keating, Patricia A, Dani Byrd, Edward Flemming, and Yuichi Todaka. 1994. Phonetic analyses of word and segment variation using the TIMIT corpus of American English. *Speech Communication*, 14(2):131–142.

Kiparsky, Paul. 1973. 'Elsewhere' in phonology. In Stephen R. Anderson and Paul Kiparsky, editors, *A Festschrift for Morris Halle*. Holt, Rinehart and Winston, New York, pages 93–106.

Kiparsky, Paul. 2000. Opacity and cyclicity. *Linguistic Review*, pages 351–367.

Klein, Thomas. 2003. Syllable structure and lexical markedness in Creole morphophonology: Determiner allomorphy in Haitian and elsewhere. In Ingo Plag, editor, *The Phonology and Morphology of Creole Languages*. Tubingen: Max Niemeyer, pages 209–228.

Laks, Bernard and Denis Le Pesant. 2009. La liaison en français: quelques conditionnements morphosyntaxiques et lexicaux. In *CIL 18*, pages 254–265.

Lapointe, Steven G. and Peter Sells. 1997. Separating syntax and phonology in Optimality Theory: The case of suppletive segment/Ø allomorphy.

Lee, Ming-Wei and Julie Gibbons. 2007. Rhythmic alternation and the optional complementiser in English: New evidence of phonological influence on grammatical encoding. *Cognition*, 105(2):446–456.

Liberman, Mark and Alan Prince. 1977. On stress and linguistic rhythm. *Linguistic Inquiry*, 8:249–336.

Łubowicz, Anna. 2006. Opaque Allomorphy in OT. In *Proceedings of the 25th West Coast Conference on Formal Linguistics*, pages 261–269, Cascadilla Proceedings Project., Somerville, MA.

MacWhinney, Brian. 1995. *The CHILDES-Project: Tools for Analyzing Talk*. Erlbaum, Hillsdale, NJ.

Malécot, André. 1954. The pronunciation of numerals in French. *French Review*, pages 287–297.

Malécot, André. 1975. French liaison as a function of grammatical, phonetic and paralinguistic variables. *Phonetica*, 32(3):161–179.

Mallet, Géraldine-Mary. 2008. *La liaison en français: descriptions et analyses dans le corpus PFC*. Ph.D. thesis, Université Paris Ouest Nanterre La Défense.

Martinet, André. 1945. La prononciation du français contemporain. *Genève, Droz*.

Mascaró, Joan. 1996. External allomorphy as emergence of the unmarked. In Jacques Durand and Bernard Laks, editors, *Current Trends in Phonology: Models and Methods*. European Studies Research Institute, University of Salford, Salford, Manchester, pages 473–483.

Mascaró, Joan. 2007. External Allomorphy and Lexical Representation. *Linguistic Inquiry*, 38(4):715–735.

McCarthy, John J. 1993. A case of surface constraint violation. *Canadian Journal of Linguistics*, 38:169–195.

McCarthy, John J. 1999. A note on Boston r and the Elsewhere Condition.

McCarthy, John J. 2002. *A Thematic Guide to Optimality Theory*. Cambridge University Press, Cambridge.

McCarthy, John J. and Alan Prince. 1993. Generalized Alignment. In Geert Booij and Jaap van Marle, editors, *Yearbook of Morphology*. Kluwer, Dordrecht, pages 79–153. Excerpts appear in John Goldsmith, ed., Essential Readings in Phonology. Oxford: Blackwell. Pp. 102?136, 1999.

McCarthy, John J. and Alan Prince. 1995. Faithfulness and Reduplicative Identity. In Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, editors, *University of Massachusetts Occasional Papers in Linguistics 18*. GLSA Publications, Amherst, Mass., pages 249–384.

McDonald, J.L., K. Bock, M.H. Kelly, et al. 1993. Word and world order: Semantic, phonological, and metrical determinants of serial position. *Cognitive Psychology*, 25:188–188.

Mencken, Henry L. 1936. *The American Language, 4th edition*.

Mester, Armin. 1994. The quantitative trochee in Latin. *Natural Language and Linguistic Theory*, 12:1–61.

Moisset, Christine. 2000. *Variable liaison in parisian French*. Ph.D. thesis, University of Pennsylvania.

Morin, Yves-Charles. 1986. On the morphologization of word-final consonant deletion in French. *Sandhi phenomena in the languages of Europe*, 33:167.

Morin, Yves-Charles. 2003. Remarks on prenominal liaison consonants in French. *Living on the Edge*, 28:385–400.

Morin, Yves Charles. 2005. La liaison relève-t-elle d'une tendance à éviter les hiatus? Réflexions sur son évolution historique. *Langages*, 158(2):8–8.

Morin, Yves-Charles and Jonathan Kaye. 1982. The syntactic bases for French liaison. *Journal of Linguistics*, 18:291–330.

Nespor, Marina and Irene Vogel. 1986. *Prosodic Phonology*. Foris, Dordrecht.

Nevins, Andrew. 2011. Phonologically Conditioned Allomorph Selection. In Hume B. van Oostendorp B. Rice K Ewen, C., editor, *The Companion to Phonology*. Wiley-Blackwell, pages 2357–2382.

Newton, Caroline and Bill Wells. 2002. Between-word junctures in early multi-word speech. *Journal of Child Language*, 29(02):275–299.

Orgun, C. Orhan. 1996. Correspondence and identity constraints in two-level Optimality Theory. In Jose Camacho, Lina Choueiri, and Maki Watanabe, editors, *The Proceedings of the West Coast Conference on Formal Linguistics 14*. CSLI Publications, Stanford, CA, pages 399–413.

Pak, Marjorie. 2008. *The postsyntactic derivation and its phonological reflexes*. Ph.D. thesis, University of Pennsylvania.

Pak, Marjorie. 2014. A/an and the: allomorphy or phonology? Presented at the Linguistic Society of America Annual Meeting, January 2014, and at SECOL 81, March 2014.

Pak, Marjorie and Michael Friesner. 2006. French phrasal phonology in a derivational model of PF. In *PROCEEDINGS-NELS*, volume 36, page 480.

Paster, Mary. 2005. Subcategorization vs. output optimization in syllable-counting allomorphy. In *Proceedings of the 24th West Coast Conference on Formal Linguistics*, pages 326–333, Cascadilla Proceedings Project., Somerville, Massachusetts.

Paster, Mary. 2006. *Phonological Conditions on Affixation*. Ph.D. thesis, UC Berkeley.

Paster, Mary. 2009. Explaining phonological conditions on affixation: Evidence from suppletive allomorphy and affix ordering. *Word Structure*, 2(1):18–47.

Pater, Joe. 2010. Morpheme-specific phonology: Constraint indexation and inconsistency resolution. In Steve Parker, editor, *Phonological Argumentation: Essays on Evidence and Motivation*. Equinox Publishing, London.

Pater, Joe, Karen Jesney, Robert Staubs, and Brian Smith. 2012. Learning probabilities over underlying representations. In *Proceedings of the Twelfth Meeting of the Special Interest Group on Computational Morphology and Phonology*, pages 62–71, Association for Computational Linguistics.

Perlmutter, David. 1998. Interfaces: Explanation of allomorphy and the architecture of grammars. In Steven G. Lapointe, Diane K. Brentari, and Patrick M. Farrell, editors, *Morphology and its Relation to Phonology and Syntax*. CSLI Publications, Stanford, CA, pages 307–338.

Pierre, Fouché. 1959. Traité de prononciation française.

Pitt, Mark A., Keith Johnson, Elizabeth Hume, Scott Kiesling, and William Raymond. 2005. The Buckeye corpus of conversational speech: Labeling conventions and a test of transcriber reliability. *Speech Communication*, 45(1):89–95.

Plag, Ingo. 1999. *Morphological Productivity: Structural Constraints in English Derivation*. Topics in English Linguistics. Mouton De Gruyter.

Plag, Ingo. 2003. *Word-Formation in English*. Cambridge Textbooks in Linguistics. Cambridge University Press.

Plénat, Marc. 2008. La liaison'obligatoire'avec et sans enchaînement. *J. Durand, B. Habert, et B. Laks, éds., Actes du Congrès Mondial de Linguistique Française (CMLF-2008)*, pages 1657–1667.

Prince, Alan. 1983. Relating to the grid. *Linguistic Inquiry*, 14:19–100.

Prince, Alan. 2002. Entailed ranking arguments. *Rutgers Optimality Archive 500*.

Prince, Alan and Paul Smolensky. 1993/2004. *Optimality theory: constraint interaction in generative grammar*. Blackwell Pub., Malden, MA.

Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, and Jan Svartvik. 1972. *A grammar of contemporary English*. Seminar Press, New York.

R Core Team. 2013. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

Raffelsiefen, Renate. 1999. Phonological constraints on English word formation. In *Yearbook of Morphology 1998*. Springer, pages 225–287.

Raffelsiefen, Renate. 2004. Absolute ill-formedness and other morphophonological effects. *Phonology*, 21(1):91–142.

Rotenberg, Joel. 1978. *The Syntax of Phonology*. Ph.D. thesis, MIT, Cambridge, Mass.

Rubach, Jerzy and Geert E Booij. 2001. Allomorphy in optimality theory: Polish iotation. *Language*, pages 26–60.

Russell, Kevin. 1995. Morphemes and candidates in Optimality Theory.

Sabin, William A. 2005. The Gregg reference manual: A manual of style, grammar, usage, and formatting.

Sampson, Rodney. 2001. Liaison, nasal vowels and productivity. *Journal of French language studies*, 11(02):241–258.

Schane, Sanford. 1968. *French Phonology and Morphology*. MIT Press, Cambridge, Mass.

Schlenker, Philippe. 2010. A phonological condition that targets discontinuous syntactic units: ma/mon suppletion in French.

Schlüter, Julia. 2003. Phonological determinants of grammatical variation in English: Chomsky's worst possible case. *Rohdenburg and Mondorf (eds)*, pages 69–118.

Selkirk, Elisabeth. 1972. *The Phrase Phonology of English and French*. Ph.D. thesis, MIT, Cambridge, Mass.

Selkirk, Elisabeth. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. MIT Press, Cambridge, Mass.

Shih, Stephanie. 2014. *Towards Optimal Rhythm*. Ph.D. thesis, Stanford University.

Shih, Stephanie, Jason Grafmiller, Richard Futrell, and Joan Bresnan. 2015. Rhythm's role in predicting genitive alternation choice in spoken English. In R. Vogel and R. van de Vijver, editors, *Rhythm in Cognition and Grammar: A Germanic Perspective*. Mouton.

Shorrocks, Graham. 1999. *A Grammar of the Dialect of the Bolton Area*. Peter Lang.

Siddiqi, Daniel. 2010. Distributed Morphology. *Language and Linguistics Compass*, 4(7):524–542.

Siegel, Dorothy. 1974. *Topics in English Morphology*. Ph.D. thesis, MIT, Cambridge, Mass.

Sivertsen, E. 1960. *Cockney phonology*. Humanities Press, New York.

Staubs, Robert. 2013. HG in R. *Software available at http://blogs.umass.edu/hgr/hg-in-r*.

Stene, Aasta and G. Tillotson. 1954. *Hiatus in English: Problems of Catenation and Juncture*. Anglistica Series. BRILL.

Steriade, Donca. 1999. Lexical conservatism in French adjectival liaison. In J.-Marc Authier, Barbara Bullock, and Lisa Reid, editors, *Formal Perspectives on Romance Linguistics*. John Benjamins, Amsterdam, pages 243–270.

Svenonius, Peter. 2012. Spanning. *Ms. University of Tromsø*.

Tesar, Bruce and Paul Smolensky. 1998. Learning Optimality-Theoretic Grammars. *Lingua*, 106:161–196.

Tesar, Bruce and Paul Smolensky. 2000. *Learnability in Optimality Theory*. MIT Press, Cambridge, Mass.

Thuilier, Juliette. 2012. *Contraintes préférentielles et ordre des mots en français*. Ph.D. thesis, Université Paris-Diderot-Paris VII.

Tilsen, Sam. 2012. Utterance preparation and Stress Clash: Planning prosodic alternations. In S. Fuchs, P. Perrier, M. Weirich, and D. Pape, editors, *Speech production and perception: Planning and dynamics*. Peter Lang Verlag.

Tranel, Bernard. 1976. A note of final consonant deletion in modern French. *Lingua*, 39(1):53–68.

Tranel, Bernard. 1981a. *Concreteness in Generative Phonology: Evidence from French*. University of California Press, Berkeley.

Tranel, Bernard. 1981b. The treatment of French liaison: Descriptive, methodological, and theoretical implications. In H. Contreras and J. Klausenberger, editors, *Proceedings of the Tenth Anniversary Symposium on Romance Linguistics (Papers in Romance, Volume 3, Supplement II)*. University of Washington, Seattle, pages 261–281.

Tranel, Bernard. 1987. *The Sounds of French*. Cambridge University Press, Cambridge.

Tranel, Bernard. 1990. On suppletion and French liaison. *Probus*, 2:169–208.

Tranel, Bernard. 1995. Current issues in French phonology: liaison and position theories. In John A. Goldsmith, editor, *The Handbook of Phonological Theory*. Blackwell, Cambridge, Mass., and Oxford, UK, pages 798–816.

Tranel, Bernard. 1996. Exceptionality in Optimality Theory and final consonants in French. In Karen Zagona, editor, *Grammatical Theory and Romance Languages*. John Benjamins, Amsterdam, pages 275–291.

Tranel, Bernard. 1996b. Suppletion and OT: On the issue of the syntax/phonology interaction. In E. Curtis, J. Lyle, and G. Webster, editors, *The Proceedings of the West Coast Conference on Formal Linguistics 16*. CSLI, Stanford, CA, pages 415–429.

Tranel, Bernard. 2000. Aspects de la phonologie du français et la théorie de l'optimalité. *Langue française*, (126):39–72.

Tychonoff, Andrey Nikolayevich and VY Arsenin. 1977. Solution of ill-posed problems. *Winston & Sons, Washington*.

Vaudelin, Gilles. 1713. *Nouvelle maniere d'ecrire comme on parle en France*.

Vennemann, Theo. 1974. Restructuring. *Lingua*, 33:137–156.

Wasow, Thomas, Rebecca Greene, and Roger Levy. 2012. Optional to and prosody. Poster presented at CUNY 2012.

Watermeyer, Susan. 1996. Afrikaans English. *Focus on South Africa*, 15:99.

Weide, Robert. 1993. Carnegie Mellon Pronouncing Dictionary [cmudict.0.2].

Wells, John C. 1982. *Accents of English, vol.2: The British Isles*. Cambridge University Press, Cambridge.

Wilson, Colin and Benjamin George. 2008. Maxent grammar tool. *Software package. University of California, Los Angeles*.

Withgott, Mary Margaret. 1982. *Segmental Evidence for Phonological Constituents*. Ph.D. thesis, University of Texas, Austin.

Wolf, Matthew. 2008. *Optimal interleaving: serial phonology-morphology interaction in a constraint-based model*. Doctoral Dissertation, University of Massachusetts, Amherst, Amherst, Mass.

Wolf, Matthew. 2014. Lexical insertion occurs in the phonological component. In Maria-Rosa Lloret Eulàlia Bonet and Joan Mascaró Altimiras, editors, *Understanding allomorphy: perspectives in Optimality Theory*. Equinox, London.

Yip, Moira. 1998. Identity avoidance in phonology and morphology. In Steven G. Lapointe, Diane K. Brentari, and Patrick M. Farrell, editors, *Morphology and its Relation to Phonology and Syntax*. CSLI Publications, Stanford, CA, pages 216–246.

Zimmer, Benjamin. 2006. The surreptious history of -licious. Post on Language Log. *http://itre.cis.upenn.edu/ myl/languagelog/archives/003546.html*.

Zuraw, Kie. 2000. *Patterned Exceptions in Phonology*. Ph.D. thesis, UCLA.

Zuraw, Kie. 2006. Prescient 'an'. Post on Phonoloblog. *https://quote.ucsd.edu/phonoloblog/2006/12/25/prescient-an/*.

Zwicky, Arnald M. 1970. Auxiliary Reduction in English. *Linguistic Inquiry*, 1(3):323–336.

Zwicky, Arnold M. 1986. The general case: Basic form versus default form. In *Annual Meeting of the Berkeley Linguistics Society*, volume 12.

Zwicky, Arnold M. 2006. -Vlicious invention. Post on Language Log. *http://itre.cis.upenn.edu/ myl/languagelog/archives/003542.html*.

Zwicky, Arnold M. 2010. Libfixes. Post on personal blog. *http://arnoldzwicky.org/2010/01/23/libfixes/*.