

SPLITTING THEORY AND CONSONANT EPENTHESIS

by

PETR STAROVEROV

A Dissertation submitted to the  
Graduate School-New Brunswick  
Rutgers, The State University of New Jersey

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

Graduate Program in Linguistics

written under the direction of

Paul de Lacy

and approved by

---

---

---

---

New Brunswick, New Jersey

October, 2014

# ABSTRACT OF THE DISSERTATION

## Splitting Theory and Consonant Epenthesis

By PETR STAROVEROV

Dissertation Director:

Paul de Lacy

This dissertation proposes Splitting theory of consonant epenthesis incorporating two key ideas: (1) there is a phonological operation ‘splitting’ where an input segment corresponds to multiple output segments, and (2) there is no insertion operation involving consonants.

Within the Splitting theory epenthetic consonants always correspond to an input segment, and therefore the mapping is always regulated by constraints requiring input-output identity. From this perspective, homorganic glide epenthesis next to high vowels is the most faithful epenthesis possible. For example, in the mapping  $/i/ \rightarrow [ji]$ , input  $/i/$  corresponds to both  $[j]$  and  $[i]$  in the output, and both output segments preserve all input features.

Splitting theory predicts that the epenthetic consonants may be unfaithful to their input vowel correspondent if the given vowel cannot faithfully appear in syllable margins. For example, there is no featurally identical glide counterpart of non-high vowels. Therefore next to non-high vowels there are several options for epenthetic consonants, all of which change some of the input’s features.

While epenthetic consonants are generally as faithful as possible to the input segments from which they split, the most faithful consonant might be banned from a surface inventory. In these cases, the inserted consonant will be the one which preserves the input features protected by faithfulness constraints which are ranked the highest in a given language. An extreme case is found in Mongolian, where a dorsal/uvular stop is epenthesized in vowel hiatus because there is no other consonant that would preserve the place, voicing, and non-nasality of underlying vowels.

Splitting theory's emphasis on faithfulness disagrees with theories where the epenthetic segment does not correspond to any input segment. For example, Insertion theories predict that epenthetic [t] is possible, while Splitting theory imposes very restrictive (and practically insurmountable) conditions on any system having epenthetic [t]. Putative cases of epenthetic [t] are shown to admit alternative analyses (e.g. Ajiyinka Apurucayali).

Splitting Theory is supported in an in-depth survey of the inventory of epenthetic consonants. The theory is illustrated by analyses of consonant epenthesis in Dutch, English, Faroese, Madurese, Mongolian, and Washo.

## DEDICATION

To the memory of Georgiy Georgiyevich Petrash

## ACKNOWLEDGEMENTS

I would like to thank a number of people for their feedback, help and encouragement during my work on this dissertation. I certainly couldn't have written anything like this without the constant help and support of Paul de Lacy. The meetings and discussions with Paul have always been a source of inspiration and encouragement. Apart from his great scientific impact on me, Paul served as a kind, practical, and understanding mentor in all aspects of academic life and beyond. I can't thank Paul enough, and I will certainly miss many of my dissertation days.

My interactions with Alan Prince were always extremely fruitful. Alan has taught me to thoroughly explore the research landscape in front of me, and to be detailed, precise, and fair about my theory. I am very grateful to Alan for setting up and fleshing out an excellent research standard. Akin Akinlabi has been immensely helpful in making me focus on the right data and ask the right questions. Akin's comments were always greatly stimulating. I doubt Marc van Oostendorp's relation to this dissertation is properly described by the word 'external'. I am very indebted to Marc for his fascinating ability to see through all my arguments and for his personal support and encouragement, not to mention his help getting me in touch with Farsi speakers, and the crucial Dutch example that proves the existence of true leftward directionality and that was pivotal to what's now Chapter 4.

Darya Kavitskaya has a very special relation to the dissertation. I owe an enormous number of things to Darya – from becoming a phonologist, to learning to do fieldwork, to mentoring me throughout the dissertation process. Somehow, all of my meetings with Darya always left me in a happier state than I was in before. Spasibo.

A number of people have inspired me with their comments and feedback throughout the dissertation process. The dissertation started out with a lot of inspiration from Shigeto Kawahara, and it ended up resonating with some ideas of Bruce Tesar. I am grateful to Shigeto and Bruce for their extremely valuable guidance. I also owe some ideas here to my discussions or correspondence with Edward Flemming, Brett Hyde, Pavel Iosad, Martin Krämer, Andrew Nevins, Elizabeth Selkirk, and Alan Yu. Parts of the dissertation were presented at various occasions at Rutgers, at the Phonology conference 2013, LSA Annual Meeting 2014, and Old World Conference in Phonology 2014. For their valuable comments I am grateful to Michael Becker, Will Bennett, Paul Boersma, Lev Blumenfeld, Andries Coetzee, Ewa Czaykowska-Higgins, Nick Danis, Laura Downing, Adamantios Gafos, Björn Köhnlein, Florian Lionnet, Hope McManus, Elliott Moreton, Alexei Nazarov, Joe Perry, Clàudia Pons-Moll, Janani Prabhakar, Renate Raffelsiefen, Sharon Rose, Brian Smith, Jennifer Smith, and Lu Wang. I am also truly grateful to those of my colleagues who helped me in clarifying some aspects of their native languages – Věra Dvořák, Elham Rohany Rahbar, Nagarajan Selvanathan, and Bahareh Soohani.

I am very indebted to many other people at and around Rutgers for making my time here so stimulating and for their continuous empirical, emotional, and moral support. The list includes: Mark Baker, Maria Bittner, Veneeta Dayal, Viviane Déprez, Jane Grimshaw, Brian Keane, Ernie Lepore, Julien Musolino, Ken Safir, Roger Schwarzschild, Kristen Syrett, Daniel Altshuler, Ümit Atlamaz, Vandana Bajaj, Matt Barros, Diti Bhadra, Aaron Braver, Jimmy Bruno, Yi-Hsun Chen, Satarupa Das, Ryan and Amanda Denzer-King, Věra Dvořák (again), Dino Dvořák, Carlos A. Fasola, Inna

Goldberg, Johnathan Gress-Wright, Sarah Hansen, Paula and Patrick Houghton, Luca Iacoponi, Kunio Kinjo, Todor Koev, Jess Law, Seunghun Lee, Carlo and Alexandra Linares, Mingming Liu, Barbara Mergelsberg, Sarah Murray, Atsushi Oho, Jeremy Perkins, Yamgur Sag, Nagarajan Selvanathan (again), Shu-hao Shih, Teresa Torres Bustamente, Eric Wirkerman, and Beibei Xu.

I am extremely grateful to Barbara Partee and Sergei Tatevosov for providing both mentorship and personal support throughout and before my dissertation years. Special thanks also to my good friends: Vera, Gennady, and Sasha Gor; Misha, Sonya, Lesha, and Grisha Bogorad, to Sasha Podobriayev and Natasha Ivlieva.

I am grateful to my parents Dmitry and Evgeniya and to my brother Georgiy. I couldn't have made it without the support of my wife Asya. And thank you, Gosha, for changing so much more than I did in the last three years.

## Table of contents

Abstract .....	ii
Dedication .....	iv
Acknowledgements .....	v
Chapter 1. Introduction .....	1
1.1 Splitting: an overview .....	1
1.2 Constraints on splitting .....	1
1.3 Illustration: splitting and featural changes .....	2
1.4 Predictions and results .....	6
1.4.1 Blocking and the inventory of epenthetic consonants .....	6
1.4.2 Extended patterns of epenthesis .....	9
1.4.3 Positionally restricted epenthesis .....	10
1.4.4 Other theories .....	10
1.4.5 Summary .....	11
1.5 Chapter outline .....	12
Chapter 2. Theory .....	13
2.1 Introduction .....	13
2.2 Splitting and Gen .....	13
2.3 Faithfulness and the trigger constraints: the basic constraint set .....	15
2.4 An illustration: minimal epenthesis in Faroese .....	16
2.4.1 Faroese epenthesis: the data .....	17
2.4.2 Analysis of Faroese glide epenthesis .....	21
2.5 Input-orientedness within the Splitting theory .....	27
2.5.1 Faroese vowel reduction, raising, and input orientedness .....	27
2.5.2 Epenthetic consonants have morphological affiliation: splitting and positional faithfulness .....	30
2.6 Generalizing minimal epenthesis: extended patterns .....	31
2.7 Splitting, blocking and the inventory of epenthetic consonants .....	32
2.7.1 Representational assumptions .....	33
2.7.2 Feature closeness and output-driven splitting .....	34
2.7.3 Inventory constraints .....	36
2.7.4 Illustration: feature similarity and ranking conditions .....	36
2.7.5 Constraints and output-drivenness .....	40
2.7.6 Summary: blocking and possible epenthetic consonants .....	43
2.8 Splitting and other theories .....	43
2.8.1 Emergent process effects on epenthetic consonants .....	45
2.9 Conclusion .....	46
Chapter 3. Extensions of minimal epenthesis .....	48
3.1 Introduction .....	48
3.2 Overview of the extensions of minimal epenthesis .....	48
3.3 Extended patterns of glide epenthesis .....	49
3.3.1 Glide epenthesis and mid vowels. The case of Dutch. ....	51
3.3.2 Glide epenthesis next to low vowels .....	53
3.3.3 Other vowels .....	56
3.3.4 Sequences of identical vowels: the constraints on long vowels .....	57
3.3.5 Summary .....	58

3.4	Extended epenthesis of other consonants: rhotics in English .....	59
3.4.1	The intrusive <i>r</i> .....	59
3.4.2	The splitting analysis .....	61
3.4.3	English glide insertion .....	63
3.4.4	Other dialects .....	65
3.4.5	Summary of section 3.4 .....	66
3.5	Extended epenthesis of other consonants: laryngeals .....	67
3.5.1	Predictions about laryngeal epenthesis .....	67
3.5.2	Laryngeal epenthesis in Farsi .....	70
3.5.3	Are laryngeals low and/or back? .....	71
3.5.4	Summary .....	72
3.6	Conclusion .....	72
Chapter 4.	Directional restrictions on inserted glides .....	74
4.1	Introduction .....	74
4.2	Restrictions on glide-vowel sequences .....	74
4.2.1	Kalaallisut hiatus resolution: data .....	77
4.2.2	Homorganic glide insertion in Kalaallisut .....	78
4.2.3	Merger to avoid *ji/wu violation .....	80
4.2.4	Disharmonic epenthesis when merger is impossible .....	80
4.2.5	Summary on Kalaallisut .....	81
4.2.6	Kalaallisut: complications .....	81
4.2.7	Kalaallisut epenthesis and Insertion theories .....	82
4.2.8	Summary .....	83
4.3	Positional faithfulness: variants of Integrity .....	83
4.3.1	Tautosyllabic integrity .....	83
4.3.2	Initial integrity .....	88
4.4	Heterosyllabic splitting .....	89
4.5	Conclusion .....	91
Chapter 5.	Epenthetic segments and the inventory. Epenthesis in Madurese .....	92
5.1	Introduction .....	92
5.2	Extended insertion and blocking in Madurese .....	92
5.2.1	Overview of the data .....	92
5.2.2	Glide insertion after non-central vowels .....	95
5.2.3	No insertion after central vowels .....	97
5.2.4	Sequences of identical vowels .....	98
5.2.5	Predictions for other sequences .....	100
5.2.6	Madurese glottal stop and the Insertion theories .....	100
5.2.7	Summary .....	101
5.3	Madurese inventory restrictions and insertion processes .....	102
5.3.1	Positional restrictions on glides and glide insertion .....	102
5.3.2	Positional restrictions and word-final glides .....	104
5.3.3	Exceptional occurrences of glides .....	105
5.3.4	Summary .....	105
5.4	Conclusion .....	106
Chapter 6.	Dual glides and edge laryngeals. Epenthesis in Washo. ....	107
6.1	Introduction .....	107



6.2	Inventory effects on epenthetic consonants: dual glides in Washo .....	107
6.2.1	Washo surface inventory: an overview .....	108
6.2.2	[j] epenthesis in Washo .....	109
6.2.3	Analysis of word-medial [j] epenthesis .....	111
6.2.4	Two kinds of glides in Washo and glide markedness .....	113
6.3	Contextual markedness effects on Washo epenthesis .....	116
6.3.1	LAR-EDGE .....	116
6.3.2	Word-initial glottal stop epenthesis in Washo .....	117
6.3.3	Phonological evidence .....	117
6.3.4	Phonetic evidence .....	120
6.3.5	Analysis of glottal stop epenthesis .....	123
6.3.6	Glide neutralization and initial epenthesis .....	124
6.3.7	Summary: Washo ranking .....	124
6.4	Vowel merger in Washo .....	125
6.4.1	Vowel merger in inflectional morphology .....	125
6.4.2	Vowel merger in bipartite constructions .....	126
6.4.3	Vowel merger and the Washo plural .....	129
6.4.4	Conclusion on vowel merger .....	130
6.5	Washo: summary and theory comparison .....	130
6.5.1	Washo and the Insertion theories .....	130
6.6	A typology of laryngeals at edges .....	131
6.6.1	Laryngeal insertion at a variety of prosodic edges .....	131
6.6.2	Laryngeals that appear only at edges .....	135
6.6.3	Chumburung: underlying vowels turn into laryngeals at edges .....	136
6.6.4	Summary of LAR-EDGE .....	137
6.7	Conclusion .....	138
6.8	Appendix: additional Washo [j]-epenthesis data .....	138
Chapter 7.	Mongolian and dorsal epenthesis .....	140
7.1	Introduction .....	140
7.2	Halh Mongolian: background and segment inventory .....	141
7.2.1	HM glides are consonantal .....	144
7.3	Dorsal epenthesis .....	145
7.4	Analysis .....	147
7.5	Other theories .....	150
7.6	Conclusion .....	151
Chapter 8.	[t]-zero alternations in Apurucayali .....	152
8.1	Introduction .....	152
8.2	Apurucayali basics .....	153
8.3	Hiatus and /t/ deletion in Ajyíninka Apurucayali .....	154
8.3.1	/t/ deletion .....	154
8.3.2	/t/-zero alternations at suffix boundaries? .....	158
8.3.3	Hiatus resolution .....	159
8.3.4	Summary .....	163
8.4	The epenthesis analysis .....	163
8.5	Subminimal words in the deletion analysis .....	165
8.6	Back glide alternations .....	168

8.6.1	First stratum: prefix level.....	168
8.6.2	Later strata: suffix level and word-level .....	169
8.7	Conclusion .....	172
8.8	Appendix: Ajyíninka Apurucayali suffixes .....	172
Chapter 9.	Non-epenthetic mappings that look like epenthesis .....	175
9.1	Introduction.....	175
9.2	‘Epenthesis’ between grammatical systems.....	176
9.2.1	Dominican Spanish and reported [s] epenthesis .....	177
9.2.2	Summary .....	178
9.3	Non-productive lexical generalizations: an example from Cantonese .....	179
9.4	Morphological patterns similar to epenthesis .....	182
9.4.1	Latent segments and suppletion in French and beyond .....	183
9.4.2	Monosegmental morphemes .....	185
9.4.3	Linking consonants in compounds.....	186
9.4.4	Fixed segmentism in reduplication .....	187
9.4.5	Syntactic category markers in Tunica.....	187
9.4.6	Summary .....	188
9.4.7	Minimality morphemes and syllable insertion.....	189
9.4.8	Summary of morphology-driven patterns .....	191
9.5	Deletion that looks like epenthesis: Uradhi .....	191
9.6	Cases with insufficient data .....	193
9.7	Conclusion .....	194
Chapter 10.	Concluding remarks .....	195
10.1	Summary of the Splitting theory.....	195
10.2	Summary of predictions and results.....	196
10.2.1	Extended minimal epenthesis.....	196
10.2.2	Segmental blocking and the inventory of epenthetic consonants .....	197
10.2.3	Epenthetic segments, the inventory, and other processes .....	200
10.2.4	Summary .....	200
10.3	Theory Comparison .....	201
10.3.1	Diachronic theories .....	201
10.3.2	Synchronic Insertion theories .....	202
10.3.3	The general markedness component.....	202
10.3.4	The similarity component .....	203
10.3.5	Summary .....	205
10.4	Further implications of splitting and directions for the future .....	205
Appendix A.	Formal basis of the Splitting theory .....	208
Appendix B.	Cross-linguistic survey of consonant epenthesis.....	213

# Chapter 1. Introduction

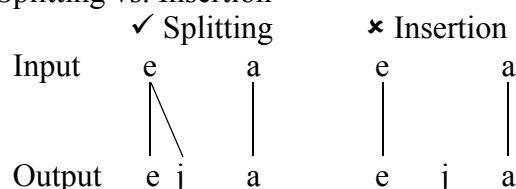
## 1.1 Splitting: an overview

This dissertation proposes that there is no phonological insertion operation, at least for consonants. Apparent addition of a consonant in the output results from a mapping where the input segment corresponds to two output segments.

Thus consonant epenthesis is reduced to the same operation that applies in diphthongization (Hayes, 1990; Selkirk, 1990), segmental fission (Keer, 1999; Yu, 2005a) and possibly reduplication (Struijke, 2000) – namely splitting (see also Yip, 1993b; Baković, 1999; Krämer, 2008 on epenthesis as splitting).

Splitting theory is set within Optimality Theory (Prince & Smolensky, 2004) with Correspondence (McCarthy & Prince, 1995, 1999). Splitting and Insertion involve different correspondence configurations, as illustrated in (1), where lines show input-output correspondence.

### (1) Splitting vs. Insertion



Within the Splitting theory the phonological function Gen, which is responsible for candidate creation, allows splitting and not insertion of consonants. On the other hand the constraint component (Con) is essentially unchanged.

A key consequence of the Splitting theory is that epenthetic consonants are profoundly influenced by faithfulness. As in any input-output mapping, epenthetic segments will seek to be as faithful as possible to their input correspondents, and any unfaithfulness must be motivated by a markedness constraint. For example, /e/ splits to [ej] in (1) and not [ew] or [eg] because [j] is more faithful to /e/ than either [w] or [g].

This dissertation focuses on the inserted consonants which correspond to input vowels. Splitting theory contrasts with Insertion theories in never allowing markedness to be the sole determinant of epenthetic quality (e.g. de Lacy 2006).

## 1.2 Constraints on splitting

This section introduces the basic constraint set which is essential to illustrating the Splitting theory and its predictions. This set includes the faithfulness constraints of McCarthy & Prince (1995, 1999) as well as the constraint ONSET (Prince & Smolensky, 2003) which can trigger epenthesis. The predictions of Splitting with respect to these basic constraints are explored in more detail in Chapter 2. The rest of the dissertation will explore additional constraints and constraint families relevant to consonant epenthesis, thus expanding on the basic set. The definitions of all constraints assumed by the Splitting theory are given in Appendix A.

The faithfulness constraint INTEGRITY is violated by splitting (McCarthy & Prince, 1995, 1999).<sup>1</sup> This constraint is formulated in (2), adapted from McCarthy & Prince (1995: 124).

- (2) INTEGRITY: assign a violation for every input segment that has multiple correspondents in the output

Featural changes often apply to the result of splitting so that the inserted consonant may not be a perfect copy of its input vowel. Featural changes are regulated by IDENT-*F* constraints of McCarthy & Prince (1995).

- (3) IDENT-*F*: let  $\alpha$  be a segment in the input and  $\beta$  be a correspondent of  $\alpha$  in the output. Assign a violation if  $\alpha$  is  $[\gamma F]$ , and  $\beta$  is not  $[\gamma F]$ .

Splitting often competes with other possible changes to the input, such as deletion of vowels in VV sequences or coalescence (Rosenthal, 1997b; Casali, 1998, 2011; Senturia, 1998; Picard, 2003). Thus the constraint MAX prohibiting deletion and UNIFORMITY prohibiting coalescence (McCarthy & Prince, 1995, 1999) will also be relevant. On the other hand, the constraint DEP-C (McCarthy & Prince, 1995: 122) which penalizes true insertion of consonants becomes redundant within the Splitting theory. Gen cannot produce candidates which violate this constraint, and therefore the constraint is never active.

Markedness constraints play a crucial role in triggering epenthetic processes, i.e. splitting. Most cases of epenthesis are motivated by prosodic well-formedness constraints (Broselow, 1982; Itô, 1986, 1989), most notably the constraint ONSET in (4).

- (4) ONSET: assign a violation for every syllable that does not start with an onset

Within the Splitting theory, the inserted consonants are always as faithful as possible to their input. However, some faithful options may be blocked by markedness – in such a case an input vowel that splits will have to change some of its features to satisfy the markedness constraints. Thus, additional markedness constraints will play a crucial role in determining epenthetic quality.

### 1.3 Illustration: splitting and featural changes

This section illustrates the splitting approach to epenthesis by providing a simplified analysis of glide insertion in Faroese (Lockwood, 1955; Anderson, 1972; Thráinsson *et al.*, 2004; Árnason, 2011). A more detailed discussion of Faroese epenthesis is presented in Chapter 2. Within the Splitting theory epenthetic patterns may differ in their faithfulness violations. Faroese is particularly interesting because it comes close to instantiating the most faithful possible epenthesis. Epenthesis in Faroese only violates INTEGRITY: it involves splitting but no featural changes. This pattern will be dubbed *minimal epenthesis* because it incurs the least possible faithfulness violations.

---

<sup>1</sup> Unless otherwise stated, all faithfulness constraints cited in the dissertation refer to the Input-Output dimension.

In Faroese a sequence of two vowels is repaired by homorganic glide epenthesis, but only if one of the vowels is high (5a). If none of the vowels is high, hiatus surfaces faithfully (5b).

(5) Faroese glide epenthesis

a. Epenthesis next to high vowels

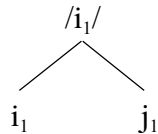
/mi:-aɪ/	[mi:jai] 'middle-PL.FEM'
/so:-m/	[so:jm] 'boiled';
/t <sup>h</sup> u:-a/	[t <sup>h</sup> u:wa] 'to say tú (thou)'
/kle:-i/	[kle:ji] 'gladness'

b. No epenthesis next to non-high vowels

[ʊmrø:a]	'discussion';
[le:a]	'to load'

It is assumed here that glides are featurally identical to the respective high vowels (Steriade, 1984; Levin, 1985; Durand, 1987; Deligiorgis, 1988; Clements & Hume, 1995; Hume, 1995; Rosenthal, 1997a, b; Harris & Kaisse, 1999; Rubach, 2000; Kawahara, 2003; Levi, 2004, 2008; Uffmann, 2007a). Consequently, the mapping /i/ → [j] does not violate any IDENT constraints, and splitting a vowel /i/ to yield [ij] does not violate IDENT either. Such a mapping is represented graphically in (6) where correspondence is shown with both lines and indices.

(6) Splitting



In what follows, shorthand notation will be used for (6): /i₁/ → [i₁j₁].

In Faroese, splitting is used to avoid having an onsetless syllable. This situation is implemented by having ONSET outrank INTEGRITY. Furthermore, since vowel sequences are not resolved by vowel deletion or coalescence, INTEGRITY must also be dominated by the relevant faithfulness constraints: MAX and UNIFORMITY (McCarthy & Prince, 1995, 1999). The splitting analysis of Faroese glide epenthesis is illustrated in (7). This tableau illustrates the format of OT evaluations adopted throughout the dissertation. In order to make explicit both ranking information and violation numbers, the tableaux combine the comparative format of Prince (2002) with violation counts indicated by numbers. The first candidate in all tableaux always shows the winner. The constraints which do not differentiate any candidates are sometimes omitted for reasons of space. Finally, the correspondence relation between input and output is shown with indices.

## (7) Faroese homorganic glide insertion

/mi: <sub>1</sub> a <sub>2</sub> ɪ/	MAX	UNIFORMITY	ONSET	INTEGRITY
☞ a. mi: <sub>1</sub> j <sub>1</sub> a <sub>2</sub> ɪ				1
b. mi: <sub>1</sub> a <sub>2</sub> ɪ			W1	L
c. mi: <sub>2</sub> ɪ	W1			L
d. mi: <sub>1,2</sub> ɪ		W1		L

In Faroese splitting is preferred to tolerating an ONSET violation as in (7b) or avoiding this violation via deletion or coalescence as in (7c-d). The splitting candidate thus (7a) wins because it violates the lowest ranked constraint – INTEGRITY.

A crucial role in the selection of epenthetic candidates is played by input-output IDENT-F constraints. Thus, splitting an input /i/ to yield any margin segment other than [j] would yield an IDENT violation. Given the constraints introduced so far, such candidates can never be optimal because nothing penalizes the more faithful splitting /i/ → [j]. To illustrate, the tableau in (8) considers an additional candidate for the same input: [mi:taɪ] where an /i/ has split to yield a [t]. This candidate violates many IDENT constraints, including for example IDENT-[consonantal]. On the other hand the candidate (8e) does not bring any improvement on other constraints, and therefore (8e) is harmonically bounded.

## (8) Non-homorganic epenthesis excluded next to high vowels

/mi: <sub>1</sub> a <sub>2</sub> ɪ/	MAX	UNIFORMITY	IDENT-[cons]	ONSET	INTEGRITY
☞ a. mi: <sub>1</sub> j <sub>1</sub> a <sub>2</sub> ɪ					1
e. mi: <sub>1</sub> t <sub>1</sub> a <sub>2</sub> ɪ			W1		1

Next to non-high vowels, Faroese epenthesis is blocked by the same mechanism, namely by IDENT constraints. This happens because non-high vowels have no featurally identical glides. Splitting a non-high vowel to yield any margin consonant will violate not only INTEGRITY, but also IDENT-F. For example if /e/ splits to yield [j], a violation of IDENT-[high] is incurred because the input vowel is [−high] but the glide is [+high]. If /e/ splits to [w], three IDENT constraints are violated: IDENT-[high], IDENT-[back], IDENT-[round]. Finally, splitting /e/ to yield a laryngeal like [ɦ] violates at least IDENT-[place] and IDENT-[spread glottis].

An analysis of Faroese hiatus with non-high vowels is presented in (9) for /le:a/ ‘to load’. Crucially, the constraint IDENT-[high] is violated by glide insertion, no matter which vowel splits (9b-c): both /e/ and /a/ are [−high] while glides are [+high]. Similarly, IDENT-[place] is violated by laryngeal insertion (9d-e). IDENT-[high] and IDENT-[place] are ranked above ONSET, and therefore having hiatus is preferred over changing the features [high] or [place]. The analysis for other possible epenthetic consonants is entirely similar: all of them are ruled out by high-ranked IDENT constraints.

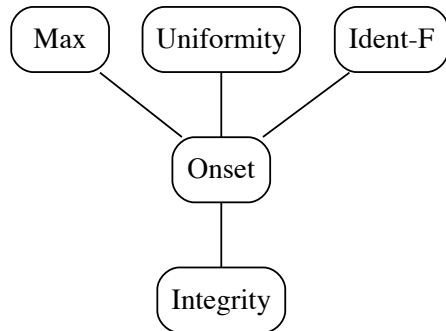
## (9) Faroese: no insertion when there is no high vowel

/le: <sub>1</sub> a <sub>2</sub> /	MAX	UNIF	IDENT-[high]	IDENT-[place]	ONS	INT
a. le: <sub>1</sub> a <sub>2</sub>					1	
b. le: <sub>1</sub> j <sub>1</sub> a <sub>2</sub>			W1		L	W1
c. le: <sub>1</sub> j <sub>2</sub> a <sub>2</sub>			W1		L	W1
f. le: <sub>1</sub> h <sub>1</sub> a <sub>2</sub>				W1	L	W1
g. le: <sub>1</sub> h <sub>2</sub> a <sub>2</sub>				W1	L	W1
d. la <sub>2</sub>	W1				L	
e. le: <sub>1,2</sub>		W1			L	

Finally, deletion or coalescence does not apply to the input sequences of non-high vowels in Faroese (9d-e). This implies that MAX and UNIFORMITY must outrank ONSET.

To summarize, a minimal epenthesis pattern involves splitting in response to a markedness constraint, such as ONSET, but no other unfaithful mappings. Several aspects of Faroese epenthesis are accounted for by the faithfulness constraints on the Splitting analysis. Thus high vowels split to yield the glides because this splitting is featurally faithful. On the other hand, non-high vowels do not split because there are no non-high glides in Faroese (and in fact in general, as proposed in Chapter 2), and therefore splitting non-high vowels has to involve featural unfaithfulness. The preliminary ranking for Faroese ranking is summarized in (10) where IDENT-F stands for IDENT constraints on all features.

## (10) Faroese ranking (to be revised in Chapter 2)



This brief analysis highlights a core consequence of the Splitting theory. Epenthetic consonants correspond to input segments, and faithfulness is the default state of affairs. Faithfulness to input segments accounts for the featural content of epenthetic segments, and blocks epenthesis in places where perfect identity is not possible. Of course, in other languages, IDENT-F constraints may be ranked below the motivating markedness constraint; such a ranking allows non-high vowels to split, and can permit epenthetic consonants other than glides.

## 1.4 Predictions and results

The minimal epenthesis pattern involves insertion of homorganic glides next to high vowels. This mapping involves just splitting – it violates INTEGRITY and no other faithfulness constraints. Within the Splitting theory, this minimal pattern is central, and all other insertion patterns can be characterized by the way in which they depart from minimal splitting.

There are two fundamentally different ways in which the minimal pattern can be amended: it may be extended (generalized to other contexts), or it may be blocked. The following sections briefly review the possible kinds of *extended patterns* and *blocking patterns* and formulate the predictions of the Splitting theory with regard to each kind of pattern. Different kinds of patterns may of course co-occur within the same language.

### 1.4.1 Blocking and the inventory of epenthetic consonants

From the point of view of the Splitting theory, faithfulness is key in determining epenthetic quality. Furthermore, epenthetic quality is regulated by the same faithfulness constraints which are responsible for general preservation of input features – there are no special IDENT constraints for split vowels. Therefore, the epenthetic consonant in a language will always be the most faithful out of the ones allowed by the language's ranking. Conversely a consonant that is unfaithful along some dimension can only be inserted if the more faithful option is blocked. Thus, there is no set universal inventory of epenthetic consonants, but rather the language's markedness constraints determine what is blocked, and the most faithful of the permitted consonants is epenthetic.

When faithful minimal epenthesis is blocked (e.g. by markedness constraints) or unavailable (e.g. next to non-high vowels), the choice of inserted consonants is based on the features that they share with an input vowel. In particular, the features that are preserved the most in a given language (i.e. protected by highest ranked IDENT constraints) will be the most important.

Thus two key components determine the possible epenthetic consonants: (i) faithfulness to the vowels, and the ranking of IDENT constraints and (ii) the markedness hierarchy of the language, which also determines the language's inventory.

For example, while [j] is perfectly faithful to /i/, it is possible for the split /i/→[fi] to win just when [j] is banned by markedness constraints. On the other hand, it is impossible for a language to insert some consonant if a more faithful consonant is also allowed by the language-particular hierarchy in a given environment. Thus, we expect that the common epenthetic consonants will be those that share most features with the vowels. Approximants are particularly good candidates. On the other hand, non-approximant epenthesis may also arise, but only in languages where the more faithful options are blocked.

The predictions of the Splitting theory were tested in a typological study of the inventory of epenthetic consonants. The range of segments that can be inserted is a subject of an ongoing debate (McCarthy & Prince, 1994; Vaux, 2001; Lombardi, 2002; Flynn, 2004; de Lacy, 2006; Rice, 2008, 2007; Blevins, 2008; Hume, 2011; Morley, 2012, 2013; de Lacy & Kingston, 2013). For that reason, this dissertation aims to single out the clear and unambiguous cases of epenthesis. The present typological survey focuses on detailed analysis of possible cases of epenthesis, and particular attention is paid to the possible alternative analyses. Because of this deep study approach, it appeared



impractical to cover all reported examples of epenthetic segments at the appropriate level of detail. Therefore an effort was made to include in the survey as many examples for each possible epenthetic segment as possible, and specifically to include the cases which appeared to be the most robust for each segment. The resulting sample of 49 languages with reported epenthesis is presented in Appendix B. This sample excludes the cases of epenthesis which were clearly only diachronic (see Chapter 9 for some discussion). In addition, the cases of minimality epenthesis and postnasal hardening were not included in the main sample, these will be discussed in Chapters 9 and 10 respectively.

Although the range of reported epenthetic consonants is quite big, many of the relevant cases were found to admit an alternative analysis. The common alternatives to epenthesis are summarized and illustrated in Chapter 9.

The table in (11) summarizes the typological findings of the dissertation. Several languages in the sample have more than one pattern of epenthesis, and therefore the total number of patterns in (11) is greater than the overall number of languages studied. The last column in (11) indicates whether among the studied languages there were any patterns of epenthesis that were found to be robust against alternative analyses. Just as with other consonants, many patterns of epenthesis for glides, laryngeals and dorsals were found to admit an alternative interpretation.

(11) Summary of the survey of possible epenthetic consonants

Consonant class	Number of patterns considered	Robust patterns
glides and related fricatives [j v]	30	yes, e.g. Faroese [j w v], Washo [j]
laryngeals	22	yes, e.g. Washo [ʔ]
voiced dorsal/uvular continuants	2	yes, e.g. Mongolian
rhotic approximants	2	yes, e.g. Boston English
other rhotics (e.g. taps, trills)	3	no
nasals	6	no
laterals	1	no
voiceless stops	6	no
voiceless fricatives	2	no

The results of the typological study are consistent with the predictions of the Splitting theory. Most of the robustly attested epenthetic segments belong to the class of approximants – they share major class features with vowels. This class includes the

vocalic glides [j w ɥ]. The back unrounded glide [ɥ] is not found in epenthesis in my sample, which must be an accidental gap since this segment is rare (Maddieson, 1984; Ladefoged & Maddieson, 1996). It is assumed here that epenthetic laryngeals [ɦ ʁ ?] are also specified as approximants, i.e. [−consonantal,+sonorant] (Chomsky & Halle, 1968; Hume & Odden, 1996; Ladefoged & Maddieson, 1996). Furthermore, as I argue in Chapter 3, laryngeals can share tongue position features like [high], [low], [back] with vowels. Laryngeal approximants are thus good candidates for epenthesis because they preserve the input vowel's major class features and tongue position features. However, laryngeals differ from vowels in place features and laryngeal features.

The fricatives [ʃ v] also appear as epenthetic, but in the languages of the sample their appearance correlates with a general glide-fricative alternation. Thus it appears that [ʃ v] may be epenthetic only if the glides [j w] are blocked in the given language and context. The rhotic approximants [ɹ] and [ɻ] are also possible epenthetic segments. As argued in Chapter 3, they are inserted next to vowels for which they preserve the tongue height features.

An important prediction of the Splitting theory is that there is no universally set class of possible epenthetic segments. If a language lacks approximants of the right kind, the choice of an epenthetic consonant will depend on other faithfulness dimensions. This prediction is borne out in Washo where [j] is inserted in all vowel sequences (see Chapter 6) and in the striking epenthesis pattern of Mongolian where dorsal [g/ɣ] or uvular [G/ʁ] is inserted depending on the vocalic environment. In a detailed analysis of Mongolian in chapter 7, I argue that these segments are selected because Mongolian lacks fully faithful vocalic glides and because the dorsal/uvular consonant best preserves the input vowels' place and voicing. The proposed analysis of Mongolian relies on the assumption that all vowels have Dorsal place or active articulator within Revised Articulator Theory (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004).

Some possible epenthetic segments are featurally very distant from the vowels. For example, [t] differs from all vowels at least in the values for features [consonantal], [sonorant], [continuant], and [voice]. For such segments, the Splitting theory imposes very restricted conditions when they may be epenthetic: the relevant language would have to prohibit all segments that are more faithful to the vowel in a given environment (e.g. voiced obstruents, continuants, glides). As I argue in Chapters 8-9, all reported cases of voiceless obstruent epenthesis admit an alternative analysis. If the Splitting theory is correct, this alternative analysis has to be the right one.

Finally, the Splitting theory imposes somewhat less stringent restrictions on the insertion of sonorants. For example [ŋ] or [ɭ] may be selected as epenthetic because these segments share the value for [sonorant] and [place] with vowels. However, there are no clear, unambiguous cases of dorsal nasal or dorsal lateral epenthesis in my sample. Thus, it would be premature to claim that this prediction of the Splitting theory is borne out.

To summarize, the Splitting theory predicts that the possible epenthetic consonants will be restricted by (i) faithfulness to the vowels, and the ranking of IDENT constraints and (ii) markedness hierarchy of the language. As a result, it is impossible for a language to insert some consonant if a more faithful consonant is also allowed by the language-particular markedness hierarchy in a given environment. The predictions of the Splitting

theory are borne out in the typology where the most robustly observed epenthetic consonants are approximants that share major class features and at least some tongue position features with vowels. On the other hand, in the few cases where approximants are blocked, other epenthetic consonants become possible such as e.g. voiced dorsals/uvulars in Mongolian.

### 1.4.2 Extended patterns of epenthesis

While minimal epenthesis inserts homorganic glides next to high vowels and involves just INTEGRITY violations, the *extended minimal epenthesis* patterns involve generalizing insertion to the non-high vowel contexts. All extended patterns arise when a trigger constraint (e.g. ONSET, FINAL-C) ranks above some of the IDENT-feature constraints, so permitting unfaithfulness in splitting.

Within the Splitting theory the faithfulness violations incurred by consonant insertion next to a non-high vowel are a superset of the faithfulness violations incurred by glide insertion next to a high vowel. For example, the mapping  $/i_1a_2/ \rightarrow [i_1j_1a_2]$  violates only INTEGRITY while  $/e_1a_2/ \rightarrow [e_1j_1a_2]$  violates INTEGRITY and IDENT-[high];  $/e_1a_2/ \rightarrow [e_1h_1a_2]$  violates INTEGRITY, IDENT-[spread glottis], and IDENT-[place] (assuming that  $[h]$  is an approximant and that it preserves the tongue position features of  $/e/$ ). In general if any non-high vowel splits to yield a margin consonant, such a mapping will always violate some IDENT constraints. On the other hand, the mapping  $/i_1a_2/ \rightarrow [i_1j_1a_2]$  violates no IDENT constraints.

Based on this faithfulness asymmetry the Splitting theory makes a clear prediction. Each extended pattern is predicted to include the minimal pattern. Consequently, every language that inserts a consonant next to a non-high vowel also inserts a glide next to a high vowel, unless there is blocking.

The extended patterns are explored in detail in Chapter 3. The present typological survey was not intended as a detailed study of glide epenthesis, and in fact many languages in the sample turned out to admit a non-epenthetic analysis. However the predictions of the theory are consistent with the data from languages showing unambiguous epenthesis. The patterns where a consonant is inserted next to non-high vowels fall into two categories. First, a number of such cases also have homorganic glide insertion next to high vowels – precisely as predicted by the Splitting theory. These cases will be described in Chapter 3. Second, the other group of cases shows clear signs of blocking – such cases will be explored in chapters 4 – 7.

Within the extended patterns, the consonant to be inserted next to a high vowel is always the fully faithful copy of a vowel (modulo blocking). However, for the non-high vowels, there is no perfect consonant counterpart, so the best of a set of unfaithful options must be selected, including the option to not insert (as in Faroese, see 1.3 above). The Splitting theory predicts that such competition will select the consonant which is faithful to the input vowel along the most important featural dimension of the language in question (i.e. according to the highest ranked IDENT constraints). This prediction is borne out, as discussed in Chapter 3. For example Farsi (the dialect described by Naderi & van Oostendorp (2011)) inserts a glottal stop next to non-high vowels, and glottal stop also belongs to the Farsi inventory. On the other hand, the inventory of Boston English does not include a glottal stop (apart from word-initial position, where it stems from a

blocking pattern of insertion), so the segment that preserves vowel height features (the approximant [ɹ]) is inserted next to non-high vowels.

### 1.4.3 Positionally restricted epenthesis

Within the Splitting theory, the quality of epenthetic segments has implications for the ranking of IO-IDENT constraints, which are also relevant for other mappings in the language. Consequently, the theory predicts that in general the inserted consonants will obey the inventory restrictions of a language. However, there may be markedness constraints which require certain consonants to appear in certain positions, as well as faithfulness constraints that require certain mappings to occur in certain positions. If such constraints are high-ranked, epenthesis may result in consonants which are positionally restricted.

Within the Splitting theory, the positional restrictions on epenthetic consonants are analyzed as effects of positional constraints. For example, in Chapter 5, I propose an account of restricted epenthesis in Madurese where glides only appear in the environments where they are inserted (after a homorganic high or mid vowel). The proposed account relies on a positional faithfulness constraint referring to syllable nuclei. Similarly, Chapter 6 explores the effects of a positional markedness constraint that requires vocalic margins to be laryngealized at prosodic edges. This positional markedness constraint often restricts the occurrences of laryngeals to a prosodic edge, precisely the environment where they are also epenthetic.

### 1.4.4 Other theories

Splitting differs from other theories in several important respects. Compared to the theories where epenthesis is restricted solely by its diachronic sources (Vaux, 2001; Blevins, 2004, 2008; Morley, 2012), the Splitting theory proposes that there are important restrictions of epenthetic consonants which cannot be reduced to the ways in which they develop over time (Bermúdez-Otero, 2006; Bermúdez-Otero & Börjars, 2006; Kiparsky, 2008; de Lacy & Kingston, 2013). The restrictive typological results obtained here support a theory with such synchronic restrictions.

There are also many differences between Splitting theory and the OT Insertion theories, which employ true insertion of consonants (McCarthy & Prince, 1994; Kitto & de Lacy, 1999; Rubach, 2000; Lombardi, 2002; Kawahara, 2003; de Lacy, 2006; Rice, 2007, 2008; Uffmann, 2007a; Naderi & van Oostendorp, 2011). First, all Insertion theories endorse the idea that epenthetic consonants are only protected by DEP, and therefore they show the emergent effects of markedness constraints, which might not be visible in the language as a whole. This general pattern of constraint violations is known as *the emergence of the unmarked* (McCarthy & Prince, 1994). Thus, all Insertion theories can be thought of as including a *markedness component*: when markedness constraints are high-ranked the universally unmarked consonants will emerge in epenthesis. The markedness component has many dimensions and predicts insertion of unmarked coronal consonants like [t] and [n], which are only predicted under very restricted circumstances within the Splitting theory. Furthermore, as argued in Chapter 2, emergent effects of intervocalic markedness also derive voiced stops like inserted [d].

The Insertion theories also have a *similarity component* – this encompasses the constraints or operations responsible for similarity requirements on epenthetic

consonants. The proposed similarity mechanisms include AGREE constraints (de Lacy, 2006); autosegmental constraints on feature insertion and spreading (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; b; Naderi & van Oostendorp, 2011); and output-output correspondence (Kitto & de Lacy, 1999). The similarity component of the Insertion theories is fully operative when similarity constraints dominate the markedness constraints. The similarity constraints make predictions which are similar to the predictions of Splitting in many cases. However, unlike in the Splitting theory, the similarity components of Insertion theories have implications for vowel-consonant assimilation processes.

To summarize, the existing theories of epenthesis either assume no synchronic restrictions on the process, or propose that restrictions come from markedness and similarity. Unlike any of these theories, the Splitting theory proposes that the restrictions on epenthetic consonants come from input-output faithfulness.

The Splitting theory differs from all other theories in that its predictions are always more restrictive. Compared to diachronically-driven theories, synchronic restrictions of the Splitting theory (namely the absence of true insertion of consonants) predicts that many consonants which are featurally distant from the vowels will be inserted only under restricted and practically impossible conditions. Compared to the Insertion theories, the Splitting theory can be thought of as doing away with the markedness component, and deriving all epenthesis with just one similarity mechanism – namely, splitting.

#### **1.4.5 Summary**

To summarize, the Splitting theory makes a number of novel predictions about possible epenthetic consonants, and about systems with multiple epenthetic consonants. It predicts that epenthetic consonants will be as faithful as possible to their input vowels, and that a consonant may not be epenthesized if a more faithful alternative is also allowed by the language-particular ranking in a given environment. While there is no set universal inventory of epenthetic consonants, many options, such as voiceless obstruent stops, are so restricted that they practically cannot occur in epenthesis.

Splitting also predicts that the extended patterns of insertion next to non-high vowels will be restricted in that they will always include the minimal epenthesis of homorganic glides next to high vowels. This prediction is restricted to cases that show no blocking effects.

Finally, the predictions of the Splitting theory are different from those of other theories. The main difference is that the Splitting theory is much more restrictive than any other existing theories.

The attested typology of epenthetic consonants conforms to the predictions in two domains: the inventory of epenthetic consonants, and implicational relations in extended epenthesis.

## 1.5 Chapter outline

The rest of this dissertation is organized as follows:

Chapter 2 summarizes the theoretical proposal, and reviews the predictions of the splitting theory in greater detail.

Chapter 3 presents an investigation of the extended patterns of epenthesis.

Chapter 4 describes the patterns of directional blocking where in a sequence of two vowels only one vowel may split.

Chapter 5 illustrates the relationship between epenthetic consonants and overall inventory of the language in an analysis of epenthesis in Madurese.

Chapter 6 investigates the blocking constraints that affect epenthetic consonants at edges of prosodic constituents. These constraints and the predictions of the theory are illustrated in a detailed analysis of Washo epenthesis, and in a survey of edge laryngeal insertion.

Chapter 7 illustrates the segmental blocking effects with an analysis of dorsal/uvular epenthesis in Mongolian.

Chapter 8 illustrates the predictions of the splitting theory with a reanalysis of [t]-zero alternations in Ajiñinca Apurucayali (Axininca Campa).

Chapter 9 illustrates the proposed methodology and the predictions of Splitting with regard to the inventory of epenthetic consonants.

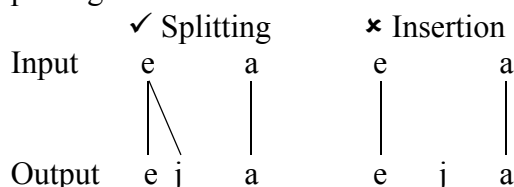
Chapter 10 presents conclusions, and directions for future research.

## Chapter 2. Theory

### 2.1 Introduction

At its core, the Splitting theory proposes that Gen has a splitting operation but no insertion operation targeting syllable margins, as in (1).

#### (1) Splitting vs. Insertion



The Splitting theory thus proposes a simplification of McCarthy & Prince's (1995, 1999) Correspondence Theory, which allows both splitting and insertion.<sup>1</sup> The implementation of this change in Gen is discussed in section 2.2, and after the relevant constraints are introduced in 2.3, an illustrative analysis of epenthesis in Faroese follows in section 2.4.

Splitting theory keeps the constraint component (Con) essentially unchanged, although some constraints become redundant as discussed in section 2.8. Sections 2.5 and 2.7 identify further predictions of the Splitting theory, and formulate the conditions on constraint systems which are necessary for the predictions to hold.

Within the Splitting theory epenthetic segments always correspond to an input segment, so faithfulness constraints regulate their form. In fact, the theory predicts that epenthetic consonants must be *as faithful as possible* to the underlying segment they split from. In contrast, within the Insertion theories, epenthetic consonants are not influenced by faithfulness constraints, apart from the insertion-specific DEP-feature constraints in some theories (Rubach, 2000; Kawahara, 2003; Howe & Pulleyblank, 2004; Uffmann, 2007a; Naderi & van Oostendorp, 2011). As a result, markedness is often the only driving force in determining the quality of inserted consonants (Lombardi, 2002; de Lacy, 2006). For such theories, epenthetic consonants that express unmarked features are to be expected, even when those consonants are very unfaithful to their neighboring segments. Some consequences of this fundamental distinction between the Splitting and Insertion theories are outlined in section 2.8.

### 2.2 Splitting and Gen

In Optimality Theory (Prince & Smolensky, 2004), Gen is responsible for producing the range of possible candidates and for establishing correspondence relationships. Gen is hypothesized to be maximally *inclusive*, or in other words it obeys the property of *freedom of analysis* (McCarthy, 2002). However this freedom is necessarily constrained by the range of representational possibilities and operations afforded by the theory (Blaho *et al.*, 2007). Many restrictions on Gen are implicit in particular analyses, although they

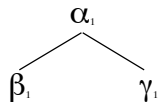
<sup>1</sup> Within Serial OT or within derivational theories, the core idea of the Splitting theory could be expressed by a derivational step where a segment is copied into an adjacent prosodic slot.

do not necessarily follow from the assumed representations. Structural and representational restrictions on Gen are familiar from metrical and prosodic theory (Selkirk, 1984, 1995; Kager, 1994; Hyde, 2002; Itô & Mester, 2003; McCarthy, 2008c a.o.). In many existing theories Gen is also assumed to only create segments which are phonetically interpretable. Segments which would be [+high +low] or [+strident glottal] are very rarely discussed, although nothing in principle prohibits such segments (de Lacy, 2007). Thus the restrictions on Gen are necessary in a wide variety of theories.

Gen comprises a number of operations, each of which can be freely applied to any input. Current conceptions of Gen allow an insertion operation, which can be expressed as a mapping from input to candidate  $/\emptyset/ \rightarrow [\alpha]$ , where  $\alpha$  is any segment (or a prosodic slot within the Containment-based approaches (Rosenthal, 1997b; Prince & Smolensky, 2004)). When such an operation applies, the output segment  $\alpha$  stands in no correspondence relation to the input. This operation violates the constraint IO-DEP.

This dissertation proposes that Gen has no such operation for consonants (whether the same can be said for vowels is discussed in Chapter 10). Thus the constraint DEP-C is redundant because it can never be violated. The only operation that can lead to addition of a consonant in the output is splitting. (Hayes, 1990; Selkirk, 1990; McCarthy & Prince, 1995; Struijke, 2000). Splitting is illustrated graphically in (2) where correspondence is shown with both lines and indices. In what follows, shorthand notation will be used for (2):  $/\alpha_1/ \rightarrow [\beta_1\gamma_1]$

(2) Splitting



For expository reasons, I will be using the terms *epenthesis* and *insertion* interchangeably, referring to the output of splitting. In a situation when a vowel splits, both of its output correspondents are formally equal – they are equally regulated by faithfulness constraints, and there is no sense in which one of them is ‘primary’ or ‘first’. However, I will continue to use the term ‘epenthetic consonant’ for the non-vocalic output segment. In the mapping  $/i_1/ \rightarrow [j_1i_1]$ , I will refer to the  $[j]$  as the ‘epenthetic consonant’. In order to refer to the formal operation which creates an output segment with no input correspondent, the term *true insertion* or *true epenthesis* will be used. The theories relying on true insertion are referred to as *Insertion theories*.

The original formulation of Correspondence Theory is compatible with epenthetic segments which come from both splitting and true insertion (McCarthy & Prince, 1995, 1999). Therefore the range of possible patterns predicted by the Splitting theory is necessarily a subset of the patterns predicted by Insertion theories. The arguments for the more restrictive Splitting theory are then of two main kinds. First, a number of patterns of epenthesis are possible under the Insertion analysis, but impossible under Splitting – these patterns are unattested, as discussed in detail in Chapters 8 – 9 (see also section 2.8 below). Second, many cases of consonant epenthesis are analyzed more adequately as splitting rather than as true insertion – such cases will be discussed in detail in Chapters 3-7 (see also Yip, 1993b; Baković, 1999; Krämer, 2008). To summarize, splitting is



necessary to analyze many patterns of epenthesis, while true insertion is in fact never necessary.

### 2.3 Faithfulness and the trigger constraints: the basic constraint set

Just as with any OT theory, the predictions of the Splitting theory are fundamentally dependent on the postulated constraints. This section introduces the minimal set of constraints which are essential to the analysis of any splitting mappings. This basic constraint set includes the faithfulness constraints of McCarthy & Prince (1995, 1999) as well as the constraint ONSET (Prince & Smolensky, 2003) which can trigger epenthesis. The original definitions of these constraints were adapted here to make explicit the way in which these constraints count violations.<sup>2</sup> The rest of the dissertation will explore additional constraints and constraint families relevant to consonant epenthesis, thus expanding on the basic set.

A number of markedness constraints can trigger epenthetic processes, i.e. splitting. Most cases of epenthesis are motivated by prosodic well-formedness constraints (Broselow, 1982; Itô, 1986, 1989), most notably the constraint ONSET in (4).

(3) ONSET: assign a violation for every syllable that does not start with an onset

As will be discussed in the following chapters, epenthesis can also be motivated by the constraints on well-formed feet (e.g. STRESS-TO-WEIGHT – Fitzgerald (1997)), or prosodic words (e.g. FINAL-C – McCarthy (1993)). Although most cases of epenthesis considered here are due to prosodic constraints, segmental factors, such as OCP (Leben, 1973; McCarthy, 1986), are also relevant to insertion, see for example the analysis of Madurese in Chapter 5.

The trigger constraints responsible for epenthesis are opposed by faithfulness constraints that penalize unfaithful mappings. Splitting mappings incur a violation of the constraint INTEGRITY (McCarthy & Prince, 1995, 1999).

(4) INTEGRITY: assign a violation for every input segment that has multiple correspondents in the output

INTEGRITY assigns a violation for every input segment that is split in the output. It is assumed here that splitting can only be binary. In other words, splitting cannot produce more than two output segments from an input segment, as in  $/a_1/ \rightarrow [\beta_1 \gamma_1 \delta_1]$ . In effect, the Splitting operation can only apply once to any input segment.

Empirically, I have been unable to find clear cases where non-binary splitting would be required. Theoretically, the binary splitting assumption allows for a straightforward input-based definition of INTEGRITY that is violated once for every instance of splitting. Finally, binary splitting puts an upper bound on the number of consonants that can be added in the output. Thus, a mapping like  $/a_1/ \rightarrow [t_1 w_1 a_1]$  is impossible in the proposed theory, although it can be achieved in DEP-based theories with true insertion (see also Łubowicz, 2003; de Lacy, 2007).

---

<sup>2</sup> I am grateful to Alan Prince for suggesting this adjustment in constraint definitions.

The splitting operation is also local. In other words, for an input  $/\alpha_1\beta_2/$  splitting cannot yield  $[\gamma_1\delta_2\varepsilon_1]$  where the correspondents of  $/\alpha/$  surround the correspondent of  $/\beta/$ . While this requirement will be shown to restrict consonant epenthesis appropriately, see Chapter 10 on the possibility of relaxing this requirement to account for copy vowel epenthesis.

In addition to splitting, many of the markedness constraints responsible for epenthesis can also be responded to by violating other faithfulness constraints such as MAX for deletion and UNIFORMITY for coalescence (McCarthy & Prince, 1995, 1999). This is particularly apparent in the case of hiatus resolution (Rosenthal, 1997b; Casali, 1998, 2011; Senturia, 1998; Picard, 2003). This dissertation does not attempt to address the ways in which epenthesis competes with other processes. In what follows, I will normally assume that INTEGRITY is outranked by the faithfulness constraints responsible for other repairs such as MAX (see section 2.4.2.1 for an illustration). The candidates considered in most tableaux will only involve epenthesis, unless other repairs are operative in the language in question. Finally, the constraint DEP-C becomes redundant within the Splitting theory since it refers to a correspondence configuration that Gen cannot produce.

While insertion of consonants is unavailable within the Splitting theory, all other available operations apply freely. Thus, although Gen is more restricted, freedom of analysis still holds for the quality of the output segments. Therefore it is not surprising that in a splitting mapping  $/\alpha_1/ \rightarrow [\beta_1\gamma_1]$  neither  $[\beta]$  nor  $[\gamma]$  has to be featurally identical to  $/\alpha/$ . Featural changes (and other operations) can freely apply in conjunction with the splitting operation. Thus Gen supplies candidates where any segment splits to yield any segment. Of course, featural departures from the input incur a cost in terms of faithfulness constraints: any pair of segments which stand in a correspondence relation and differ in a value for some feature violate the constraint IDENT-F (McCarthy & Prince, 1995, 1999).

- (5) IDENT-F: let  $\alpha$  be a segment in the input and  $\beta$  be a correspondent of  $\alpha$  in the output. Assign a violation if  $\alpha$  is  $[\gamma F]$ , and  $\beta$  is not  $[\gamma F]$

For every segment in the output of splitting, the violations of IDENT are calculated separately. Thus in a mapping  $/\alpha_1/ \rightarrow [\beta_1\gamma_1]$  there are two pairs of corresponding segments:  $\langle \alpha, \beta \rangle$  and  $\langle \alpha, \gamma \rangle$ , and IDENT assesses violations for each pair (see section 2.7.5 for further discussion of this assumption).

To summarize, within the Splitting theory every instance of splitting incurs a violation of the faithfulness constraint INTEGRITY-IO. Furthermore for a mapping  $/\alpha_1/ \rightarrow [\beta_1\gamma_1]$  any featural discrepancies in either  $[\beta]$  or  $[\gamma]$  compared to  $/\alpha/$  will incur a violation of input-output IDENT-F constraints.

## 2.4 An illustration: minimal epenthesis in Faroese

Within the Splitting theory, faithfulness constraints play a crucial role in determining the outcome of epenthesis. The patterns of epenthesis can be organized according to the degree of unfaithfulness they introduce. This section considers the pattern I will refer to as *minimal splitting*. This pattern introduces the least unfaithfulness possible, it violates INTEGRITY and no other faithfulness constraints. I argue that the pattern of epenthesis in

Faroese is approximated very closely by the theoretical minimal epenthesis system. The analysis of Faroese thus illustrates the central role of faithfulness constraints in analyzing epenthesis within the Splitting theory.

When a vowel splits into a margin position, as in  $/V_1/ \rightarrow [C_1V_1]$ , feature-identity constraints (IDENT) apply to both mappings:  $/V_1/ \rightarrow [V_1]$  and  $/V_1/ \rightarrow [C_1]$ . IDENT constraints will encourage epenthetic consonants to be as faithful to their input vowels as possible. Of course the ‘most faithful’ epenthetic consonant is different for different input vowels. In line with many preceding treatments of glides, I will assume that vocalic glides such as [ɥ j w ʉ] are featurally identical to the respective high vowels /y i u ʉ/ (Steriade, 1984; Levin, 1985; Durand, 1987; Deligiorgis, 1988; Clements & Hume, 1995; Hume, 1995; Rosenthal, 1997a, b; Harris & Kaisse, 1999; Rubach, 2000; Kawahara, 2003; Levi, 2004, 2008; Uffmann, 2007a). Thus [j] is a fully faithful result of splitting for /i/, but [j] is not fully faithful to /u/.

Furthermore, I will assume throughout the dissertation that only high vowels have fully faithful glide counterparts. In other words, all glides are [+high –low] phonologically (Pullum & Ladusaw, 1986; Martínez-Celdrán, 2004)<sup>3</sup> and the non-high vowels have no fully faithful glide counterparts. Thus splitting a non-high vowel such as /e/ to yield a margin segment such as [j] would necessarily involve violations of IDENT constraints. The mapping  $/e/ \rightarrow [j]$  incurs one violation of IDENT-[high] because the input /e/ is [–high] and the output [j] is [+high].

As we shall see, this faithfulness asymmetry between high and non-high vowels provides a unified account of most aspects of Faroese epenthesis. Faithfulness explains which of the vowels may split, which consonants result from splitting, and in which direction the splitting happens.

#### 2.4.1 Faroese epenthesis: the data

The account of Faroese presented here is based on the descriptions and data in Lockwood (1955), Anderson (1972), Young & Clever (1985); Thráinsson et al. (2004), and Árnason (2011). For expository reasons the transcription conventions of Árnason (2011) will be followed in all examples, even when the original source follows a different convention. Faroese vowel inventory (6) can be organized in two series which are generally in complementary distribution. The ‘long’ vowels generally appear in stressed open syllables while their ‘short’ counterparts appear in unstressed open syllables and in all closed syllables. The vowels in parentheses only appear in loanwords.

---

<sup>3</sup> The only possible cases of mid glides that I know of are Nepali (Ladefoged & Maddieson, 1996: 323–324), and Spanish (Hualde *et al.*, 2008). In the former case, the evidence is somewhat scarce, and in both cases the reported mid glides only occur at faster speech rates, corresponding to vowels at a slower speech rate. It is likely that the phonetic mid glides really correspond to a phonological mid vowel target. The alternations of high back unrounded glide [ʉ] in Apurucayali (Axininca) are discussed in Chapter 8.

## (6) Faroese vowels

## a. In stressed open syllables

Monophthongs	Diphthongs
i: (y:) u:	ɛi: ʊu: ɛa:
e: ø: o:	ai: au:
(a:)	ɔi: ɔu: ɔa:
	ui:

## b. In other syllables

Monophthongs	Diphthongs
ɪ ʏ ʊ	ui ai ɔi
ɛ œ ɔ	
a	

There are a number of exceptions and complications to the general vowel length/tenseness alternation pattern (Árnason, 2011: 152-155). Thus monosyllables behave in a special way, and certain CC clusters act as onsets with respect to the length/tenseness alternations. Furthermore, in some cases, a long vowel appears before a CC cluster which would normally close the preceding syllable. The analysis of these vowel alternations is irrelevant for our purposes. It suffices to say that most of the vowels in (6) can be contrastive and should, at least in some cases, be underlying.

Since surface stress is largely predictable from the quality of the vowels in the word, stress is often not transcribed in my sources. The Faroese inventory of surface consonant segments is presented in (7), adapted from Árnason (2011: 114).

## (7) Faroese consonants

p p <sup>h</sup> p	t t <sup>h</sup> t	t̪ t̪ <sup>h</sup>	k k <sup>h</sup> k	(ʔ)
		tʃ tʃ <sup>h</sup>		
	s	ʃ	h	
m m̥	n n̥	ɲ	ɲ̥	
	l l̥	ʎ ʎ̥		
	ɹ ɹ̥	ɹ̥		
v/v/w		j		

The labio-dental fricative [v] occurs as a variant pronunciation of /v/ in word-initial position, while [w] occurs medially after high vowels. The glottal stop is transcribed by Árnason (2011: 117) for cases of word-initial glottalization of stressed vowel-initial syllables. No glottal stop or glottalization is discussed in my other sources.

The syllable structure of Faroese is (C)(C)V(X)(C) where X is either a vowel or a consonant. While some onsetless syllables are allowed, in other cases hiatus is avoided

via homorganic glide epenthesis.<sup>4</sup> In what follows, I will only focus on the patterns of epenthesis that arise in combinations of simple vowels, and abstract away from diphthong + vowel combinations. Although the behavior of such sequences is largely parallel to the simple VV sequences, the analysis of diphthongs would lead us too far afield because it necessarily involves some complications. For one thing, the analysis of diphthongs themselves requires introducing an additional constraint set, see e.g. Rosenthal (1997a, b) for an OT treatment. In addition, hiatus resolution after diphthongs interacts non-trivially with a set of morphologized alternations in Faroese which are generally referred to as *Verschärfung* or *skerping*. Although the general pattern of hiatus resolution applies both after simple vowels and after diphthongs, the sequences with diphthongs will not be considered here due to these additional complications.

Faroese allows vowel-initial words (modulo the possibility of glottalization/glottal stop insertion), as illustrated in (8)

(8) Faroese vowel-initial words

[ɪtʃ:ɪ] 'not'	[ʊʂkʊɾ] 'Irish'
[e:plɪ] 'potato'	[ɛn:] 'still'
[ɔŋk] 'meadow'	[ɔitnɪ] 'the island-DAT'
[ø:l] 'beer'	[œdn] 'tempest'
[appə] 'grandfather'	[ai:ja] 'to own'

Faroese imposes restrictions on word-medial vowel sequences only allowing sequences where both vowels are non-high. Underlying vowel sequences where one of the vowels is high undergo homorganic glide insertion. The distribution of epenthetic glides may be summarized as in (9). Most examples of epenthesis occur after a stressed vowel, and therefore  $V_1$  in (9) is long in most cases. The suffixal vowels are restricted to [ɪ ʊ a] thus restricting the set of possible  $V_2$ 's. The choice between epenthetic [j] vs. [w] and [w] vs. [ʊ] will be discussed in detail below.

---

<sup>4</sup> According to Thráinsson et al. (2004) Faroese also exhibits word-final glide insertion after diphthongs ending in high vowels and possibly after other vowels as well. This process is not addressed in what follows since it is clearly not motivated by ONSET.

## (9) Summary of Faroese hiatus resolution after simple vowels

V <sub>1</sub> \ V <sub>2</sub>	i	u	a
i:	j	j	j
u:	w	w	w
e:	j	ʊ	Ø
ø:	j	ʊ	Ø
o:	j	ʊ	Ø
a:	j	ʊ	no data

Faroese epenthesis between simple nuclei is illustrated in (10). Glosses are given when they are present in the source. The forms in (10) exemplify all vowel sequences that were found in my dataset. For epenthetic forms the last column in (10) lists the same stem occurring without a glide, when available. (10a) shows that underlying sequences of non-high vowels surface faithfully. (10b) considers the sequences where the first vowel is high: in this case [j] is inserted after /i:/ and [w] after /u:/. On the other hand, when the first vowel is non-high, the epenthetic glides are [j] and [ʊ], as shown in (10c).

## (10) Faroese glide epenthesis after monophthongs

## a. No epenthesis next to non-high vowels

VV Example

/e:a/ [le:a] 'to load'

/o:a/ [ʌo:a] 'to make red'

/ø:a/ [ʊmrø:a] 'discussion'

## b. Epenthesis after high vowels

VV Example

Stem alternations

/i:a/ /mi:-aɪ/ [mi:jaɪ] 'middle-PL.FEM'

/i:ɪ/ /si:-ɪ/ [si:ji] 'lower-PST.PART'

/i:ʊ/ /si:-ʊɪ/ [si:juɪ] 'custom-NOM' [si:ləsʊɪ] 'immoral'

/u:a/ /tʰu:-a/ [tʰu:wa] 'to say tú (thou)'<sup>5</sup>

/u:ɪ/ /pu:-ɪ/ [pu:wɪ] 'live-1SG.PST' [puiɪ] 'live.2SG'

/u:ʊ/ /su:-ʊɪ/ [su:wʊɪ] 'south-NOM' [su:ɪ] 'southerly'

<sup>5</sup> This example is from Árnason (2011: 82), the same form is transcribed with a diphthong [tʰu:wa] in Thráinsson et al. (2004: 39).

c. Epenthesis after non-high vowels, if a high vowel follows

VV	Example	Stem alternations
/o:ɪ/	/so:-ɪn/	[so:jɪn] 'boiled'      [so:a] 'scum on boiling liquid'
/e:ɪ/	/kle:-i/	[kle:ji] 'pleasure'      [kle:a] 'please'
/e:ʊ/	/le:-ʊɪ/	[le:vʊɪ] 'leather-NOM'
/ø:ɪ/	/lø:-ɪn/	[lø:jɪn] 'odd'
/aɪ/	/k <sup>h</sup> atla-ɪ/	[k <sup>h</sup> atlajɪ] 'call-1SG.PST'      /k <sup>h</sup> atla-ɪ/ [k <sup>h</sup> atlajɪ] 'call-2SG.PRES'

To summarize, Faroese resolves vowel sequences via homorganic glide insertion, but only if one of the vowels in a sequence is high. The quality of the glide inserted next to rounded vowels depends on the first vowel of the sequence: [w] after high vowels and [ʊ] after non-high vowels. Importantly, the distribution of epenthetic glides mirrors a general restriction in Faroese whereby [w] only appears after high vowels and [ʊ] shows up after non-high vowels.

Finally, a number of stems end in a rounded glide underlyingly, giving rise to the forms like those in (11) where the quality for the glide is not predictable from surrounding vowels. The appearance of these forms is completely expected under the OT analysis, since under Richness of the Base glides should appear stem-finally.

(11) Faroese contrastive glides

/rø:v-a/	[rø:va] 'speech-NOM'
/eʃskav-aɪ/	[eʃskavajɪ] 'beloved-NOM/ACC.FEM.PL'
/le:v-a /	[le:va] 'place_where_something_lies-NOM'

## 2.4.2 Analysis of Faroese glide epenthesis

This section shows that several important aspects of glide epenthesis in Faroese follow from the same general property: although splitting is allowed, feature changes are prohibited. In other words, splitting has to be minimal. The analysis is based on the constraint set introduced in 2.3 which includes the faithfulness constraints INTEGRITY, IDENT, MAX, and UNIFORMITY as well as a markedness constraint ONSET.

### 2.4.2.1 Motivating splitting

Splitting is an unfaithful mapping violating the constraint INTEGRITY. In order for this mapping to be optimal, a motivating markedness constraint – in our case ONSET – must dominate INTEGRITY. Furthermore, splitting must beat the candidates which would satisfy ONSET by applying some other operation, such as deletion and coalescence. This can be achieved by ranking the constraints against these operations – MAX and UNIFORMITY – over INTEGRITY. Faroese provides a good illustration of this ranking, and unless otherwise noted I will assume that a parallel ranking argument holds for other cases of splitting to be analyzed.

The analysis of Splitting in Faroese is presented in (12) for [mi:jaɪ] 'middle-PL.FEM' where I focus on the ranking argument just described. As other tableaux in this

dissertation, this tableau combines the violation numbers with comparative format (Prince, 2002), and shows correspondence with indices.

(12) Faroese epenthesis as splitting

	/mi: <sub>1</sub> a <sub>2</sub> ɪ/	MAX	UNIFORMITY	ONSET	INTEGRITY
☞ a.	mi: <sub>1</sub> j <sub>1</sub> a <sub>2</sub> ɪ				1
b.	mi: <sub>1</sub> a <sub>2</sub> ɪ			W1	L
c.	mi: <sub>2</sub> ɪ	W1			L
d.	mi: <sub>1,2</sub> ɪ		W1		L

The splitting candidate (12a) wins because INTEGRITY is ranked the lowest of all constraints. Faroese does not opt to tolerate an ONSET violation as in (12b) or avoid this violation via deletion or coalescence as in (12c-d). Importantly, within the Splitting theory Gen does not produce any candidates which would have true insertion of a consonant. Hence for the input /mi:<sub>1</sub>a<sub>2</sub>ɪ/ there is no candidate like [mi:<sub>1</sub>t<sub>0</sub>a<sub>2</sub>ɪ] where the output segment [t<sub>0</sub>] corresponds to no input segment. Because such candidates are absent, the constraint DEP-C can never be violated and becomes redundant.

#### 2.4.2.2 Splitting yields a homorganic glide

Given the somewhat impoverished constraint set defined so far, the Splitting theory makes a prediction: next to high vowels, only homorganic glide epenthesis is possible. Thus, the vowel sequence in /mi:<sub>1</sub>a<sub>2</sub>ɪ/ considered in (12) cannot be repaired by inserting some consonant other than the homorganic glide. Any such consonant would necessarily change some features of an input vowel, while the glide [j] is featurally identical to /i/ and hence makes no featural changes.

This prediction is illustrated in (13) which considers additional candidates for the tableau in (12). An epenthetic [t] and the constraint IDENT-[consonantal] are considered: mapping a vowel to [t] violates this IDENT constraint. The candidate (13e) splits the first input vowel /i:/ to yield a [t] whereas the candidate (13f) splits the second vowel /a/. Both of these candidates, are harmonically bounded because they involve a gratuitous violation of IDENT.

(13) Non-homorganic epenthesis is excluded next to high vowels

	/mi: <sub>1</sub> a <sub>2</sub> ɪ/	MAX	UNIFORMITY	IDENT-[cons]	ONSET	INTEGRITY
☞ a.	mi: <sub>1</sub> j <sub>1</sub> a <sub>2</sub> ɪ					1
e.	mi: <sub>1</sub> t <sub>1</sub> a <sub>2</sub> ɪ			W1		1
f.	mi: <sub>1</sub> t <sub>2</sub> a <sub>2</sub> ɪ			W1		1

Note that the tableau in (13) provides no information as to where IDENT should be ranked. The sheer existence of the constraint family IDENT makes it impossible for gratuitous feature changes to arise.



Splitting a vowel to yield a consonant other than [t] would incur violations of other IDENT constraints. For example, splitting /i/ to yield [w] violates IDENT-[round], and splitting /i/ to yield [ŋ] violates IDENT-[nasal]. Thus given the constraints introduced so far, only a homorganic glide [j] may be inserted next to /i/. All other margin segments differ from vowels in at least one feature – see section 2.7.1 for a more detailed discussion of the assumed feature theory and Appendix A for a summary of feature specifications.

The harmonic bounding relations illustrated in (13) may not hold in larger constraint systems because there may be markedness constraints motivating IDENT violations. However this basic prediction serves well to illustrate the crucial role of faithfulness constraints within the Splitting theory.

### 2.4.2.3 Non-high vowels do not split

The non-high vowels cannot split without also violating IDENT constraints because there are no margin segments which would share all features with a non-high vowel. All glides are [+high] and all other epenthetic segments will differ from vowels in some other feature. To give some examples, the glide [j] is specified [+high, –low] whereas the vowel [e] is [–high, –low], and therefore a mapping /e/ → [j] violates the constraint IDENT-[high]. On the other hand the rhotic approximant [ɹ] is arguably [–high], as discussed in detail in Chapter 3 in connection with non-rhotic dialects of English. However, [ɹ] differs from all vowels in that it is [+rhotic]. Consequently mapping a non-high vowel to [ɹ] violates IDENT-[rhotic].

Splitting a non-high vowel into a margin position will always incur a violation of some IDENT constraint. However, IDENT violations are not allowed in Faroese hiatus resolution, and therefore non-high vowels never split. In combinations of high and non-high vowels, it is always the high vowel that splits, because this splitting is always more faithful. For example, for the input /mi:ai/ 'middle-PL.FEM' the first vowel splits and the surface form is [mi:jaɪ]. On the other hand, for the input /k<sup>h</sup>atla-i/ 'call-1SG.PST' it is the second vowel that splits yielding [k<sup>h</sup>atlaɪi]. This variable directionality follows from the fact that splitting may apply to any input segments.

To illustrate the splitting analysis, the tableau in (14) compares two candidates for the input /k<sup>h</sup>atla-i/ 'call-1SG.PST' which are minimally distinct. The winner splits the high vowel /i/ to yield a glide [j] whereas the loser splits /a/ to yield [j]. (14b) loses because it incurs a fatal unmotivated violation of IDENT-[high].

(14) Non-homorganic epenthesis is excluded next to high vowels

	/k <sup>h</sup> atla <sub>1</sub> i <sub>2</sub> /	MAX	UNIFORMITY	IDENT-[high]	ONSET	INTEGRITY
☞ a.	k <sup>h</sup> atla <sub>1</sub> j <sub>2</sub> i <sub>2</sub>					1
b.	k <sup>h</sup> atla <sub>1</sub> j <sub>1</sub> i <sub>2</sub>			W1		1

Observe that the ranking of IDENT again does not matter for the choice of the winner: candidates like (14b) are harmonically bounded and hence universally excluded. Given the basic constraint set, out of a high and a non-high vowel, it is always the high vowel that splits, because this splitting is inherently more faithful.

When there are no high vowels to split, hiatus surfaces faithfully. Thus an input like /le:a/ ‘to load’ surfaces with hiatus. The splitting analysis of this mapping relies on a high ranking of IDENT constraints, as illustrated in (15). The candidates (15b-c) and other splitting candidates violate different instantiations of IDENT-F schema. These violations arise regardless of whether the first vowel splits (15b) or the second (15c). On the other hand, the candidates in (15d-e) satisfy both IDENT and ONSET at the cost of violating MAX or UNIFORMITY – these violations make the candidates suboptimal. The tableau in (15) thus gives evidence for the ranking IDENT, MAX, UNIFORMITY >> ONSET.

(15) Faroese: no insertion when there is no high vowel

	/le: <sub>1</sub> a <sub>2</sub> /	MAX	UNIF	ID-[high]	ID-[rhotic]	ONSET	INT
✶ a.	le: <sub>1</sub> a <sub>2</sub>					1	
b.	le: <sub>1</sub> j <sub>1</sub> a <sub>2</sub>			W1		L	W1
c.	le: <sub>1</sub> i <sub>2</sub> a <sub>2</sub>				W1	L	W1
d.	la <sub>2</sub>	W1				L	
e.	le: <sub>1,2</sub>		W1			L	

To summarize, since there are no non-high glides, splitting a non-high vowel into a margin position will always incur some IDENT violations. In Faroese, non-high vowels never split, precisely because their splitting would yield IDENT violations. IDENT constraints play a pivotal role in accounting for various aspects of the Faroese pattern: the quality of inserted segments, the choice of the vowel that splits, and the blocking epenthesis in positions where it is unfaithful. Within the minimal epenthesis pattern, these diverse effects all follow from a high ranking of IDENT.

#### 2.4.2.4 Enriching the constraint set: directionality and the [w]/[v] alternation

The analysis of Faroese presented so far relies only on the standard faithfulness constraints in their interaction with the markedness constraint ONSET. However, some aspects of the Faroese epenthesis pattern require the introduction of additional constraints. First, in sequences of high vowels it is always the first vowel that splits. Second, the quality of the glide inserted next to /u/ varies according to the general pattern of the language: [w] after high vowels and [v] after non-high vowels.

The principles that govern directionality of splitting will be discussed in detail in Chapter 4. One relevant constraint encodes the observation that homorganic glide+vowel sequences like [ji] and [wu] are dispreferred across languages (Kawasaki, 1982; Hayes, 1989). This constraint, formulated in (16), will be referred to as \*ji/wu in what follows.

- (16) \*ji/wu: assign a violation mark for every margin-nucleus sequence of two segments which are identical in all features

A mirror image prohibition against the sequences [ij] and [uw] is more scarcely documented, and therefore I will tentatively assume that either there is no separate constraint of the form \*ij/uw, or this constraint is universally lower ranked than \*ji/wu. Given these restrictions, the sequences of high vowels will always be repaired by splitting the first, rather than the second vowel. Thus, /pu:-ɪ/ 'live-1SG.PST' surfaces as [pu:wɪ] rather than \*[pu:jɪ] in Faroese because the latter form violates \*ji/wu. The same reasoning holds for the input /si:-uɪ/ 'custom-NOM' which surfaces as [si:jʊɪ] rather than \*[si:wʊɪ].

The relative ranking of the constraint \*ji/wu and its role in the analysis of Faroese is illustrated by the two tableaux in (17). On the one hand, \*ji/wu has to be ranked below ONSET because otherwise epenthesis would be blocked before high vowels. This is why [k<sup>h</sup>atlaɪɪ] 'call-1SG.PST' is preferred over \*[k<sup>h</sup>atlaɪ] (17a). On the other hand, the sheer presence of \*ji/wu in the system predicts that in sequences of high vowels splitting the first high vowel is better than splitting the second one. This is illustrated in (17b), where the apparent harmonic bounding could be overridden if there was a constraint of the form \*ij/uw.

(17) The role of \*ji/wu in Faroese

a. No blocking of epenthesis

/k <sup>h</sup> atla <sub>1</sub> ɪ <sub>2</sub> /	MAX	UNIF	IDENT	ONSET	*JI/WU	INT
☞ a. k <sup>h</sup> atla <sub>1</sub> ɪ <sub>2</sub> ɪ <sub>2</sub>					1	1
b. k <sup>h</sup> atla <sub>1</sub> ɪ <sub>2</sub>				W1	L	L

b. Influence on directionality

/si: <sub>1</sub> u <sub>2</sub> ɪ/	MAX	UNIF	IDENT	ONSET	*JI/WU	INT
☞ a. si: <sub>1</sub> j <sub>1</sub> u <sub>2</sub> ɪ						1
b. si: <sub>1</sub> w <sub>2</sub> u <sub>2</sub> ɪ					W1	1

To summarize, the well-known restrictions on glide-vowel sequences exert an influence on splitting, and this influence is expected within the splitting theory.

Let us now turn to the general alternation between [w] and [v] in Faroese. [w] only occurs after high vowels, and [v] occurs after non-high vowels. This alternation is active in the language as a whole and it affects the epenthetic glides. The exact nature of the constraints responsible for the alternations of rounded glides remains to be investigated. Such an investigation would lead us too far afield, and therefore I will simply assume a descriptive constraint against the vowel-glide sequences prohibited in Faroese (18).

(18) HIGH-W: assign a violation for every sequence of a [–high] vowel followed by [w] and for every sequence of a [+high] vowel followed by [v]

The general [w/v] alternation represents a departure from minimal epenthesis. Due to a high-ranking markedness constraint, the underlying /u/ does not surface faithfully as [w] but rather changes to [v]. After non-high vowels, splitting is no longer minimal: the features of an input vowel are changed. Within the context of the feature theory assumed here, this featural alternation is interpreted as a change in Place: whereas [u] and [w] have Dorsal place (in fact I will assume that these segments only have a dorsal specification, see section 2.7.1 and Chapter 7), [v] has no Dorsal specification. Therefore a mapping from /u/ to [v] violates IDENT-[place].

The ranking of HIGH-W above IDENT-[place] accounts for the observed pattern. Splitting an /u/ yields either [w] or [v] depending the height of a preceding vowel, and [w/v] in general are distributed according to the same principles. The analysis of Faroese epenthetic [v] is illustrated in (19) for [le:vʊɪ] 'leather-NOM'. The ranking of \*ji/wu below ONSET is preserved from (17). The suboptimal candidate (19c) shows that ONSET must dominate IDENT-[place], since otherwise an onsetless syllable would be tolerated.

(19) Faroese: general [w/v] alternation in epenthetic segments

	/le: <sub>1</sub> ʊ: <sub>2</sub> ɪ/	HIGH-W	ONS	ID-[place]	*JI/WU	INT
✖ a.	le: <sub>1</sub> ʊ: <sub>2</sub> ʊ: <sub>2</sub> ɪ			1		1
b.	le: <sub>1</sub> w: <sub>2</sub> ʊ: <sub>2</sub> ɪ	W1		L	W1	1
c.	le: <sub>1</sub> ʊ: <sub>2</sub> ɪ		W1	L		L

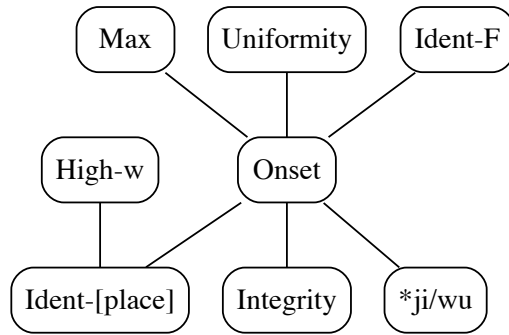
We have seen that the epenthetic glides sometimes undergo place changes in Faroese, and that ONSET must dominate IDENT-[place]. However, ONSET itself cannot force a split vowel to change its place, because there are no other margin segments in Faroese which would differ from vowels only in place, and changes in all other features are disallowed by higher-ranking IDENT constraints on these features. This can be verified by examining the feature specifications of possible epenthetic consonants in Appendix A.

The different labial glides in Faroese illustrate an interesting consequence of the splitting approach. Within the Splitting theory epenthetic segments are underlying. The same ranking HIGH-W >> IDENT-[place] is responsible for the fate of underlying /u/ in the margins, no matter whether such a segment ends up having a nucleus correspondent or not: the alternations of 'underlying w' and 'epenthetic w' are really the same alternation. This consequence of the Splitting theory will be explored in more detail in section 2.8.

#### 2.4.2.5 Faroese: summary

The overall ranking responsible for the Faroese epenthesis pattern is presented in (20). In this diagram, I use IDENT-F as an abbreviation for IDENT constraints on all features except place.

(20) Faroese ranking (preliminary)



The minimal epenthesis pattern allows no changes to the input apart from the splitting operation itself. In such a pattern, only INTEGRITY is ranked below the triggering markedness constraint (ONSET in our case) whereas all other constraints dominate the trigger constraint. Faroese approximates this ranking very closely, low ranking of IDENT-[place] being an exception. The high ranking of almost all IDENT constraints in Faroese provides a unified analysis for the quality of epenthetic segments, for the prohibition on splitting non-high vowels, and for the directionality of splitting. Faithfulness thus plays a crucial role in deriving the epenthetic quality within the Splitting theory. The typological variation in the quality of epenthetic segments arises when markedness constraints outrank some faithfulness constraints (in particular some of the IDENT-F constraints).

## 2.5 Input-orientedness within the Splitting theory

The splitting theory accounts for the quality of epenthetic segments based on their similarity to the *input* – in this sense the theory is input-oriented. This is a crucial difference from other OT theories of epenthesis where epenthetic segments are required to be similar to some *output* segment (Kitto & de Lacy, 1999; Rubach, 2000; Kawahara, 2003; de Lacy, 2006; Uffmann, 2007a; Naderi & van Oostendorp, 2011). This section outlines some consequences of input-orientedness, illustrated by additional examples from Faroese. Empirically, the dissertation will focus on the predictions of splitting with regard to the inventory of epenthetic consonants. A detailed empirical investigation of input-orientedness in consonant epenthesis is left for the future.

### 2.5.1 Faroese vowel reduction, raising, and input orientedness

The faithfulness constraints on a splitting mapping like  $/V_1/ \rightarrow [C_1V_1]$  relate both output segments to their input vowel. If an input vowel splits, its two correspondents may undergo independent changes, since each correspondent is related independently to the input. The splitting of  $/u_1/$  to  $[v_1u_2]$  in Faroese  $[le:v\ddot{u}ɹ]$  'leather-NOM' is an example of this. In this case the nucleus correspondent of the input  $/u/$  is completely identical to its input, while the margin correspondent  $[v]$  differs from the input in having labial place. The Splitting theory naturally leads us to expect another kind of relationship where the margin correspondent of a split vowel is more faithful to the input than the nucleus. A possible example comes from the interaction between glide epenthesis and dialectal

vowel reduction in Faroese described by Árnason (2011: 90-97), see Uffman (2010) for a similar example from dialects of English.

Vowel reduction in unstressed syllables is mainly observed in northern and southern varieties of Faroese as well as in the capital city of Tórshavn. In addition to dialectal variation, the extent of vowel reduction varies across morphological contexts, sociolects and sometimes even in speech of one speaker. Vowel reduction merges the underlying /ɪ/ and /ʊ/ resulting in different output vowels in different dialects: [ə], [ɪ], [ʊ]. For concreteness, I will focus on the examples where the result of reduction is a schwa, but it is important to keep in mind that other qualities are also attested. Some examples of vowel reduction are given in (21). For the reasons to be discussed immediately below, I assume that underlyingly /ɪ/ and /ʊ/ are still contrastive in this dialect.

(21) Dialectal vowel reduction in Faroese

/hʉu:sɪ/	[hʉu:sə] 'the house'
/vɪltɪ/	[vɪltə] 'wanted'
/vɔu:ɪʊ/	[vɔu:ɪə] 'were'
/fetlʊɪ/	[fetləɪ] 'traps'

Even though the vowels in the final syllable may be reduced, the quality of the epenthetic glide still depends on the original vowel, as illustrated in (22).<sup>6</sup>

(22) Epenthetic glides reflect the quality of underlying vowel

/hɔi:la-ʊɪ/	[hɔi:lavəɪ] 'holy-SG'
/hɔi:la-ɪɪ/	[hɔi:lajəɪ] 'holy-PL'
/klea:-ʊɪ/	[klea:vəɪ] 'happy'
/klea:-ɪ/	[kle:jə] 'happiness'
/k <sup>h</sup> atla-ʊ/	[k <sup>h</sup> atlavə] 'called-PL'
/k <sup>h</sup> atla-ɪ/	[k <sup>h</sup> atlajə] 'called-SG'

I assume here that glide epenthesis is an active alternation in the relevant dialects, so the glides are not reanalyzed as part of the stem or the affix. For the purposes of illustration, this assumption is adopted without conducting a more detailed dialectal investigation.

From the point of view of the Insertion theories, the data in (21-22) seem to present an opaque interaction since the quality of inserted glide does not reflect the surface quality of the reduced vowel. However, within the Splitting theory, the interaction is entirely transparent and parallel to the other cases of glide epenthesis. In a mapping like /hɔi:la-ɪɪ/ → [hɔi:laj<sub>1</sub>ə<sub>2</sub>ɪ] 'holy-PL', the output [j] preserves all features of its input, namely /ɪ/, and this is completely independent of whether the nucleus correspondent of

<sup>6</sup> The examples in (22) might not be from the same speaker as in (21).

/i/ surfaces intact. Thus, cases like Faroese dialectal epenthesis are entirely expected and unproblematic under the splitting account.

On the other hand, the Splitting theory has no inherent resources to account for potential cases where a change in the input vowel seems to result in a parallel change to the epenthetic consonant. Such potentially problematic case can be illustrated by the interaction between vowel raising and epenthesis in Faroese.

Sequences of non-high vowels undergo variable raising of the first vowel illustrated in (23). The extent of raising is described differently in my sources, and for the purposes of illustration I concentrate on the patterns described by Árnason (2011: 82 – 85). Although raising affects both mid and low input vowels, I will focus here on the way it applies to mid vowels.

(23) lists multiple available pronunciations of the forms with underlying hiatus where  $V_1$  is mid and  $V_2$  is low, i.e. /a/. The discussion in Árnason (2011: 82 – 85) implies that faithful realization is also possible for /po:-a/ [po:a] 'to preach' and /sko:-a/ [sko:wa] 'to investigate', but these exact forms are not cited. Crucially, according to Árnason, glide insertion resolves hiatus only if the mid vowels become high.

(23) Vowel raising before /a/ in Faroese

/kle:-a/	[kle:a], [klɪ:ja], [kli:ja] 'to gladden, make happy'
/ske:-an/	[ske:an], [skɪ:jan] 'the damage-ACC'
/po:-a/	[pu:wa] 'to preach'
/sko:-a/	[sku:wa] 'to investigate'

Within the Splitting theory, the quality of an inserted glide is dependent on the input rather than the output. Therefore a sequence like /e:a/ in Faroese is predicted to surface without a glide, regardless of whether the input /e:/ ends up being pronounced as a high vowel. Therefore in principle, cases like the Faroese vowel raising present a potential problem.

The particular pattern in (23) is only scarcely documented in the literature: in contrast to Árnason (2011), Lockwood (1955) reports examples such as /lo:a/ [lu:a] 'to hang down' without a glide. Thus, we do not have enough systematic data on Faroese vowel raising, in order to be able to tell whether the correlation between raising and glide epenthesis is real. It could be that glide insertion is variably extended to mid vowels as well – to rule out this hypothesis a detailed phonetic comparison between the reported [e:a] and [ɪ:ja] would be needed.

To summarize, within the Splitting theory the quality of epenthetic segments is compared to their input source, rather than to their output neighbor. This input-oriented character of splitting predicts that the epenthetic glide may sometimes reflect the quality of its input more faithfully than a nucleus correspondent of the same vowel. On the other hand, the cases where a nucleus change triggers a concomitant change in the epenthetic

consonant have to be analyzed within the Splitting theory as involving multiple derivational strata (Bermúdez-Otero, *forthc.*; Kiparsky, *forthc.*).

### 2.5.2 Epenthetic consonants have morphological affiliation: splitting and positional faithfulness

Because epenthetic consonants have input correspondents within the Splitting theory, they also have morphological affiliation. Therefore the constraints that reference morpheme edges can apply in a novel way. For example, certain morphological edges and constituents act as prominent positions with regard to positional faithfulness constraints (Beckman, 1998; Casali, 1998). Just like other faithfulness constraints, the constraint INTEGRITY has more specific versions prohibiting splitting in prominent positions. Throughout the dissertation, I will argue that many of the observed restrictions on epenthetic consonants follow from positional INTEGRITY constraints.

One such constraint relevant to Faroese is INI-INTEGRITY that prohibits word-initial splitting (24).

(24) INI(TIAL)-INTEGRITY: assign a violation for every word-initial input segment that has multiple correspondents in the output

Recall that Faroese allows word-initial onsetless syllables, even if they start with a high vowel.<sup>7</sup> Thus although /ɪ/ undergoes splitting in a word-medial vowel sequence, e.g. /k<sup>h</sup>atla-ɪ/ [k<sup>h</sup>atlajɪ] 'call-1SG.PST', word-initial syllables may begin with [ɪ], as in [ɪtʃ:ɪ] 'not'. Within the Splitting theory, this can be analyzed as an effect of positional faithfulness: word-initial /ɪ/ cannot split because it is protected by INI-INTEGRITY. The analysis of [ɪtʃ:ɪ] 'not' is illustrated in (25), showing that INI-INTEGRITY crucially dominates ONSET.

(25) Epenthesis is blocked word-initially in Faroese

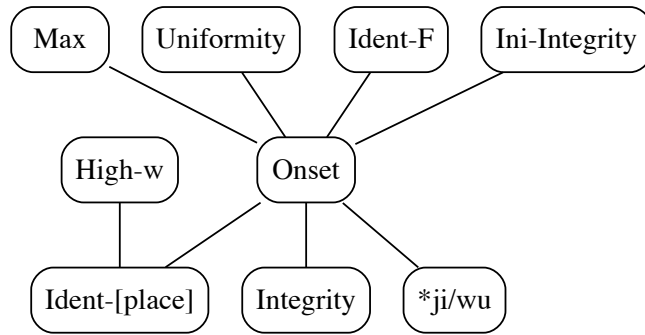
	/ɪ <sub>1</sub> tʃ:ɪ/	INI-INTEGRITY	ONSET	INTEGRITY
☞ a.	ɪ <sub>1</sub> tʃ:ɪ		1	
b.	j <sub>1</sub> ɪ <sub>1</sub> tʃ:ɪ	W1	L	W1

Thus, the basic constraint set can be updated to include positional versions of INTEGRITY. The final ranking for Faroese is presented in (26).

<sup>7</sup> Unlike my other sources, Árnason (2011: 117) reports that word-initial *stressed* vowels undergo glottal stop insertion.



(26) Faroese ranking: final



The fact that positional faithfulness constraints can block epenthesis is unique to the Splitting theory: it follows from input-orientedness and from the fact that epenthetic segments have morphological affiliation. In contrast, within the Insertion theories, avoidance of word-initial epenthesis can be analyzed as an effect of Alignment or Anchoring (e.g. IO-ANCHOR-L) constraints (McCarthy & Prince, 1993a; b, 1995; Rosenthal, 1997b; Rubach, 2000, 2002). From the point of view of the Splitting theory, word-initial epenthesis does not violate Anchoring. For example, the epenthetic [j] in (25b) corresponds to the word-initial segment in the input, and hence Anchoring is satisfied.

To summarize, epenthetic consonants belong to the input, and hence to the morphemes within the Splitting theory. Consequently, the positional restrictions on epenthesis can be analyzed as effects of positional faithfulness, and cannot be due to Anchoring or Alignment. Splitting theory differs from the Insertion theories in this aspect of the analysis. The exact empirical consequences of this difference remain to be investigated. However, the Faroese data demonstrate that word-initial epenthesis can be prohibited without banning word-medial epenthesis.

## 2.6 Generalizing minimal epenthesis: extended patterns

The minimal epenthesis pattern involves insertion of homorganic glides next to high vowels. This mapping involves just splitting – it violates INTEGRITY and no other faithfulness constraints. Within the Splitting theory, this minimal pattern is central, and all other insertion patterns can be characterized by the way in which they depart from minimal splitting.

There are two fundamentally different ways in which the minimal pattern can be amended: it may be extended (generalized to other contexts), or it may be blocked. While *blocking patterns* will be discussed in section 2.7, the *extended patterns* are schematically very similar to minimal epenthesis.

The *extended minimal epenthesis* patterns involve generalizing insertion to the non-high vowel contexts. This happens when the trigger constraint (e.g. ONSET, FINAL-C) ranks above some of the IDENT-F constraints, permitting unfaithfulness in splitting. The properties of such patterns reflect the fact that they *extend* some basic pattern to additional contexts.

As we have seen, within the Splitting theory the faithfulness violations incurred by homorganic insertion next to a non-high vowel are a superset of the faithfulness violations incurred by insertion next to a high vowel. A mapping like /i<sub>1</sub>a<sub>2</sub>/ → [i<sub>1</sub>j<sub>1</sub>a<sub>2</sub>]

violates only INTEGRITY while  $/e_1a_2/ \rightarrow [e_1j_1a_2]$  violates INTEGRITY and IDENT-[high]. This situation is further illustrated in (27), which shows various examples of /V/ splitting. Given this faithfulness asymmetry, there is no way to use faithfulness to prevent  $/i/ \rightarrow [ji]$  if any other split is permitted in a language.<sup>8</sup>

(27) Faithfulness relationships between epenthesis patterns

		IDENT-[high]	IDENT-[low]	IDENT-[back]	IDENT-[round]
a.	$/i/ \rightarrow [ji]$				
b.	$/e/ \rightarrow [je]$	*			
c.	$/a/ \rightarrow [ja]$	*	*	*	
d.	$/o/ \rightarrow [jo]$	*		*	*
e.	$/i/ \rightarrow [wi]$			*	*

It follows that each extended pattern must include the minimal pattern. Consequently, every language that inserts a consonant next to a non-high vowel also inserts a glide next to a high vowel (unless there is blocking). This prediction is explored in Chapter 3.

Within the extended patterns, the consonant to be inserted next to a high vowel is always the fully faithful copy of a vowel (modulo blocking). However, for the non-high vowels, there is no perfect consonant counterpart, so the best of a set of unfaithful options must be selected, including the option to not insert (as in Faroese, see 2.4 above). The Splitting theory predicts that such competition will select the consonant which is faithful to the input vowel along the most important featural dimension of the language in question (i.e. according to the highest ranked IDENT constraints). For example Farsi (the dialect described by Naderi & van Oostendorp (2011)) inserts a glottal stop next to non-high vowels, and glottal stop also belongs to the Farsi inventory. On the other hand, the inventory of Boston English does not include a glottal stop (apart from word-initial position, where it stems from a blocking pattern), so the segment that preserves vowel height features – the approximant  $[ɹ]$  – is inserted next to non-high vowels.

## 2.7 Splitting, blocking and the inventory of epenthetic consonants

Within the Splitting theory, the inventory of possible epenthetic consonants is inherently tied to the featural assumptions and to the surface inventory of a given language. In particular, the Splitting theory predicts that the epenthetic consonant will always be the closest segment to its input available in the inventory and allowed by a language-particular markedness constraint ranking. In order to substantiate this prediction, section 2.7.1 discusses the representational assumptions that the dissertation will follow. Section 2.7.2 introduces the notion of feature closeness, and sections 2.7.3 – 2.7.4 illustrate the predictions of the Splitting theory with regard to the epenthetic inventory. Section 2.7.5 considers the conditions on Con that lay ground for the restrictive predictions of splitting. Section 2.7.6 concludes.

<sup>8</sup> The faithfulness predictions would of course change considerably if there were INTEGRITY constraints on specific segments, such as INTEGRITY-/e/, or INTEGRITY-/i/. These constraints are not proposed here, and they are not necessary to account for the typology of consonant insertion.

### 2.7.1 Representational assumptions

The core idea of the Splitting theory – that true insertion of consonants is not available – is not necessarily committed to a particular feature theory. However the predictions of the theory do depend on the particular feature theory assumed, because similarity between an input vowel and its output correspondents is regulated by IDENT-F.

In this dissertation I will generally assume Revised Articulator Theory (RAT) of Halle (1995); Halle *et al.* (2000). The proposed feature specifications are spelled out in Appendix A. Within RAT all vowels are specified for the designated articulator (or place) [Dorsal] (Flynn, 2004). This assumption plays a crucial role in the analysis of Mongolian [g/ɣ]-epenthesis in Chapter 7.

The Splitting theory endorses the common assumption that vocalic glides [j w] are featurally identical to the respective high vowels<sup>9</sup> (Steriade, 1984; Levin, 1985; Durand, 1987; Deligiorgis, 1988; Clements & Hume, 1995; Hume, 1995; Rosenthal, 1997a, b; Harris & Kaisse, 1999; Rubach, 2000; Kawahara, 2003; Levi, 2004, 2008; Uffmann, 2007a). However, the Splitting account of consonant epenthesis relies on the assumption that glides can have two kinds of feature specification, referred to as *vocalic* and *consonantal*. The dual behavior of glides is discussed in Cohn (1993a); Hume (1995); Levi (2004, 2008); Nevins & Chitoran (2008); Padgett (2008), among others. I follow Levi (2004, 2008) in assuming that the consonantal glides, symbolized [j<sub>c</sub> w<sub>c</sub>], differ from vocalic [j w] (and from [i u]) in their place specification. In addition, there is a difference in major class features such as [consonantal] (Hyman, 1985; Deligiorgis, 1988; Hayes, 1989; Waksler, 1990; Rosenthal, 1997b). Just as with vocalic dorsality mentioned above, this assumption is crucial for the analysis of Mongolian in Chapter 7.

To mention some of the alternative approaches to the dual specification of glides, a number of theories assume that vocalic and consonantal glides differ underlyingly, but not on the surface, either in syllabification or in the major class features (Clements & Keyser, 1983; Levin, 1985; Rubach, 2000; Nevins & Chitoran, 2008). This option is difficult to implement in a parallelist theory such as the one employed here. Hume (1995) and Hume and Odden (1996) argue that the two kinds of glides differ in having C-Place vs. V-Place features within the feature theory of Clements & Hume (1995).

Laryngeal consonants have properties that make them likely to be epenthetic within the Splitting theory. The epenthetic laryngeals are assumed to be specified as approximants, i.e. [–consonantal +sonorant] (Jakobson *et al.*, 1951; Chomsky & Halle, 1968; Kenstowicz & Kisseberth, 1979; McCarthy & Prince, 1995). See Lass (1976) and Durand (1987) for some challenges to this assumption. Just like glides, laryngeals exhibit dual behavior in sometimes alternating with consonants and sometimes with vowels. I therefore assume that laryngeals in general can be specified as either consonantal or vocalic.

In summary, surface inventories may contain either the vocalic or the consonantal versions of [j w ʔ h], or both. There are no reported phonetic differences corresponding to the two kinds of feature specification, although this issue may require further instrumental study (see Levi (2008) for some discussion).

---

<sup>9</sup> On the phonetic differences between glides and vowels see Maddieson & Emmorey (1985); Aguilar (1999); Chitoran (2002, 2003); Padgett (2008).

Another important property of laryngeals is that they do not impose formant transitions on the neighboring vowels, and do not affect the position of the tongue (Ladefoged & Maddieson, 1996; Garellek, 2013). It is therefore assumed here that laryngeals are compatible with any specification for vocalic tongue position features such as [high] [low] [back]. Specifically, inserted laryngeals will always be faithful to these features from their input vowels (see Chapter 3 for a more detailed discussion).

The laryngeals are also featurally different from vowels: they have [glottal] place of articulation. Laryngeal epenthesis always violates IDENT-[place] because there are no [glottal] vowels.

To summarize, the present dissertation shares with the Revised Articulator Theory the assumption that all vowels are [dorsal] (Halle *et al.*, 2000; Flynn, 2004). It is also assumed here that vocalic glides are featurally identical to respective high vowels, and that vocalic laryngeals can share tongue position features with vowels. Finally, glides and laryngeals can have dual feature specification as vocalic or consonantal. I follow Levi (2004, 2008) in assuming that consonantal glides differ from vocalic glides in place of articulation.

### 2.7.2 Feature closeness and output-driven splitting

The predictions of splitting to be described here hold for a class of grammatical maps known as *output-driven maps*, ODM for short (Tesar, 2008, 2013). The property of output-drivenness encodes the general intuition that departures from the input are motivated exclusively and systematically by output conditions (Moreton, 2004; Prince & Smolensky, 2004). The definition of output-drivenness does not presuppose a particular phonological theory, but it relies crucially on certain representational assumptions, and on the notion of input-output similarity, to be defined below. Thus, although the predictions of the Splitting theory will necessarily depend on the constraints in Con, it makes sense to talk about the predictions that the theory makes for *all* OT systems which are output-driven.

A grammar defines a set of grammatical mappings where an input is paired with an output via some correspondence relation. The set of such mappings will be referred to as a map. The notion of output-drivenness crucially relies on comparing different mappings within the same map. A general idea behind it is that the grammaticality of mappings with relatively greater phonological disparities implies grammaticality of mappings with smaller disparities involving the same output. For instance, if an input  $in_1$  maps to an output  $o_1$ , and this mapping involves some number of featural changes to the input, then any input  $in_2$  which is closer in features to  $o_1$  should also map to  $o_1$  (see Tesar (2008, 2013) for a precise definition).

The featural disparities between the input and the output play a crucial role for the splitting mappings, and the definition of ODM has to rely on a well-defined notion of input-output disparities. In order to be able to precisely characterize input-output disparities, I will make the following featural assumptions, most of which follow from the Revised Articulator Theory. It will be assumed here that all features, with the exception of Place, are binary, and that an input-output difference in feature values constitutes one disparity. Place is assumed here to be multi-valued, and the possible segments may have more than one place value. Any difference between input and output

in the specification of place is assumed to constitute one disparity. The general notion of feature closeness employed here can be defined as follows.

(28) *Feature-Closeness*

Given three segments,  $\alpha, \beta, \gamma$  such that  $\beta$  differs from  $\alpha$  in all and only the values of features from the set  $\Theta = \{F_1 \dots F_n\}$ , and  $\gamma$  differs from  $\alpha$  in all and only the values of features from the set  $\Pi = \{F_1 \dots F_m\}$ ,  **$[\gamma]$  is featurally closer to  $[\alpha]$  than  $[\beta]$  is** iff  $\Pi \subset \Theta$ .

For example,  $[d]$  is featurally closer to  $[i]$  than  $[t]$  is because there is no feature that  $[t]$  and  $[i]$  share that  $[d]$  and  $[i]$  don't also share, and there is some feature that  $[d]$  and  $[i]$  share that  $[t]$  and  $[i]$  do not share, namely  $[+voice]$ .

Splitting an input segment so that it has more than one correspondent in the output also constitutes a disparity. In fact, all instances of splitting considered here are binary, and therefore splitting always corresponds to exactly one input-output disparity.

Any splitting mapping introduces the disparity of splitting and possibly some featural disparities between input and output. Therefore, a splitting mapping always involves more disparities than a non-splitting featural change involving the same features. For example, if an input segment  $/\alpha/$  splits to yield  $[\beta\gamma]$  in the output, such a mapping introduces all featural disparities between  $\alpha$  and  $\beta$  as well as those between  $\alpha$  and  $\gamma$ , and crucially involves a splitting disparity. On the other hand, a featural change mapping  $/\alpha/ \rightarrow [\beta]$  introduces just the featural disparities, but no splitting disparity. In output-driven maps, grammaticality of a greater-disparity mapping implies grammaticality of a smaller-disparity mapping. From this it follows that if in some language  $/\alpha/$  splits to yield  $[\beta]$ , then the mapping from  $/\alpha/$  to  $[\beta]$  should also be grammatical in that language, in the same environment.

In output-driven maps splitting and featural changes always have to yield the closest available output segment. Consider for example, a situation where  $[\gamma]$  is closer to  $[\beta]$  than  $/\alpha/$  is. If some language  $L_1$  has a mapping  $/\alpha/ \rightarrow [\beta]$  in some context, then this mapping will necessarily introduce all the disparities involved in mapping  $[\gamma] \rightarrow [\beta]$ . Thus the property of output-drivenness implies that  $[\gamma]$  will be mapped to  $[\beta]$  in the same context in  $L_1$ . If  $[\gamma]$  and  $[\beta]$  are distinct, then this means that  $[\gamma]$  is ungrammatical in this context in  $L_1$ : an input  $/\gamma/$  maps to  $[\beta]$  rather than to itself.

To summarize, in output-driven OT systems, the outcome of splitting is inherently related to the language-particular inventory. This result can be encoded as the Feature closeness principle (or FCP) in (29).

(29) *Feature closeness principle*

If a language  $L$  has a mapping where an input segment  $S_1$  splits to yield a segment  $S$ , then any segment  $S_2$  which is Feature-closer to  $S$  than  $S_1$  will be avoided in  $L$  in the same environment, and  $S_2$  will be mapped to  $S$ .

To illustrate this principle at work, consider first the high vowel  $/i/$ . This vowel has a glide counterpart to which it is featurally identical, namely the vocalic glide  $[j]$ . Therefore if  $/i/$  splits to yield some segment  $C$  that is anything other than  $[j]$ , it must be the case that

the vocalic /j/ maps to C in that system. To generalize this prediction, insertion of any segment next to a high vowel  $V_h$  is possible only if the vocalic glide corresponding to  $V_h$  maps to that segment in the given language and in the given environment.

To take another example, the dorsal nasal [ŋ] shares the designated articulator (or place) as well as sonorancy with the vowels. Therefore if any language splits a vowel to yield a coronal [n], in such a language underlying /ŋ/ must map to [n] in the same environment.

To summarize, the Splitting theory predicts that in any given context, the inserted segment should always be the closest possible to its input vowel, where ‘possible’ is limited by the ranking of markedness constraints – ‘impossible’ segments are avoided by a general alternation. As we shall see, most epenthetic consonants share major class features with vowels. In rare cases where this is not the case, the Splitting theory predicts that a general alternation should get rid of the approximants which would be closer to input vowels. Thus, the Splitting theory relates the high frequency of epenthetic approximants to the general rarity of major class feature alternations (Kaisse, 1992; Cho & Inkelas, 1994). Non-approximant consonants may be epenthetic if a language prohibits the vocalic approximants in a given environment. This prediction is borne out in Mongolian, where the selection of epenthetic consonant is based on the IDENT constraints for place and voicing (see Chapter 7).

### 2.7.3 Inventory constraints

In order to describe the theory's predictions with regard to the inventory of epenthetic consonants, we need to enrich our constraint set with constraints that may prohibit the relatively more faithful epenthetic consonants (e.g. glides, approximants) and favor the less faithful ones (e.g. obstruents). For illustration, I will propose a very simplistic set of inventory constraints. Each segment is penalized by a constraint from the family \*SEG. For example, each occurrence of surface [t] incurs a violation of \*t, each [f] is penalized by \*f etc. The general definition of \*SEG constraints is given in (30)

(30) \*SEG: assign a violation for each surface occurrence of a segment  $S$

The \*SEG constraints are not intended as a serious theory of markedness in phonological inventories, which is a matter of considerable complexity (Rice, 2000, 2007; Howe & Pulleyblank, 2004; de Lacy, 2006). Instead, these constraints are used here simply to illustrate the properties of the Splitting theory – the properties that will hold in *any* output-driven OT system. Thus, the \*SEG constraints are added for illustration to the basic constraint set discussed in 2.3.

### 2.7.4 Illustration: feature similarity and ranking conditions

Within the Splitting theory there is no set universal inventory of epenthetic consonants. Instead, the possible epenthetic consonants are tightly related to the language-particular inventory via blocking. The inserted consonants will always be featurally the closest available to the input vowels. In other words, if splitting yields a consonant which differs from its input in some features, then all consonants which are featurally closer to the same vowel must be blocked in the same language.

Certain consonants may be avoided in splitting because they are prohibited in a particular position. This positional blocking will be exemplified in Chapters 5 and 6 for Madurese and Washo. An extreme case of blocking occurs if some consonant does not appear anywhere in the language, i.e. it is excluded from the language's inventory. This across-the-board blocking occurs in Mongolian, as discussed in Chapter 7, and this kind of blocking will be schematically illustrated in this section.

The theory's predictions crucially depend on the feature closeness relations between consonants which may result from splitting and vowels which serve as input. The assumed feature specifications for relevant consonants and vowels are given in Appendix A. Vocalic glides are of course most similar to the respective vowels, in fact they are identical. The feature specification of vocalic laryngeals will be discussed in detail in Chapters 3 – 6, and we abstract away from laryngeals here. In line with Revised Articulator Theory, it is assumed here that all segments are specified for all features, and that vowels and vocalic glides are dorsal (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004; Levi, 2004, 2008). I further assume that for nasals, rhotics, liquids, and obstruents the characteristically vocalic features such as [high] [back] and [round] all have a minus specification. Thus, obstruents and nasals are all specified [–high; –back; –round]. Because of this assumption, the features that differentiate between vowels do not distinguish between most consonants, and therefore the vowel-consonant feature closeness relations are the same for all vowels with respect to most consonants.

To summarize, apart from the characteristically vocalic segments, most margin segments do not differ in their closeness relationship to different vowels. Thus it makes sense to consider how close the different consonants are to *any* vowel. These closeness relations are illustrated in (31) for a subset of consonants. The features listed are shared by all vowels and vocalic glides (the latter represented here as 'G'). The feature closeness relations apparent in (31) also hold for the full feature specifications, provided in Appendix A.

(31) Feature specifications of vowels/glides compared to some consonants

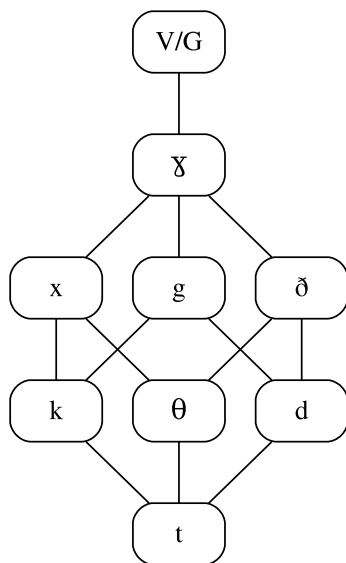
	cons	son	cont	voi	place
V/G	–	+	+	+	Dor
ɥ	+	–	+	+	Dor
x	+	–	+	–	Dor
g	+	–	–	+	Dor
k	+	–	–	–	Dor
ð	+	–	+	+	Cor
θ	+	–	+	–	Cor
d	+	–	–	+	Cor
t	+	–	–	–	Cor

Some potential epenthetic consonants are closer to vowels than others. Thus the vocalic glides are completely identical to the respective high vowels. The dorsal consonants are closer to vowels than coronals, because all vowels are dorsal. The

continuant consonants are closer to vowels than stops. Finally, the voiced consonants are closer to vowels than voiceless ones.

These feature closeness relations can be represented in a lattice in (32) where each segment on a higher tier is featurally closer to top than all segments it dominates. Within the Splitting theory, insertion of some segment  $\alpha$  which appears on a lower tier in this lattice implies that any segments which dominate  $\alpha$  directly or indirectly have to be blocked. Thus, if [ɣ] is inserted, then vocalic glides must be blocked in the same environment. If [k] is inserted, all of glides and [ɣ x g] have to be blocked. If splitting yields [t], then all other segments in the lattice have to be blocked.

(32) Feature closeness lattice for vowels and some consonants



To summarize, some consonants are featurally closer to the vowels than others. The consonants which are closer to the vowels are more likely to be inserted, since the theory imposes less conditions on languages which have insertion of these consonants.

These predictions about the relationship between the inserted consonants and the inventory are quite general – they apply in any output-driven system. The rest of this section illustrates how feature closeness relations translate into ranking conditions on epenthesis in the output-driven constraint system introduced so far. This system of constraints includes the blocking constraints \*SEG. The other constraints included in the system are limited to the basic constraint set: the faithfulness constraints IDENT-F, MAX, UNIFORMITY, INTEGRITY, and the markedness constraint ONSET.

In order to focus on rankings responsible for particular epenthetic consonants, I will assume that in examples to be discussed below splitting is the preferred way of resolving hiatus. This is achieved by the ranking ONSET, MAX, UNIFORMITY >> INTEGRITY, as illustrated for Faroese data in section 2.4.2.1. The crucial ranking conditions on IDENT-F and \*SEG constraints will account for both the inserted consonants and the inventory.

Assume that in some language  $L_g$ , the input /ti<sub>1</sub>a<sub>2</sub>/ maps to [ti<sub>1</sub>g<sub>1</sub>a<sub>2</sub>] (33). This mapping implies that the constraints \*g, INTEGRITY and IDENT for [consonantal], [sonorant], and [continuant] may all be violated in order to satisfy ONSET – these are the



ranking conditions necessary for splitting (33a). Furthermore, the competing candidates where [j] or [ɣ] would be inserted provide crucial ranking information.

(33) Splitting yields [g] in language  $L_g$

	/ti <sub>1</sub> a <sub>2</sub> /	ONSET	*ɣ	*j	Id-[cns]	Id-[son]	Id-[cnt]	*g	INT
☞ a.	ti <sub>1</sub> g <sub>1</sub> a <sub>2</sub>				1	1	1	1	1
b.	ti <sub>1</sub> a <sub>2</sub>	W1			L	L	L	L	L
c.	ti <sub>1</sub> j <sub>1</sub> a <sub>2</sub>			W1	L	L	L	L	1
d.	ti <sub>1</sub> ɣ <sub>1</sub> a <sub>2</sub>		W1		1	1	L	L	1

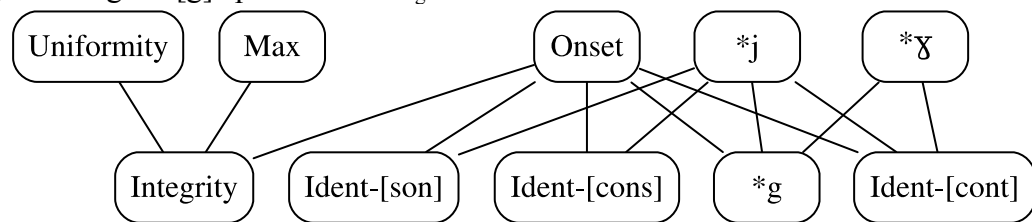
Consider for instance the candidate (33d). Because [ɣ] is closer to /i/ than [g], splitting from /i/ to [g] implies that the constraint \*ɣ, must dominate IDENT-[continuant] and \*g. However, the feature [continuant] is precisely the difference between [ɣ] and [g] and therefore an input /ɣ/ would necessarily be mapped to [g] under this ranking. This is illustrated in (34).

(34)  $L_g$  necessarily avoids [ɣ] and maps /ɣ/ to [g]

	/ɣa/	ONSET	*ɣ	*j	Id-[cns]	Id-[son]	Id-[cnt]	*g	INT
☞ a.	ga						1	1	
b.	ɣa		W1				L	L	

To summarize, within the Splitting theory the ranking that produces epenthetic [g] from /i/ necessarily implies that any segment that is featurally closer to /i/ than [g] maps to [g]. The complete ranking for language  $L_g$  is given in (35), and this ranking implies that  $L_g$  should lack both [j] and [ɣ].

(35) Ranking for [g] epenthesis in  $L_g$



This brief illustration is representative of a much more general result. The exact constraint set does not affect the validity of Feature Closeness Principle, so long as the system as a whole is Output-Driven. The fact that the closest available segment is always the result of splitting holds up in many OT systems, unless some constraints allow for non-output-driven behavior.

Thus, given the particular featural assumptions adopted here, the Splitting theory leads us to expect that we might find epenthetic [ɣ] or perhaps [ŋ] (especially from nasalized vowels). These segments could occur as epenthetic in languages where vocalic glides are either excluded altogether or blocked in some context. On the other hand, the conditions under which an epenthetic [t] could occur are much more stringent, and therefore the Splitting theory predicts that [t]-epenthesis should be extremely rare.

### 2.7.5 Constraints and output-drivenness

Whether the proposed constraints preserve the output-driven nature of the map will have a profound effect on the predictions of the theory. Thus certain kinds of constraints have to be non-existent, in order for the output-driven nature of the system to be preserved and for the Feature Closeness Principle to hold. It is instructive to consider what kinds of constraints could lead to non-output-driven mappings. Of particular interest here are some alternative formulations of the faithfulness constraints.

One relevant class of constraints is essentially a mirror image of \*SEG. Assume for example, that feature changes to each input segment are prohibited by a designated IDENT-SEG constraint. IDENT-t is violated if an input /t/ is changed, Ident-i is violated for input /i/ etc.

- (36) IDENT-SEG: let  $\alpha$  be a segment in the input and  $\beta$  be a correspondent of  $\alpha$  in the output. Assign a violation if  $\alpha$  is a segment  $S$ , and  $\beta$  is not identical to  $\alpha$

The IDENT-SEG constraints can produce a situation where a relatively large featural change happens in a language without smaller changes also being grammatical. Consider, for example the language in (37). The mappings (37a-b) are grammatical, but the mapping in (37c) is ungrammatical.

- (37) Non-output-driven language  $L_1$

	Grm	Input	Output	Disparities
a.	✓	/g/ →	t	place, voice
b	✓	/d/ →	d	none
c.	*	/d/ →	t	voice

The mapping in (37a) changes an input /g/ to [t] thus involving disparities in place and voicing. If the language was output-driven, an input which differs from /t/ just in voicing would also have to map to [t]. However, this is not what happens in  $L_1$ : an input /d/ is preserved because of a high-ranking IDENT-d.

The tableau in (38) introduces the ranking conditions for the mapping /g/ → [t]. The constraint \*g dominates the IDENT constraints on place and voicing as well as IDENT-g. Changing just place or just voicing in response to \*g is impossible because \*d and \*k are also high-ranked

(38) /g/ → [t] mapping in L<sub>1</sub>

	/g/	Id-d	*g	*k	*d	Id-[place]	Id-[voice]	Id-g	*t
☞ a.	t					1	1	1	1
b.	g		W1			L	L	L	L
c.	d				W1	1	L	L	L
d.	k			W1		L	1	L	L

Observe, however, that the constraints IDENT-d is satisfied by all candidates in (38), because the input has no /d/. Therefore (38) yields no ranking information about IDENT-d. If IDENT-d is high-ranked, it will preserve the voicing and other features of an input /d/, thus avoiding a smaller change in a grammar where a larger change is allowed. This is illustrated in (39): any changes to an input /d/ are prohibited by high-ranked IDENT-d.

(39) /d/ → [d] mapping in L<sub>1</sub>

	/d/	Id-d	*g	*k	*d	Id-[place]	Id-[voice]	Id-g	*t
☞ a.	d				1				
b.	t	W1			L		W1		W1
c.	k	W1		W1	L	W1	W1		
d.	g	W1	W1		L	W1			

To summarize, IDENT-SEG constraints can easily produce non-output-driven patterns. Therefore the Feature Closenes Principle in (29) will only hold if there are no IDENT-SEG constraints in Con.

Another example related to splitting comes from existential IDENT constraints proposed by Struijke (2000). Within the theory proposed here, IDENT constraints are violated once per each pair of non-identical correspondents. Therefore, when a vowel splits as in /i<sub>1</sub>/ → [j<sub>1</sub>i<sub>1</sub>] it is not enough for the nucleus correspondent [i] to keep the features of the input. The margin correspondent [j] is also required to be identical to the input by the IDENT constraints. Unlike the IDENT-F constraints proposed here, existential IDENT constraints require that each input feature of a segment correspond to an identical feature value in *some* correspondent output segment. The formulation of existential IDENT in (40) is adapted from Struijke (2000: 23).

(40)  $\exists$ IDENT-F: let  $\alpha$  be a segment in the input. Assign a violation if  $\alpha$  has no output correspondent  $\beta$  s.t.  $\alpha$  is [ $\gamma$ F], and  $\beta$  is [ $\gamma$ F]

The theory of existential faithfulness allows otherwise impossible featural changes if they occur in conjunction with splitting. This is illustrated by the language L<sub>2</sub> in (41) where an /ia/ surfaces as [ika] via splitting but an input /ixa/ does not map to [ika].

(41) Non-output-driven language L<sub>2</sub>

	Grm	Input	Output	Disparities
a.	✓	/i <sub>1</sub> a <sub>2</sub> / →	i <sub>1</sub> k <sub>1</sub> a <sub>2</sub>	splitting, [sonorant], [continuant], [cons] ...
b.	✓	/i <sub>1</sub> x <sub>2</sub> a <sub>3</sub> / →	i <sub>1</sub> x <sub>1</sub> a <sub>2</sub>	none
c.	*	/i <sub>1</sub> x <sub>2</sub> a <sub>3</sub> / →	i <sub>1</sub> k <sub>1</sub> a <sub>2</sub>	voice

The mapping /i<sub>1</sub>a<sub>2</sub>/ → [i<sub>1</sub>k<sub>1</sub>a<sub>2</sub>] in (41a) introduces the splitting disparity as well as a number of featural disparities in features such as [sonorant], [continuant], [consonantal] etc. This is because the input /i/ is [−consonantal, +sonorant, +continuant] whereas the output [k] has the opposite values: [+consonantal, −sonorant, −continuant]. On the other hand, a mapping which would just introduce a disparity in continuancy /i<sub>1</sub>x<sub>2</sub>a<sub>3</sub>/ → [i<sub>1</sub>k<sub>2</sub>a<sub>3</sub>] (41c) is ungrammatical because such a mapping, unlike (41a), would violate the constraint  $\exists \text{IDENT-}[\text{continuant}]$ .

The ranking conditions implied by the mappings in (41) are given in (42). The input /i<sub>1</sub>a<sub>2</sub>/ surfaces as [i<sub>1</sub>k<sub>1</sub>a<sub>2</sub>] because epenthetic options which are closer to vowels than [k] are penalized by high-ranked \*SEG constraints (42a).

(42) A possible-ranking with existential IDENT derives non-output driven language L<sub>2</sub>

## a. Featural changes possible with splitting

	/i <sub>1</sub> a <sub>2</sub> /	$\exists \text{Id-}[\text{cont}]$	ONS	*x	*g	*y	*j	*k	INT
☞ a.	i <sub>1</sub> k <sub>1</sub> a <sub>2</sub>							1	1
b.	i <sub>1</sub> a <sub>2</sub>		W1					L	L
c.	i <sub>1</sub> j <sub>1</sub> a <sub>2</sub>						W1	L	1
d.	i <sub>1</sub> x <sub>1</sub> a <sub>2</sub>			W1				L	1
e.	i <sub>1</sub> g <sub>1</sub> a <sub>2</sub>				W1			L	1
f.	i <sub>1</sub> y <sub>1</sub> a <sub>2</sub>					W1		L	1

## b. Featural changes impossible otherwise

	/i <sub>1</sub> x <sub>2</sub> a <sub>3</sub> /	$\exists \text{Id-}[\text{cont}]$	*x	*k	INT
☞ a.	i <sub>1</sub> x <sub>2</sub> a <sub>3</sub>		1		
b.	i <sub>1</sub> k <sub>2</sub> a <sub>3</sub>	W1	L	W1	

Crucially, the mapping in (42a) has no implications for the ranking of  $\exists \text{IDENT-}[\text{continuant}]$ . Therefore the existential constraint can be high-ranked and prohibit simpler mappings in a language where more complex ones are allowed – this is illustrated in (42b).

The Splitting theory puts a lot of emphasis on faithfulness and on IDENT-F constraints in particular. The predictions of the theory would be very different, if the IDENT constraints were existential (Struijke, 2000) or referring to whole segments. Both of these constraints have independent properties which lead to non-output-driven patterns.

### 2.7.6 Summary: blocking and possible epenthetic consonants

Blocking patterns involve some markedness constraint that blocks the featurally faithful insertion. In all of these patterns, the insertion of homorganic glides next to high vowels is blocked, at least in some contexts. The typology of blocking is determined by the constraints which block the featurally identical minimal epenthesis of glides.

The Splitting theory makes precise predictions regarding the possible segments that may arise when the featurally identical glides are blocked. In particular, the inserted segments in these cases must be the segments of the language which are featurally the closest available to the input vowel. Thus, if some segment  $\alpha$  results from splitting in the language in question, all segments which are featurally closer to the respective input vowel must be blocked.

The Splitting theory thus establishes a tight link between the inventory of the language and the consonants which may be inserted in that language. However, it is not the case that epenthetic consonants in each language must come from a pre-defined set. If certain segments or certain mappings are actively preferred in a certain position, then the epenthetic consonants will also obey this preference. Therefore, the Splitting theory allows for cases where epenthetic consonants have a quality which does not occur in other environments in the language. Some relevant positional constraints will be discussed in Chapter 5 (positional faithfulness) and Chapter 6 (positional markedness).

## 2.8 Splitting and other theories

The differences between the Splitting theory and the Insertion theories will be explored throughout the dissertation. In general, the Splitting theory is more restrictive than other theories, because it allows fewer operations while leaving the constraints essentially unchanged.

Within the Insertion theories, epenthetic quality is influenced by two kinds of – the general markedness constraints promote the 'default' epenthetic consonants (Lombardi, 2002; de Lacy, 2006; Morley, 2013), while some other constraints require that epenthetic consonants be similar to the neighboring segments. Thus, Kitto & de Lacy (1999) propose that epenthetic quality is regulated by faithfulness constraints, but in this theory the relevant constraints are defined over an entirely new correspondence domain. The epenthetic segment has a correspondent in the output, rather than in the input. Similarity between epenthetic segments and their non-epenthetic neighbors is therefore due to faithfulness constraints on output correspondence. In contrast, in Splitting Theory, similarity follows from having a common input.

De Lacy (2006) uses AGREE constraints, requiring featural agreement between a consonant and a nearby vowel, to account for epenthetic quality. Similarly, autosegmental approaches account for similarity between epenthetic consonants and neighboring vowels via feature-sharing. For example, a number of theories employ DEP-feature constraints, which can be satisfied by spreading features instead of inserting them (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011). In these theories, epenthetic similarity is due to emergent assimilation. In contrast, in Splitting Theory emergent processes cannot affect epenthetic segments.

While the existence of general markedness is not contested within the Splitting theory, the similarity requirements on epenthetic segments follow from the IO-IDENT constraints here. The special mechanisms accounting for epenthetic similarity, such as

DEP-feature or OO-correspondence, become redundant within Splitting theory. The faithfulness constraints that are responsible for epenthetic quality are the same as the constraints regulating featural alternations in the language. Consequently the epenthetic segments are similar to their input for the same reason that other segments are.

The theoretical differences described above amount to an interesting difference in predictions. The Splitting theory predicts that epenthetic consonants will undergo processes and be subject to requirements that apply to underlying consonants, and that epenthetic consonants will *not* undergo processes that underlying consonants do not undergo. On the other hand, within the Insertion theories epenthetic consonants may be affected by ‘emergent’ processes or requirements – the general markedness pressures which are not apparent in the language as a whole.

This prediction follows from the assumption that epenthetic quality is regulated by Input-Output faithfulness. In terms of Input-Output faithfulness, epenthetic consonants are identical to non-epenthetic consonants: both have input correspondents, and both are subject to IO-IDENT constraints. Thus if an epenthetic consonant undergoes a general change under a pressure from some markedness constraint, a ranking  $M \gg \text{IDENT}$  is implied, and this same ranking predicts that a featural alternation will be operative on the segments with the relevant features in a given language.

The general predictions of the Splitting theory can be illustrated as follows. Suppose we discover a case of epenthesis where [v], and not [w], is epenthesized before round vowels: e.g. /ou/ → [ovu], \*[owu]. [w] is more faithful to /u/ than [v] is; specifically, [v] violates IDENT-[consonantal] and IDENT-[place] (recall that all vocalic glides are dorsal (Levi, 2004, 2008)). Therefore, a constraint that is violated by [w] and not [v] (call it \*w) must outrank all constraints that would favor the /u/ → [wu] mapping: i.e. IDENT-[cons] and IDENT-[place]. However if \*w outranks these faithfulness constraints, then [w] would be banned everywhere (or at least in the same environment that [v] appears in): underlying /owu/ must also surface as [ovu].

There are a number of cases where epenthetic consonants are affected by processes and restrictions which are otherwise active in the language as a whole. As discussed in 2.4, in Faroese [w] and [v] are in complementary distribution, with [v] appearing after non-high vowels and [w] elsewhere. This allophony is also manifested in epenthetic glides (Anderson, 1969, 1972; Thráinsson *et al.*, 2004; Árnason, 2011). In Woleaian the general restriction on high vowel + glide sequences also restricts consonant epenthesis (Sohn, 1971, 1975; Sohn & Tawerilmang, 1976). In Cuzco Quechua the consonant inserted word-initially alternates between [ʔ] and [h] according to the general laryngeal co-occurrence restrictions of the language (Rowe, 1950; Carenko, 1975; Cushihuamán, 1976; Parker & Weber, 1996; Parker, 1997). These cases conform to the predictions of the Splitting theory.

However, there are no cases where emergent processes influence epenthetic consonant quality. For example, there are no reported cases where a language contrasts [t] and [d] intervocalically, but the epenthetic consonant shows an emergent intervocalic voicing effect, showing up as [d]. Patterns of this sort are predicted by Insertion theories of epenthesis (see section 2.8.1).

Consider for example the constraint \*VTV which bans voiceless obstruents intervocalically and motivates intervocalic voicing. Within the Splitting theory, this constraint does not contribute towards deriving the epenthetic [d] pattern. The epenthetic

consonants are protected by faithfulness, and therefore the Principle of Feature Closeness still holds. This is illustrated in the tableau in (43). No matter where the constraint \*VTV is ranked, candidates (43c-e) cannot win because they are harmonically bounded. Even if \*VTV is ranked above all other constraints, the most faithful output showing homorganic glide epenthesis emerges as a winner.

(43) Splitting theory and intervocalic voicing

	/tuo/	ONS	*VTV	ID-[place]	ID-[cons]	INT
☞ a.	tuwo					1
b.	tuo	W1				L
c.	tudo			W1	W1	1
d.	tuʔo			W1		1
e.	tuto		W1	W1	W1	1

### 2.8.1 Emergent process effects on epenthetic consonants

Insertion theories of epenthesis claim that epenthetic segments are not protected by faithfulness, and thus their quality is determined by markedness constraints. Such theories, when set within Optimality Theory, predict that epenthetic quality can be affected by ‘emergent’ restrictions and processes (McCarthy & Prince, 1994).

For the sake of argument, the Insertion theory of epenthesis presented in de Lacy (2006) is discussed below. Other OT theories yield the same general result (Lombardi, 2002; Rice, 2007).

In Insertion theories, inserting a consonant violates the constraint DEP-C. The selection between epenthetic glides vs. glottal stop can be handled by the markedness constraints \*CONTINUANT penalizing [+continuant] segments (\*CONT for short) and AGREE which requires feature sharing between consonants and neighboring vowels. Epenthetic [ʔ] is assumed to be a true consonant, and it is favored by place the markedness constraint \*{KPT} penalizing non-glottal place of articulation. The tableau in (44) shows that an epenthetic [d] can be derived in this theory.

(44) [d] epenthesis and \*VTV in a markedness-based theory

	/tuo/	ONS	*CONT	*VTV	*{KPT}	AGREE	DEP-C
☞ a.	tudo		2		2	1	1
b.	tuo	W1	2		L1	L	L
c.	tuʔo		2	W1	L1	1	1
d.	tuwo		W3		2	L	L

In this tableau a well-attested markedness pressure – \*VTV – blocks the unmarked epenthetic option ([ʔ]) and leads to the selection of an unattested epenthetic consonant.

Patterns of this sort are not restricted to languages which would otherwise have unattested or rare mappings. In fact, the tableau in (44) does not imply that any of the constraints \*VTV, AGREE or \*CONT should affect non-epenthetic outputs in the same

language. All of these constraints could well be dominated by faithfulness, and the language could have intervocalic voiceless obstruents (IDENT-[voice], MAX >> \*VTV), continuants (IDENT-[cont], MAX » \*CONT) and non-agreeing sequences of consonants and vowels (IDENT, MAX >> AGREE). In other words, any system could have epenthetic [d], even those that do not have an overt process of intervocalic voicing.

To summarize, the markedness-based theory of epenthesis creates the so-called too-many-solutions or too-many-repairs problems (Pater, 2003; Blumenfeld, 2006; Van Oostendorp, 2007; Steriade, 2008). These problems arise because any well-motivated universal markedness constraint can contribute to selecting the epenthetic consonant. On the other hand, no such problems arise within the Splitting theory since any markedness constraint relevant for epenthetic consonants will have to dominate the input-output IDENT constraints. Finally, the problem arises regardless of the particular formal mechanism that the theory employs to capture similarity requirements on epenthetic consonants, be it AGREE (de Lacy, 2006), DEP-feature (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; b) or Output-Output correspondence (Kitto & de Lacy, 1999).

Within the Splitting theory, the processes affecting the inserted consonants must be otherwise applicable to margin vowels in the given language. Thus the general markedness constraints can affect the inserted consonants only if they are active in the language as a whole. On the other hand, within the Insertion theories we expect to find cases of epenthesis where the epenthetic consonant is selected by some general markedness pressure, which is not otherwise operative in the language as a whole.

## 2.9 Conclusion

This chapter has introduced the core concepts of the Splitting theory. Gen has a splitting operation, and no insertion operation for consonants. The splitting operation is binary and local, so that  $/\alpha_1/ \rightarrow [\beta_1 \gamma_1]$ , but never  $/\alpha/ \rightarrow [\beta_1 \gamma_1 \delta_1]$ , or  $/\alpha_1 \chi/ \rightarrow [\beta_1 \chi \gamma_1]$ .

Certain theories of segmental features provide a more explanatorily adequate account of the consonant epenthesis patterns. Here, the Revised Articulator Theory is adopted (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004), along with the idea that there are both vocalic and consonantal glides (Hume, 1995; Levi, 2004, 2008 a.o.). The splitting approach presents a highly restrictive theory of epenthesis. This approach predicts that in any given environment the inserted segment should always be the closest possible to an input vowel in the given language. Thus there are no consonants which are inherently designated as impossible in epenthesis. However insertion of consonants which are featurally distant from the vowels (e.g. voiceless stops) is practically impossible, since every language will have some segments which are closer to the vowels.

The theory predicts that the minimal pattern of homorganic glide epenthesis next to the high vowels is central to the typology. The existing patterns of epenthesis may involve generalization of minimal epenthesis to other environments (*extended patterns*) or blocking minimal epenthesis in some environments (*blocking patterns*). The patterns of blocking and extension obey certain implicational relations. Thus if a language has consonant insertion next to non-high vowels, it will also have glide epenthesis next to high vowels (unless glide insertion is blocked). Furthermore if glide epenthesis next to high vowels is blocked in some language and context, then it will also be blocked next to non-high vowels in the same language and context.



Finally, within the Splitting theory, the processes affecting the inserted consonants must be otherwise applicable to margin vowels in the given language.

## Chapter 3. Extensions of minimal epenthesis

### 3.1 Introduction

Chapter 2 identified the pattern of homorganic glide epenthesis next to high vowels as central to the typology of splitting. This pattern involves the most faithful epenthesis possible: only INTEGRITY is violated.

This chapter considers the cases where the most faithful minimal pattern of epenthesis is extended to environments with non-high vowels. There are no perfectly faithful consonant counterparts for non-high vowels, with the consequence that a variety of epenthetic options are available. Such cases are ‘extensions’ of the minimal pattern in the sense that they all include the minimal pattern, discussed in 3.2.

Another fundamental prediction of the Splitting theory is that the quality of segments inserted in extended patterns may vary depending on the ranking of IDENT constraints and the ranking of markedness constraints which (among other things) restrict the language inventory. These predictions are explored in sections 3.3-3.5. These sections identify and illustrate the ranking conditions necessary for a particular segment to be inserted next to non-high vowels.

This chapter focuses mostly on the word-medial hiatus resolution patterns because epenthesis patterns at edges involve additional blocking constraints (see Chapter 6). Finally, another family of blocking constraints determines which of the two vowels in vowel hiatus splits. These blocking constraints are discussed in Chapter 4.

### 3.2 Overview of the extensions of minimal epenthesis

From the point of view of the Splitting theory, the most faithful possible epenthesis pattern inserts glides next to homorganic high vowels. This pattern is dubbed *minimal epenthesis* in Chapter 2, and it occurs in Faroese.

As argued in Chapter 2, only high vowels have glide counterparts which are featurally completely identical. Therefore, when non-high vowels split, the result of splitting necessarily violates both INTEGRITY and IDENT. For example, as illustrated in table (1) inserting the glide [j] next to the high vowel [i] incurs no violations of IDENT, but splitting any non-high vowels to yield [j] violates various IDENT constraints. Note that this table merely compares various possible candidates without indicating the winner or the ranking.

(1) IDENT violations incurred by a split to [j] in different vowel contexts

	IDENT-[high]	IDENT-[low]	IDENT-[bk]	IDENT-[rnd]
a. /i/ → [ji]				
b. /e/ → [je]	1			
c. /a/ → [ja]	1	1	1	
d. /o/ → [jo]	1		1	1

Extended patterns of epenthesis arise when onsets are required for at least some non-high vowels. Since splitting non-high vowels violates IDENT, this means that in all extended

patterns some markedness constraint that triggers epenthesis must dominate some IDENT constraints as well as INTEGRITY.

Based on these faithfulness asymmetries, the Splitting theory predicts that each extended pattern must include the minimal pattern, except in the situation when there is blocking such as markedness constraints blocking [ji] and [wu] (see Chapter 4). Consequently, every language that inserts a consonant next to a non-high vowel also inserts a glide next to a high vowel unless there is blocking.

The predictions of the Splitting theory are instantiated in a subset of cases in the results of the typological survey (see Appendix B). In a number of robust cases of epenthesis glide insertion next to high vowels coexists with insertion next to non-high vowels. The relevant languages include, for example, Dutch, Farsi, Woleaian, and Boston English.

On the other hand, none of the constraints proposed in this dissertation has the capacity to block splitting only for high vowels (see Appendix A for a complete list of constraints). Therefore, the predicted range of the insertion patterns does not include a language which would have epenthesis next to non-high vowels but faithful hiatus with high vowels. No such languages were found in the typological survey, although this result can only be considered preliminary. The present typological survey was not designed to test this particular prediction, since it was focused on the epenthetic inventory rather than the fate of different vowel sequences.

Since the extended patterns of epenthesis by definition do not block high vowel splitting, many of these patterns can be analyzed with the basic constraint set introduced in Chapter 2, i.e. with just faithfulness constraints and the constraint ONSET. In other cases the basic constraint set will need to be expanded with additional trigger constraints such as FINAL-C (section 3.4) and with additional markedness constraints selecting the consonants to be inserted next to non-high vowels (sections 3.4 – 3.5).

An important consequence of the Splitting theory is that in addition to markedness, faithfulness constraints also influence the quality of consonants epenthesized next to non-high vowels. For example, glide epenthesis next to mid vowels violates IDENT-[high], but, as argued in the following sections, insertion of laryngeal approximants or a rhotic approximant in English satisfies this constraint, but violates other IDENT constraints. Thus while homorganic glides are epenthesized next to high vowels in all extended patterns, next to non-high vowels no inserted consonant is completely featurally identical to the vowel, and various inserted segments compete. The results of this competition are further illustrated in the following sections.

Finally, the Splitting theory restricts the range of possible segments that may be epenthesized next to non-high vowels in the extended patterns. The inserted segment must be the one most faithful to the input vowel, that satisfies the general markedness constraints of the language (see Chapter 2 for further discussion).

### 3.3 Extended patterns of glide epenthesis

This section considers the rankings that derive glide epenthesis next to non-high vowels. The constraint set assumed here will be limited to basic constraints, i.e. faithfulness constraints as well as ONSET. In section 3.3.4 additional constraints relevant to long vowels will be introduced.

Vocalic glides share major class features with vowels, but they may differ in tongue position features. It is also assumed here that all vocalic glides share the place specification Dorsal with all vowels (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004). The table in (2) compares the IDENT violations incurred by glide epenthesis next to some vowels (this is not a tableau, hence there is no winner and no ranking information).

(2) Faithfulness violations incurred by glide epenthesis next to non-high vowels

	IDENT-[high]	IDENT-[low]	IDENT-[bk]	IDENT-[rnd]
a. /i/ → [ji]				
b. /i/ → [wi]			1	1
c. /u/ → [ju]			1	1
d. /u/ → [wu]				
e. /e/ → [je]	1			
f. /e/ → [we]	1		1	1
g. /o/ → [jo]	1		1	1
h. /o/ → [wo]	1			
i. /a/ → [ja]	1	1	1	
j. /a/ → [wa]	1	1		1

This table illustrates several important predictions of the Splitting theory. These predictions are summarized in (3) below, and discussed in detail in the following sections.

(3) Predictions of the Splitting theory for glide epenthesis in non-high vowel contexts

- i) Glide epenthesis next to any non-high vowel violates IDENT-[high]. Therefore if glide insertion is extended to non-high vowels, the epenthesis-motivating markedness constraint (e.g. ONSET) must dominate IDENT-[high]
- ii) For high and mid vowels one of the inserted glides is more faithful than the other (2a-h). Consequently, unless some markedness constraint (e.g. \*ji/wu discussed in Chapters 2 and 4) has a blocking effect, glide epenthesis next to high and mid vowels will always be homorganic
- iii) Homorganic glide epenthesis next to mid vowels is more faithful than glide epenthesis next to low vowels. Therefore while languages that insert glides next to high and mid vowels are expected, there should be no languages which insert glides next to high and low (but not mid) vowels
- iv) For low vowels, none of the glides is more faithful than the other, and therefore we expect to find both [j] and [w] epenthesized in this context

Predictions (ii) and (iii) are illustrated in 3.3.1, and prediction (iv) is discussed in 3.3.2. Finally, section 3.3.3 considers the predictions with regard to other vowels, and section 3.3.4 concludes.

### 3.3.1 Glide epenthesis and mid vowels. The case of Dutch.

When one epenthesis pattern violates more faithfulness constraints than another, such a pattern will always be preferred in Splitting, unless there are blocking effects. For example, the mapping /e/ → [je] violates only IDENT-[high] whereas /e/ → [we] violates the IDENT constraints for [high], [back], and [round]. More generally, epenthesis of non-homorganic glides next to high and mid vowels is harmonically bounded within the basic constraint set. This is illustrated in (4) for the sequence /ea/. In all tableaux in this chapter, it is assumed that the first vowel splits – the constraints that determine which vowel splits are discussed in Chapter 4.

(4) Non-homorganic glide insertion is harmonically bounded next to high and mid vowels

/te <sub>1</sub> a <sub>2</sub> /	ID-[high]	ID-[back]	ID-[round]	INTEGRITY
a. te <sub>1</sub> j <sub>1</sub> a <sub>2</sub>	1			1
b. te <sub>1</sub> w <sub>1</sub> a <sub>2</sub>	1	W1	W1	1

Similarly if there are no blocking effects, the mappings /e/ → [je] and /o/ → [wo] violate more constraints than any glide epenthesis mappings next to low vowels. Splitting a mid vowel to yield a high glide only violates IDENT-[high], whereas splitting a low vowel to yield a high glide always violates at least IDENT-[high] and IDENT-[low]. For this reason if glide epenthesis occurs next to low vowels in an extended pattern, we also expect to find it next to high and mid vowels.

Both of these implicational relations (the predictions (ii) and (iii) in (3)) are illustrated in Dutch glide epenthesis (Zonneveld, 1978; Gussenhoven, 1980; Booij, 1995). The vowel inventory of Dutch is given in (5). The length/tenseness opposition can be analyzed based on either feature, and I assume here that length is phonemic.

(5) Dutch vowels

*Monophthongs:*

i: ɪ                      u: ʊ

y: ʏ

e: ɛ              ə              o: ɔ

ø:

a: ɑ

*Diphthongs:* ei, œy, au

Here I focus only on glide epenthesis in Dutch (Rosenthal, 1997b; Rubach, 2002), while the other hiatus repairs are discussed in Chapter 6 (glottal stop) and Chapter 9 ([n]). The suffix vowels are limited to [i ə], and thus the only vowel sequences that show alternations end in [i ə]. Foreign roots that could have underlying vowel sequences

exhibit the same pattern with regards to the glides (although in these cases the glides could synchronically be underlying).

Hiatus is resolved via glide epenthesis after high and mid vowels (6a-b). However, the vowel sequences starting with /a/ surface faithfully (6c). The inserted glide after round vowels is transcribed as [w] by Zonneveld (1978). However but Booij (1995) argues that the relevant glide is better transcribed as [ʋ], and this is the transcription adopted here for all cases.

(6) Hiatus resolution depends on the first vowel in Dutch

a. Glide epenthesis after a high vowel

- |      |              |  |
|------|--------------|--|
| /iə/ | /kni-ə/      | [ <sup>l</sup> kniʝə] ‘knees’            |
| /ui/ | /hɪndu-ismə/ | [hɪndu <sup>l</sup> ʋismə] ‘hinduism’    |
| /uə/ | /barbəkju-ə/ | [ <sup>l</sup> barbəkjuʋə] ‘to barbecue’ |

b. Glide epenthesis after a mid vowel

- |      |                |   |
|------|----------------|---|
| /ei/ | /fa:ri:ze:-is/ | [fa:ri <sup>l</sup> ze:ʝis] ‘pharisaic’ |
| /eə/ | /ze:-ə/        | [ <sup>l</sup> ze:ʝə] ‘seas’            |
| /oi/ | /e:ʝo:-ismə/   | [e:ʝo: <sup>l</sup> ʋismə] ‘egoism’     |
| /oə/ | /jydo:-ə/      | [ <sup>l</sup> jydo:ʋə] ‘to judo’       |

c. No epenthesis after a low vowel

- |      |              |                                    |
|------|--------------|------------------------------------|
| /ai/ | /pro:za:-is/ | [pro: <sup>l</sup> zais] ‘prosaic’ |
| /aə/ | /rumba-ən/   | [ <sup>l</sup> rumbaən] ‘to rumba’ |

Hiatus resolution in Dutch is more complex than suggested by (6). Schwa is always deleted before another vowel, and the quality of the glide after front rounded vowels /y: ʏ ø:/ is variable, at least in some dialects. The glides occurring after front rounded vowels will be discussed in 3.3.3 (see also Chapter 4).

Abstracting away from these complications, the basic pattern of glide epenthesis in Dutch illustrates two faithfulness relations that are significant in the Splitting theory (3): glide epenthesis next to mid vowels is more faithful than glide epenthesis next to low vowels, and homorganic glide epenthesis is more faithful than non-homorganic glide epenthesis.

An analysis of Dutch within the Splitting theory uses the ranking of ONSET over IDENT-[high] to motivate epenthesis after high and mid vowels. This situation is illustrated in (7) for the input /ze:-ə/ ‘seas’. Importantly, candidate (7c) is harmonically bounded, illustrating an instance of the general schema in (4). Because of this bounding effect, the competition in (7) yields no information about the relative ranking of IDENT-[back].

## (7) Glide epenthesis after mid vowels in Dutch

	/ze: <sub>1</sub> ə <sub>2</sub> /	ONS	ID-[back]	ID-[high]	INT
☞ a.	ze: <sub>1</sub> j <sub>1</sub> ə <sub>2</sub>			1	1
b.	ze: <sub>1</sub> ə <sub>2</sub>	W1		L	L
c.	ze: <sub>1</sub> w <sub>1</sub> ə <sub>2</sub>		W1	1	1

In Dutch, ONSET is dominated by IDENT-[low], and thus splitting a low vowel is prohibited, as illustrated in tableau (8).<sup>1</sup>

## (8) Low vowels do not split in Dutch

	/rumba <sub>1</sub> ə <sub>2</sub> n/	ID-[low]	ONS	ID-[high]	INT
☞ a.	rumba <sub>1</sub> ə <sub>2</sub> n		1		
b.	rumba <sub>1</sub> j <sub>1</sub> ə <sub>2</sub> n	W1	L	W1	W1
c.	rumba <sub>1</sub> w <sub>1</sub> ə <sub>2</sub> n	W1	L	W1	W1

The Splitting theory predicts that the opposite of Dutch is impossible: no language inserts glides next to low and high vowels, but not next to mid vowels. For there to be splitting of low vowels, ONSET must dominate the faithfulness constraints IDENT-[high] and IDENT-[low] as /a/→[ja] violates both of these IDENT constraints. However if ONSET dominates IDENT-[high], nothing prevents /e/ from splitting to [je] (or /o/ to [wo]).

The predicted relationship between low- and mid-vowel glide epenthesis follows because there is no IDENT-[F] constraint where F is a feature that low vowels and glides share but mid vowels and glides do not. For example if [a] and [j] shared feature [+F] but [e] and [j] did not, then IDENT-[F] could be used to block /e/→[je] while permitting /a/→[ja].

To summarize, within the Splitting theory glide epenthesis is more faithful in some context than others. These faithfulness asymmetries translate into predictions about the typology, and these predictions are instantiated in Dutch.

### 3.3.2 Glide epenthesis next to low vowels

Splitting a low vowel to yield a glide always violates the constraints IDENT-[high] and IDENT-[low]. However, whether other IDENT constraints are violated depends on the exact featural content of the vowel. For example, splitting of front low /æ/ to yield [jæ] does not violate either IDENT-[round] or IDENT-[back], and so /æ/→[jæ] is always preferred to /æ/→[wæ], which violates both of these constraints. The same point applies to splitting the back round /ɒ/ to [wɒ], so that /ɒ/→[wɒ] is always preferred to /ɒ/→[jɒ].

However, for some low vowels there is no ‘best’ choice of epenthetic glide – both [j] and [w] can be more faithful, depending on the ranking of IDENT constraints. For example, splitting the back low /ɑ/ to [ja] violates IDENT-[back] while /ɑ/→[wa] violates

<sup>1</sup> For input sequences like /a:i/ in (6c) a viable alternative would be to split the second vowel. This option is blocked by constraints discussed in Chapter 4.

IDENT-[round]. If IDENT-[back] outranks IDENT-[round], then /a/→[wa], but the opposite ranking yields /a/→[ja]. For some low vowels – specifically /a/ – there is no ‘most faithful’ glide.

Consequently, the theory predicts that languages may differ in whether they insert [j] or [w] next to these low vowels. Indeed, both kinds of languages appear in my sample. For example, Dakota has homorganic glide epenthesis next to high and mid vowels and [j] epenthesis next to low vowels (Shaw, 1980). Similarly, Woleaian inserts the palatal glide [j] between two low vowels if one of them is long (Sohn, 1971, 1975; Sohn & Tawerilmang, 1976).<sup>2</sup> This pattern coexists with homorganic glide epenthesis after high and mid vowels (9).

(9) Glide epenthesis in Woleaian

a. After high and mid vowels

/gasʌ-a/	[gasʌwɛ] 'build it'
/se-ali/	[sejaɭi] 'one thin piece'
/li:-a/	[li:jɛ] 'kill it'
/gaʌ-ai/	[gaʌwei] 'tell me'

b. After low vowels

/wa:-ali/	[wa:jaɭi] 'airplane'
/gʌla: + ai/	[gʌla:jai] 'know me'

In vowel sequences where the second vowel is high, hiatus is unresolved in Woleaian due to a blocking effect of the constraint on homorganic glide-vowel sequences (Kawasaki, 1982; see also Chapter 4). Hence, the vowel sequences in [gaʌwei] 'tell me' and [gʌla:jai] 'know me'. The examples in (9) also show evidence of a raising process that applies to underlying /a/ in certain environments (Sohn, 1971).

Within the Splitting theory, epenthetic [j] is selected over [w] next to /a/ because it shares the feature [–round] with its input source. Tableau (10) illustrates this for the form [wa:jaɭi] 'airplane'. The candidate (10c) could also be favored by the constraint IDENT-[back] if /a/ in Woleaian is specified [+back]. No data that would bear on backness specification of /a/ is available, but for the purposes of illustration I assume that Woleaian /a/ is [+back].

<sup>2</sup> Some previous accounts of Woleaian argue that glide epenthesis only occurs word-initially (Flack, 2007, 2009). However, a detailed study of the dictionary and grammar uncovered evidence supporting word-medial glide insertion in this language. Some examples are given in (9).



## (10) [j] epenthesis next to /a/ in Woleaian

	/wa: <sub>1</sub> a: <sub>2</sub> li/	ONS	ID-[rnd]	ID-[high]	ID-[low]	ID-[back]	INT
a.	wa: <sub>1</sub> j <sub>1</sub> a: <sub>2</sub> li			1	1	1	1
b.	wa: <sub>1</sub> a: <sub>2</sub> li	W1		L	L	L	L
c.	wa: <sub>1</sub> w <sub>1</sub> a: <sub>2</sub> li		W1	1	1	L	1

Finally, glide epenthesis in Woleaian does not occur in sequences of identical short vowels – these sequences surface as a long vowel. The special status of long vowels will be discussed in 3.3.4.

The Splitting theory predicts that [w] may also be inserted next to low vowels. This prediction is borne out in Chamicuro where [w] is inserted after /a/ while all other vocalic sequences are resolved by gliding (Parker, 1989, 1991, 1994, 1995, 2001, 2010).<sup>3</sup> Similarly, in Tamil word-medial hiatus is resolved by glide epenthesis, where the epenthesis glide is [v] with low vowels (Christdas, 1988; Wiltshire, 1998).<sup>4</sup> Glide insertion after vowel-final stems in Tamil is illustrated in (11a), compared to the same stems in isolation in (11b) and to consonant-final stems in (11c). Note that long vowels are only allowed in the first syllable in Tamil.

## (11) Glide epenthesis in Tamil

## a. Vowel-final stems

- /pɒli-ε/      [pɒlijε] ‘tiger-ACC’  
 /ta:tta-ε/      [tattavε] ‘grandfather-ACC’  
 /pɒra-a:/      [pɒra:va:] ‘pigeon-INTERROGATIVE’<sup>5</sup>

## b. Vowel-final stems show no glide in isolation

- [pɒli] ‘tiger’  
 [tatta] ‘grandfather’

## c. Consonant-final stems

- /ka:d-ε/      [ka:dε] ‘ear-ACC’

<sup>3</sup> However, the evidence for [w]-insertion in Chamicuro comes from only one personal prefix. Vowel deletion applies with suffixes (Parker, 1989, fn8). It could be that the relevant prefix has a special phonological process associated with it, or a latent segment (see Chapter 9).

<sup>4</sup> The glide-zero alternations are analyzed as deletion by Christdas (1988) but as insertion in Wiltshire (1998). In addition to analytical differences (e.g. Chirtdas’s analysis relies on morpheme structure constraints which are not used in the OT approach of Wiltshire), there may be a dialectal difference for some forms. In other words, the forms with underlying glides in relevant contexts may be robustly present in some dialects but absent or marginal in others. This was verified in my brief elicitation, for which I am grateful to Nagarajan Selvanathan.

<sup>5</sup> The two contrasting rhotics, viz. [r] vs. [ɾ] in Tamil, vary in their realization by dialect. This contrast has been studied from the phonetic as well as sociolinguistic point of view (Zvelebil, 1970; Narayanan *et al.*, 1996, 1999; McDonough & Johnson, 1997; Schiffman, 2000)

Within the Splitting theory, [v] insertion next to /a/ can be captured by assuming that the low vowel is back in Tamil, as is [v], hence [v]-epenthesis satisfies IDENT-[back]. Booij (1995) also analyzes the Dutch glide [v] as phonologically [+back].

The analysis of [v]-insertion next to /a/ is illustrated in (12) with a hypothetical input /tae/, which is modeled on [tattavɛ] ‘grandfather-ACC’ in (11a). As in the other tableaux, I assume here that it is always the first vowel that splits, the relevant constraints will be discussed in Chapter 4.

(12) [v] epenthesis next to /a/

	/ta <sub>1</sub> e <sub>2</sub> /	ONS	ID-[bk]	ID-[rnd]	ID-[high]	ID-[low]	INT
✖ a.	ta: <sub>1</sub> v <sub>1</sub> e <sub>2</sub>			1	1	1	1
b.	ta: <sub>1</sub> e <sub>2</sub>	W1		L	L	L	L
c.	ta: <sub>1</sub> j <sub>1</sub> e <sub>2</sub>		W1	L	1	1	1

To summarize, the Splitting theory predicts that both [j] and [w] may be epenthesized next to low vowels that are [–round, +back] (e.g. [a ɔ]). This prediction is confirmed by glide insertion in Dakota, Woleaian, Tamil, and Chamicuro.

### 3.3.3 Other vowels

For expositional purposes, the preceding discussion has focused on the most common vowels /i e a o u/. The Splitting theory makes predictions about glide epenthesis next to other vowels, too. In principle if there is no blocking, the front round glide [ɥ] should always be split from [y] as it is more faithful to [y] than [j], and the back unround glide [ɯ] should be split from the back unround vowel [u]. If glide epenthesis is extended to mid vowels, one would expect [ɥ] from [ø] and [ɯ] from [ɤ].

However, the glides [ɥ ɯ] violate constraints on [round] and [back] feature co-occurrence. Therefore blocking often occurs with these glides – they are commonly excluded from inventories. The respective vowels [y ɯ] also occur with a comparatively small frequency (Maddieson, 1984). Consequently, opportunities to observe splitting of /y ɯ/ into [ɥy ɥɯ] are very small.

One illustrative case occurs in Dutch, where the glide [ɥ] is inserted after front rounded vowels (Gussenhoven, 1980; Booij, 1995). This is illustrated in (13), from Booij (1995).<sup>6</sup>

<sup>6</sup> As pointed out by Booij (1995: 66) and Marc van Oostendorp (p.c.), the situation may be more complex than portrayed in (13). Some words seem to allow either [j] or [ɥ], and some cases of [ɥ] may be better transcribed as [w] (Zonneveld, 1978). Here the analysis focuses on the ranking that generates [ɥ]; free variation can be captured by a variable ranking of IDENT constraints with respect to a constraint against front rounded vocalic margins.

## (13) Glide epenthesis next to front rounded vowels in Dutch

/fɔndy:-ən/      [fɔn'dy:ɥən] 'to fondue'

/rø:-ən/      ['rø:ɥən] 'dogs'

This epenthesis pattern is exactly as predicted by Splitting theory since the front rounded glide occurs only next to front rounded vowels.

**3.3.4 Sequences of identical vowels: the constraints on long vowels**

Sequences of identical vowels behave in a special way with regard to glide epenthesis. For non-identical vowels, faithful realization of vowel sequences often leads to a violation of ONSET (Rosenthal, 1997b; Casali, 1998). However, for sequences of identical vowels, underlying sequences like /aa/ and /ii/ can be mapped both to long vowels ([a:, i:]) and to heterosyllabic sequence of vowels ([a.a], [i.i]), although these realizations are only rarely distinguished in a given language (cf. Churchward, 1953). Although these two realizations probably differ in their faithfulness violations, the exact treatment of this difference is irrelevant for the present purposes. I will therefore assume (somewhat simplifying, of course), that both of these are faithful realizations of the underlying sequences of identical vowels. The heterosyllabic realization is penalized by ONSET, while the constraint \*LONG prohibits the long vowel outcome. Thus the constraint \*LONG formulated in (14) is relevant to the treatment of the identical vowel sequences.

## (14) \*LONG: assign a violation for each long vowel

To illustrate, sequences of underlying identical short vowels in Woleaian surface as a long vowel (15b). Glide epenthesis applies to non-identical vowel sequences, as shown in (9) above. Finally, two identical vowels trigger glide epenthesis if one of them is long (15b).

## (15) Sequences of identical vowels in Woleaian

## a. [j] inserted after a long vowel

/wa:-ali/      [wa:jali] 'airplane'

/gʷla:-ai/      [gʷla:jai] 'know me'

## b. Two short vowels surface as a long vowel

/ga-ama:/      [ga:ma] 'make him familiar with it'

/ga-atʷ:/      [ga:tʷ] 'make him excited'

These patterns show that the constraint \*LONG is relatively low-ranked in Woleaian, allowing long vowels on the surface. However, input length is protected by the constraint MAX-μ in (16) which penalizes shortening of an input long vowel.

## (16) MAX-μ: assign a violation for each input mora which does not have a correspondent in the output

Hiatus resolution in sequences of identical vowels in Woleaian is illustrated in (17) where I abstract away from the effects of word-final vowel devoicing and shortening. All candidates in (17a) satisfy MAX- $\mu$  and all candidates in (17b) violate \*LONG.

(17) Treatment of the sequences of identical vowels in Woleaian

a. Two short vowels

/ga <sub>1</sub> a <sub>2</sub> ma/	ONS	MAX- $\mu$	ID-[high]	ID-[low]	INT	*LNG
☞ a. ga <sub>1</sub> <sub>1,2</sub> ma						1
b. ga <sub>1</sub> a <sub>2</sub> ma	W1					L
c. ga <sub>1</sub> j <sub>1</sub> a <sub>2</sub> ma			W1	W1	W1	L

b. One of the vowels is long

/wa <sub>1</sub> a <sub>2</sub> li/	ONS	MAX- $\mu$	ID-[high]	ID-[low]	INT	*LNG
☞ a. wa <sub>1</sub> j <sub>1</sub> a <sub>2</sub> li			1	1	1	1
b. wa <sub>1</sub> a <sub>2</sub> li	W1		L	L	L	1
c. wa <sub>1,2</sub> li		W1	L	L	L	1

To summarize, sequences of identical vowels exhibit special behavior with regard to glide epenthesis, since these sequences may be realized as a long vowel.

### 3.3.5 Summary

This section identified and illustrated the following predictions of the Splitting theory for splitting the vowels /i e u o a/:

(3) Predictions of the Splitting theory for glide epenthesis

- i) Glide epenthesis next to any non-high vowel violates IDENT-[high]. Therefore if glide insertion is extended to non-high vowels, the epenthesis-motivating markedness constraint (e.g. ONSET) must dominate IDENT-[high]
- ii) For high and mid vowels one of the inserted glides is more faithful than the other (2a-h). Consequently, unless some markedness constraint (e.g. \*ji/wu) has a blocking effect, glide epenthesis next to high and mid vowels will always be homorganic
- iii) Homorganic glide epenthesis next to mid vowels is more faithful than glide epenthesis next to low vowels. Therefore while languages that insert glides next to high and mid vowels are expected, there should be no languages which insert glides next to high and low (but not mid) vowels
- iv) For low vowels, none of the glides is more faithful than the other, and therefore we expect to find both [j] and [w] epenthesized in this context

The predictions with regard to other vowels are harder to assess because the relevant systems are much more rare. Finally, sequences of identical vowels exhibit a special

behavior with regard to glide epenthesis because these sequences can be realized as a long vowel.

### 3.4 Extended epenthesis of other consonants: rhotics in English

Section 3.3 showed that glide epenthesis next to non-high vowels always violates IDENT-[high] within the Splitting theory. In fact, due to the lack of non-high glides, even non-glides can be split from non-high vowels in extended patterns.

The circumstances of non-glide epenthesis are clearly defined by the Splitting theory. First, IDENT-[high] must be ranked above other relevant IDENT constraints. Second, a language must have a [-high] segment which is close enough to the vowels to satisfy the other IDENT constraints. Both of these conditions are met in the dialects of English that exhibit [ɹ]-epenthesis. These dialects thus illustrate two important predictions of the Splitting theory. First, the inventory of inserted consonants is tightly related to the overall inventory of the language: unless positional restrictions are at work, a consonant can be epenthetic only if it is permitted in the surface inventory. Second, a greater variety of inserted consonants is permitted with non-high vowels, where no perfectly faithful glides exist. Finally, [ɹ]-epenthesis in English is interesting because it necessitates the introduction of an additional trigger constraint on epenthesis, namely FINAL-C. Note that word-initial glottalization in English is not treated here; it is discussed in Chapter 6.

#### 3.4.1 The intrusive *r*

This section focuses on two dialects of English which exhibit the pattern of the so-called *r*-intrusion: British Received Pronunciation (RP) and Eastern Massachusetts. The differences between these dialects are noted when relevant. Intrusive *r* is reported for many other dialects, and the details may vary considerably (Wells, 1982; Trudgill, 1986). Some other relevant dialects will be discussed in section 3.4.4. *r*-intrusion has been noted at least since Sweet (1908) and Jespersen (1913) and has generated a considerable amount of debate in the theoretical literature (Venneman, 1972; McCarthy, 1991, 1993; Harris, 1994; Halle & Idsardi, 1997; Gick, 1999; Van Oostendorp, 2000; Orgun, 2001; Vaux, 2001; Uffmann, 2007a; Krämer, 2008).

[ɹ] or [ɹ̥] insertion applies at the end of a prosodic word and before a following vowel.<sup>7</sup> The process is operative only after mid and low vowels [ə ʌ ɔ] (other non-high vowels do not occur word-finally).<sup>8</sup> This is illustrated in (18). The vowel sequences starting with a high vowel will be discussed in section 3.4.3.

<sup>7</sup> In a number of dialects, which Wells (1982) dubs *hyper-rhotic*, intrusive *r* appears in coda contexts as well. These dialects show historical reinterpretation of the underlying forms of the relevant morphemes, such that they always contain an *r* and there are no alternations (see also Harris, 1994: 296, fn. 40; Gick, 1999).

<sup>8</sup> Some British dialects allow word-final [ɛ] or [æ] which also triggers intrusive *r* (Wells, 1982; Uffmann, 2007a).

## (18) Hiatus resolution across a prosodic word boundary in English

<i>The law is</i>	[lɔ:ɪɪz]
<i>The spa is</i>	[spɑ:ɪɪz]
<i>The idea is</i>	[aɪdɪəɪɪz]

[ɪ] epenthesis coexists with deletion alternations which affect an underlying /ɪ/ in the coda, making the pairs like *spa* – *spar* and *law* – *lore* identical in most contexts. McCarthy (1991) argues extensively that the underlying representations of the words in similar pairs have to be different, with both deletion and epenthesis applying to produce neutralization. Evidence for this comes from Level I affixation illustrated in (19) and a number of other Level I processes as well as from the difference between a final schwa and /ɪ/ in triggering schwa epenthesis.

## (19) Underlying contrast between the words with and without /ɪ/

<i>doctor</i> - <i>docto</i> [ɪ] <i>al</i>	vs.	<i>idea</i> - <i>ideal</i>
<i>Homer</i> - <i>Home</i> [ɪ] <i>ic</i>	vs.	<i>algebra</i> - <i>algebraic</i>

A deletion-only analysis would have to assume that there are no words which end underlyingly in /ə ɑ ɔ/ (Harris, 1994; Gick, 1999). However, such an analysis would have a problem capturing the data in (19) and other data cited by McCarthy (1991). Another possible argument against the deletion-only approach is that [ɪ] epenthesis operates obligatorily in new words such as *rumba*[ɪ]*ing*, *blah*[ɪ]*er* 'more mediocre' as well as in the English interlanguage (McCarthy, 1991; Uffmann, 2007a).<sup>9</sup> To summarize, to the extent that the Level I alternations and the difference in schwa epenthesis support the underlying contrast between /ɪ/-final and vowel-final words, the phonology of the relevant dialects has to include [ɪ]-epenthesis.

[ɪ]-epenthesis is restricted to the PWd-final environment. Thus, hiatus is either allowed or resolved by glide epenthesis word-medially, before Level I suffixes, and after clitics (20, from Boston dialect).

## (20) Hiatus allowed after non-high vowels prosodic word-medially

<i>boa</i>	[o(w)ə]
<i>He shoulda eaten</i>	[də ɪ]
<i>I'm gonna ask...</i>	[nə æ]

<sup>9</sup> However, the productivity of intrusive [ɪ] may not be as compelling as the other arguments, since it is possible that the native speakers interpret the vowel-final loanwords as /ɪ/-final underlyingly (see also Gick, 1999).

The clitics like those in (20) may also appear at an end of a prosodic word, in which case they trigger intrusive [ɹ] (21, Boston dialect).

(21) Prosodic-word final clitics trigger [ɹ]-epenthesis

*Did you, or didn't you?* [dɪdʒəɹ ə]

To summarize, [ɹ] is epenthesized in RP and Eastern Massachusetts English after a prosodic word ending in a non-high vowel [ə ʌ ɔ] and before another vowel.

### 3.4.2 The splitting analysis

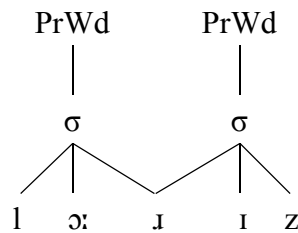
English epenthetic [ɹ] has previously been analyzed as resulting from splitting (Kahn, 1976; Broadbent, 1991; Gnanadesikan, 1997; Ortmann, 1998; Baković, 1999; Krämer, 2008). These analyses fit easily within the Splitting theory. As we shall see, the analysis of English [ɹ] epenthesis requires that the basic constraint set be enriched with additional constraints.

The distribution of [ɹ] in the relevant dialects is restricted – [ɹ] only occurs in onsets (McCarthy, 1993; Harris, 1994; Halle & Idsardi, 1997; Baković, 1999; Orgun, 2001; Krämer, 2008). Crucially the epenthetic [ɹ] only occurs in a subset of onsets, as demonstrated in (20). In particular, it only occurs at the right edge of a prosodic word.<sup>10</sup> Following McCarthy (1993), I assume that in this environment [ɹ] appears in satisfaction of the constraint FINAL-C which requires prosodic words to end in a consonant.

(22) FINAL-C: assign a violation for a prosodic word which does not end in a consonant

The word-final epenthetic [ɹ] has several properties which are reminiscent of onsets, and it has been analyzed as being ambisyllabic (Kahn, 1976; McCarthy, 1993). This is illustrated in (23) for the utterance *law is* [lɔ:ɹɪz] (adapted from Krämer, 2008).

(23) Ambisyllabic [ɹ] at a boundary



Level II suffix boundaries are assumed to project a PrWd boundary as in *sawing* ((sɔ:ɹ)PrWdɪŋ)PrWd (Selkirk, 1984; Nespov & Vogel, 1986; Inkelas, 1989). These boundaries

<sup>10</sup> In some dialects, intrusive *r* appears to repair any onsetless syllable, as in South East London (Tollfree, 1999: 174). See also Harris (2013) on dialects where *r* alternations are related to the foot.

have the same representation as (23) and hence trigger [ɹ] epenthesis. To summarize, [ɹ] is inserted in the position where it can be both in the onset and at the end of a prosodic word.<sup>11</sup>

The epenthetic [ɹ] competes with other possible epenthetic segments. [ɹ]'s major place of articulation is Coronal, and hence its epenthesis violates IDENT-[place] (assuming that all vowels are Dorsal). Furthermore, [ɹ] is specified for rhoticity, hence correspondence between a vowel and [ɹ] violates IDENT-[rhotic] (Walsh Dickey, 1997; Proctor, 2009).

The epenthetic laryngeals also do not share place with vowels, but as argued in section 3.5 below, they preserve the tongue position features of their input vowels. For that reason laryngeal epenthesis presents an interesting competitor to [ɹ]-insertion. This competition is resolved by the high-ranking constraint \*LAR in (24) which prohibits any glottal segments.<sup>12</sup> The constraints on laryngeal epenthesis are discussed in greater detail in section 3.5.

(24)\*LAR: assign a violation mark for any segment whose major place of articulation is glottal

[ɹ] is a decent candidate for the result of splitting a non-high vowel because it is itself specified [-high]. [ɹ] epenthesis thus satisfies IDENT-[high] while glide insertion violates this constraint next to non-high vowels. This feature specification is compatible with the assumption that [ɹ] is featurally close to the vowel [ə], which was previously expressed via place or height features (Kahn, 1976; Gnanadesikan, 1997; Ortmann, 1998; Baković, 1999; Krämer, 2008 a.o.).<sup>13</sup> The phonetics of intrusive [ɹ] is compatible with its phonological closeness to schwa: [ɹ] has a vocalic tongue retraction component, which is similar to the articulation of [ə] (Delattre & Freeman, 1968; Gick, 1999; Gick *et al.*, 2006; Proctor, 2009). Thus, [ɹ] is non-high just like the vowels [ə ʌ ɔ].

The tableau in (25) identifies the ranking conditions necessary for [ɹ] epenthesis. In general in this chapter, it is assumed that it is always the first vowel that splits. In the relevant English dialects, this is enforced by a positional faithfulness constraint INITIAL-INTEGRITY that prohibits word-initial splitting (not shown in (25), see Chapters 2 and 4). Epenthetic [ɹ] is an approximant, and unlike say [ɣ] in (25e) it shares the specification

<sup>11</sup> Note also that there is no intrusive *r* when the second word begins with a glottal stop (Mompeán & Gómez, 2011). In this cases (usually before a stressed vowel), the boundary is strong enough to be subject to the blocking constraints LAR-EDGE (see Chapter 6), and the onset of the second word is occupied by a laryngeal. Hence intrusive *r* is not licensed.

<sup>12</sup> Surface [h] occurs in English only in stressed syllable onsets where it is preserved by positional faithfulness. See chapter 6 for a discussion of word-initial glottalization.

<sup>13</sup> For Kahn (1976) the American English *r* is [+high], although little justification is given for this specification. Uffman (2007a) argues that *r* is [+low], rather than just [-high], but this is not incompatible with a [-high] specification.



[+sonorant] with the vowels. The high ranking of IDENT-[sonorant] predicts that approximants will result from splitting. On the other hand, epenthetic [ɹ] is better than glides because it shares the specification [–high] with non-high vowels. Thus, high-ranked IDENT-[high] rules out glide insertion (25c). In section 3.5 it is shown that laryngeal approximants resulting from splitting may share tongue position features with their input. Hence epenthetic [h] in (25d) satisfies IDENT-[high]. However, laryngeals are in general very restricted in English, as encoded in a high ranking of \*LAR.

(25) [ɹ] epenthesis in non-rhotic dialects of English

	/lɔ <sub>1</sub> I <sub>2</sub> z/	ID- [high]	FIN-C	*LAR	ID- [son]	ID- [place]	ID- [rhot]	INT
☞ a.	lɔ <sub>1</sub> I <sub>1</sub> I <sub>2</sub> z					1	1	1
b.	lɔ <sub>1</sub> I <sub>2</sub> z		W1			L	L	L
c.	lɔ <sub>1</sub> w <sub>1</sub> I <sub>2</sub> z	W1				L	L	1
d.	lɔ <sub>1</sub> h <sub>1</sub> I <sub>2</sub> z			W1		1	L	1
e.	lɔ <sub>1</sub> ɹ <sub>1</sub> I <sub>2</sub> z				W1	L	L	1

Finally, this tableau illustrates that epenthesis may be triggered by a variety of constraints: while in most examples so far it was ONSET, in English epenthesis occurs to satisfy FINAL-C.

Krämer (2008) extends this analysis of [ɹ] insertion to cover the alternations between /ɹ/ and schwa, as well as schwa epenthesis before liquids which have been recognized as a potential challenge to OT (Halle & Idsardi, 1997; Hale & Reiss, 2000; Orgun, 2001). Krämer's account further supports the claim that /ɹ/ is [–high] as well as the splitting approach to epenthesis, since /ɹ/ can both surface as schwa and split to yield [əɹ].

To summarize, the intrusive *r* in English is picked as an epenthetic consonant because it shares the feature specifications [–high +sonorant] with its input vowels, conforming to the predictions of the Splitting theory.

### 3.4.3 English glide insertion

The Splitting theory predicts that if there is no blocking, *r*-insertion next to non-high vowels must coexist with homorganic glide insertion next to high vowels. While *r*-intrusion after non-high vowels has received much attention in the literature, the fate of VV sequences where the first vowel is high is discussed somewhat less often. There are at least two kinds of dialects in this regard.

In the Eastern Massachusetts dialect, the high tense vowels are reportedly diphthongized in all contexts, and thus words may not end in a high vowel, ending in the redundant diphthongs [ij, ej, uw, ow] or the distinctive diphthongs [aj, əj, aw] (McCarthy, 1993; Baković, 1999). For this dialect, the words in both (26a) and (26b) contain diphthongs.

On the other hand, there are other dialects with *r*-intrusion which have a glide inserted before a vowel-initial word (even after diphthongs). In these dialects the words in (26b) all have a glide, and they differ from those in (26a), even for diphthongs: [p<sup>h</sup>er] *pay the bill* vs. [p<sup>h</sup>erjɪz] *pay is* (Wells, 1982; Uffmann, 2007a; Krämer, 2008).

(26) Diphthong-final words

- |                                 |                            |
|---------------------------------|----------------------------|
| a. Before a consonant           | b. Before a vowel          |
| <i>Do you see the problem?</i>  | <i>I see it.</i>           |
| <i>Who will pay the bill?</i>   | <i>I'll pay it.</i>        |
| <i>Who will shoe the horse?</i> | <i>I'll shoe it.</i>       |
| <i>Who will mow the lawn?</i>   | <i>I'll mow it.</i>        |
| <i>Who will fly the plane?</i>  | <i>I'll fly it.</i>        |
| <i>Where is the boy today?</i>  | <i>The boy is not here</i> |
| <i>Where is the cow today?</i>  | <i>The cow is not here</i> |

In the case of the Massachusetts dialect, all phonetic diphthongs are analyzed as nucleus plus coda sequences (McCarthy, 1991, 1993; Baković, 1999), and thus the sequences V<sub>1</sub>#V<sub>2</sub> show no special behavior with regard to diphthongization. Of course, based on Richness of the Base there must be some machinery to ensure that possible inputs like /si/ always surface as [sij]. This could be done with a general constraint against syllable-final high vowels which would enforce splitting. Thus in the Massachusetts dialect high vowels are always diphthongized, and hence this dialect vacuously conforms to the predictions of the Splitting theory: while non-high vowels undergo splitting in hiatus across word boundary, high vowels undergo splitting in all environments.

The case of RP is more illustrative. In this dialect [ɪ] epenthesis after non-high vowels coexists with glide epenthesis after high vowels. In fact, given the constraints and the ranking established so far, vowel sequences where the first vowel is high have to undergo splitting and this splitting has to yield a glide. The tableau in (27) provides another illustration of the familiar faithfulness asymmetry. Splitting a non-high vowel is always more costly in terms of faithfulness than splitting a high vowel. Thus the ranking conditions on [ɪ] insertion next to non-high vowels automatically predict that high vowels will split since FINAL-C dominates INTEGRITY. Furthermore, the result of splitting the high vowel has to be a homorganic glide – all other options are less faithful and hence harmonically bounded (given the present constraint set), as exemplified by (27c).

(27) Glide epenthesis after a high vowel in English (RP)

	/ki: <sub>1</sub> I <sub>2</sub> z/	ID-[high]	FINAL-C	ID-[place]	ID-[rhotic]	INT
☞ a.	ki: <sub>1</sub> j <sub>1</sub> I <sub>2</sub> z					1
b.	ki: <sub>1</sub> I <sub>2</sub> z		W1			L
c.	ki: <sub>1</sub> .I <sub>1</sub> I <sub>2</sub> z	W1		W1	W1	1

The phonetics of English vowel sequences has recently been analyzed by Davidson & Erker (2014), for speakers of American English who do not have intrusive *r*. Davidson &

Erker compared the underlying root-medial VV sequences, to V#V across word boundary and to the sequences with a glide (V#GV) across word boundary in casual speech. Their findings indicate that there are clear acoustic differences between V(#)V and V#GV such that the sequences with an underlying glide show a significantly larger dip in intensity and significantly more extreme formant values than the underlying vowel sequences.

These results present somewhat of a challenge to the traditional account of glide epenthesis sketched above. Davidson & Erker (2014)'s proposal is that hiatus is actually unresolved in the relevant dialect of American English, and that vowel diphthongization is a dialect-specific phonetic property. It is not clear, though, whether the diphthongal nature of American vowels equally applies in preconsonantal and prepausal environment, as these sequences were not considered. In any case, it would be interesting to see if these findings extend to the other dialects, and if the contrast also exists in the dialects which are reported to have a different realization in (26a) vs. (26b).

In addition to the unresolved hiatus hypothesis, a number of other analyses are possible (as discussed by Davidson & Erker). The splitting account of English glides may give rise to a particularly interesting story in this case, since it is possible to maintain that the glides in hiatus correspond to underlying vowels whereas the glides in word-initial position may come from underlying consonants (i.e. they may be consonantal glides). Furthermore, it is possible that the epenthetic glides would be more reduced since they are ambisyllabic while word-initial glides are exclusively syllable and word-initial (McCarthy, 1991).

Of course, it remains to be seen if these findings extend to the dialects that have *r*-intrusion, but even if they did, this would not be problematic for the splitting account. It is possible to assume that the constraint FINAL-C requires a true consonant, i.e. something consonantal at a word boundary. On this account [ɹ] would be consonantal and it would satisfy FINAL-C, but it would not be inserted after high vowels since IDENT-[high] is high ranked. On the other hand, glide epenthesis would not satisfy FINAL-C, since the glides are not consonantal.

Additional data from other dialects of English (section 3.4.4), as well as possibly from other languages (see Chapter 9) could yield support to the idea that epenthesis of true consonants happens word-finally. However, currently there is not sufficient data to support this idea.

### 3.4.4 Other dialects

Intrusive *r* and related phenomena are subject to dialectal variation. Importantly for the splitting theory, certain dialects are reported to exhibit 'intrusion' or 'insertion' of other sounds in some of the positions that are associated with intrusive *r* in RP and Eastern Massachusetts English. However, the available data on these dialects is not sufficient to disambiguate between the different possible sources of the 'intrusive' sounds. In what follows, I will discuss three examples: American intrusive /l/ (Gick, 1999, 2002), Bristol /l/ (Wells, 1982; Trudgill, 1986), and the labiodental realization of /r/ (Foulkes & Docherty, 2000)<sup>14</sup>.

<sup>14</sup> See also Uffman (2010) on a particularly interesting case where the phonetics of conditioning vowels undergoes a change, but their featural content (and hence the patterns of [ɹ] epenthesis) remain the same.

Gick (1999, 2002) observes that many dialects of American English, such as southern Pennsylvania, exhibit a phenomenon whereby [l] appears in word boundary hiatus and at Level II suffix boundary after /ɔ:/, and sporadically also after /ɑ: ə/ (see also Bermúdez-Otero & Hogg, 2003; Bermúdez-Otero, 2006; Bermúdez-Otero & Börjars, 2006). This is illustrated in (28).

(28) American intrusive *l*

*paw is* or *Paul is* [pɔl ɪz]

*drawing* [dɹɔlɪŋ]

These variants are associated with a highly casual speech style, and are hard to elicit consistently (Gick, 2002). Gick (1999, 2002) suggests that these examples may be due to a historical reinterpretation of the underlying form, which in the relevant dialect and speech style contains a final /l/. The fact that this consonant undergoes deletion in coda is probably needed in any analysis. It remains to be seen if there are any alternations which would support an epenthetic alternation (in addition to or instead of deletion), but the evidence currently available is not sufficient to decide on whether e.g. *paw* is underlyingly /pɔl/ due to historical reinterpretation, or /pɔ/ with a synchronic epenthesis process. The situation is similar for the widely cited case of *Bristol l*. The dialect surveys report that words that end in a schwa in RP may end in [l] in the Bristol dialect, both prepausally and prevocally (Weissmann, 1970; Wells, 1982). However no alternations are reported, and thus it is not clear whether the pattern involves synchronic alternations.

Finally, Foulkes & Docherty (2000) document an ongoing change in the realization of /ɹ/ in two British dialects (Newcastle and Derby) where it is variably realized as [v] (see also Uffman, 2007a). The status of word-final /ɹ/ is not discussed, and so it is not clear if there are any alternations between [v] and zero.

To summarize, a number of dialects of English could provide examples of inserted laterals or possibly labiovelars in word-final position. However, further research is needed to determine whether these are true cases of synchronic epenthesis supported by alternations. Interestingly, in all such cases the reported sonorant epenthesis processes occur word-finally. If there are indeed synchronic alternations to support epenthesis in these cases, such alternations could be analyzed as resulting from the constraint FINAL-C, on the assumption that FINAL-C requires true consonants, not just any consonants at the end of a word.

### 3.4.5 Summary of section 3.4

Intrusive *r* in English dialects illustrates several important predictions of the Splitting theory. First, the identify of the epenthetic segment depends on the segments available in a particular language. Second, in the extended patterns of epenthesis, glides are always favored next to high vowels, whereas next to non-high vowels they are only favored if IDENT-[high] is dominated. Finally, epenthesis may be triggered by a variety of structural constraints, and the resulting patterns may depend on the nature of the relevant markedness requirements.

### 3.5 Extended epenthesis of other consonants: laryngeals

A key prediction of the Splitting theory has been illustrated throughout this chapter: no inserted consonant is fully faithful to non-high vowels, and therefore various consonants may be inserted in this position, depending on the ranking of IDENT constraints with respect to each other and with respect to markedness constraints. In this section, I identify the constraints and rankings relevant to extended epenthesis of laryngeals.

#### 3.5.1 Predictions about laryngeal epenthesis

The splitting account of laryngeal epenthesis relies on several important assumptions. First, the laryngeal consonants inserted next to vowels are faithful to these vowels in major class features. In other words, epenthetic laryngeals are approximants, just like glides (Jakobson *et al.*, 1951; Chomsky & Halle, 1968; Kenstowicz & Kisseberth, 1979; McCarthy & Prince, 1995 a.o.). Thus the inserted laryngeal approximants are all specified [–consonantal; +sonorant], and they all share the place (or active articulator) Glottal. This should not be taken to imply that all laryngeals in all languages are approximants. Rather it seems likely that laryngeals will prove to have dual specification – just like vocalic and consonantal glides. The consonant-like behavior of laryngeals is discussed by Lass (1976) and Durand (1987).

The laryngeal consonants [ʔ h ɦ] pattern alike in terms of epenthesis. I will assume that these consonants are distinguished by the features [constricted glottis], [spread glottis], and [voice]. The selection of a particular laryngeal consonant as epenthetic is accounted for by a ranking of markedness constraints associated with laryngeal features. For example [ʔ] is penalized by the constraint \*[constricted glottis] (Rubach, 2000, 2002; Yu, 2011a) and similarly [h] is prohibited by \*[spread glottis]. The splitting theory incorporating these constraints predicts that laryngeals will pattern together in epenthesis, and that different languages will have different epenthetic laryngeals.

- (29) \*[constricted glottis] (\*[cg]): assign a violation for every segment that has the feature [constricted glottis]
- (30) \*[spread glottis] (\*[cg]): assign a violation for every segment that has the feature [spread glottis]

Another component of the Splitting account is the constraint \*LAR militating against all laryngeal consonants (31) (Lombardi, 1999). While there is independent evidence that laryngeals have unmarked place of articulation, these consonants are often either prohibited altogether or limited to prosodic edges (on which see Chapter 6). Constraints that specifically penalize laryngeal consonants are also required in other theories of epenthesis (Rubach, 2000; Lombardi, 2002; de Lacy, 2006; Steriade, 2008). This constraint is used to rule out laryngeal epenthesis next to non-high vowels in the languages discussed in 3.3-3.4.

- (31) \*LAR: assign a violation mark for any segment whose major place of articulation is glottal

Finally, it is assumed here that laryngeals are compatible with any specification for vocalic tongue position features such as [high], [low] and [back]. Effectively then, the inserted laryngeal approximants will always copy these feature specifications from vowels. This assumption is in line with the theories that assume that laryngeals are unspecified for lingual gestures (Borroff, 2007) or can easily overlap with vocalic gestures (Hall, 2003, 2006) (see section 3.5.2 on the assumption that laryngeals share features with low vowels).

Phonetically, the assumed feature specifications are consistent with the fact that laryngeal consonants do not impose formant transitions on the neighboring vowels (Ladefoged & Maddieson, 1996; Garellek, 2013). From the point of view of the Splitting theory, we expect that the tongue position in epenthetic laryngeals will be more similar to the vowel to which they correspond in the phonology.

The Splitting theory leads us to consider the question of whether epenthetic laryngeals can also be specified as [+round] when they correspond to input rounded vowels. This prediction remains to be tested. I know of no detailed phonetic studies which would specifically address whether say [h] inserted next to /u/ has a lip-rounding component.

Laryngeals may also differ in their laryngeal specification from the vowels which are specified for modal voicing. Finally, laryngeals differ from all vowels in their place specification since vowels are Dorsal and laryngeals are Glottal. Splitting a vowel to yield a laryngeal then violates IDENT-[place] and thus on this dimension laryngeals are further away from vowels than dorsal consonants. This assumption was relevant to the discussion of English in section 3.4 and it will play a role in the analysis of Mongolian in Chapter 7.

The table in (32) summarizes the violations that inserted [ɸ] incurs in different vowel contexts. The constraint IDENT-[round] is omitted, as discussed above.

(32) Violations incurred by a split to a laryngeal in different vocalic contexts

	*LAR	IDENT- [spread glottis]	IDENT- [place]	IDENT- [high],[low],[back]
a. /i/ → [ɸi]	1	1	1	✓
b. /e/ → [ɸe]	1	1	1	✓
c. /u/ → [ɸu]	1	1	1	✓
d. /o/ → [ɸo]	1	1	1	✓
e. /a/ → [ɸa]	1	1	1	✓

Epenthesis of [ʔ] next to vowels that aren't specified as creaky also violates IDENT-[constricted glottis].

Next to high vowels, laryngeal epenthesis is less faithful than homorganic glide epenthesis. Therefore in all extended laryngeal insertion patterns, glides are predicted to be inserted next to high vowels. On the other hand, laryngeals *are* inserted next to high vowels in some cases; this pattern is due to blocking by markedness constraints, and is discussed in detail in Chapter 6.

Next to non-high vowels, laryngeal epenthesis competes with glide epenthesis and with other epenthetic segments. Laryngeal consonants are good candidates for epenthesis since they preserve the tongue position features of the vowels. Glides on the other hand are specified [+high, –low]. Thus, glide insertion next to mid vowels violates IDENT-[high], and next to low vowels it violates IDENT-[high] and IDENT-[low]. Laryngeal epenthesis in the same vowel context satisfies the IDENT constraints on tongue position features, as illustrated in (33).

(33) Competition between laryngeals and glides next to non-high vowels

a. Mid vowel context

	te <sub>1</sub> a <sub>2</sub>	ID-[high]	*LAR	ID-[place]	INTEGRITY
a.	te <sub>1</sub> j <sub>1</sub> a <sub>2</sub>	1			1
b.	te <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub>		1	1	1

b. Low vowel context

	ta <sub>1</sub> a <sub>2</sub>	ID-[high]	ID-[low]	*LAR	ID-[place]	INTEGRITY
a.	ta <sub>1</sub> j <sub>1</sub> a <sub>2</sub>	1	1			1
b.	ta <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub>			1	1	1

Within the proposed theory laryngeal epenthesis is equally faithful next to low and mid vowels, while glide epenthesis is more faithful next to mid vowels than next to high vowels. Because of this, we expect that if laryngeal epenthesis occurs (and glide epenthesis is blocked) next to mid vowels, it will also occur next to low vowels. Conversely, the Splitting theory excludes an extended pattern where glides are inserted next to low vowels but laryngeals appear next to mid vowels. These predictions will be illustrated in the analysis of Farsi in section 3.5.2 below. However, it is probably premature to claim that these predictions are borne out since most other cases of laryngeal insertion in my sample clearly involve a blocking pattern, on which see Chapter 6.

To summarize, this section has proposed that inserted laryngeals are approximants, and that they get their tongue position features ([high, low, back]) from the input vowels. Based on these assumptions, the Splitting theory predicts that laryngeal approximants, just like glides, may occur next to non-high vowels in the extended patterns of epenthesis. Finally, laryngeal epenthesis and glide epenthesis pattern differently in different non-high vowel contexts. Laryngeal epenthesis is equally faithful in both contexts, while glide epenthesis is more faithful next to mid vowels. As a result, the Splitting theory in its current form makes two predictions:

- glide epenthesis next to low vowels implies glide epenthesis next to mid vowels
- laryngeal epenthesis next to mid vowels should always coexist with laryngeal epenthesis next to low vowels, since they incur the same faithfulness violations

The former prediction was illustrated in section 3.3, while the latter is illustrated in the analysis of Farsi below.

### 3.5.2 Laryngeal epenthesis in Farsi


The Splitting theory predicts that laryngeal epenthesis may occur next to mid vowels, but in this case it is expected to coexist with laryngeal epenthesis next to low vowels. These predictions are confirmed by formal Farsi (the dialect described by Naderi & van Oostendorp (2011)). In this dialect, hiatus is resolved by homorganic glide epenthesis after a high vowel (34a), but a glottal stop resolves hiatus after mid and low vowels (34b).

#### (34) Hiatus resolution in Farsi

- a. /sep̤hi-ɒn/      [sep̤hiɔ̃n] ‘soldiers’  
      /ʔahu-i/        [ʔahuwi] ‘a deer’
- b. /xɒne-at/        [xɒneʔat] ‘colloquial’  
      /rɒdijo-i/        [rɒdijoʔi] ‘relating to radio’  
      /bɒlb-i/         [bɒlbʔi] ‘the one above’


The tableau in (35) instantiates a familiar pattern: next to high vowels, only homorganic glides can be inserted in extended epenthesis. Laryngeal epenthesis in this context is harmonically bounded because it is inherently less faithful (35c).

#### (35) Farsi homorganic glide epenthesis after high vowels

/sep̤hi <sub>1</sub> ɒ <sub>2</sub> n/	ONSET	IDENT-[place]	INTEGRITY
 a. sep̤hi <sub>1</sub> j <sub>1</sub> ɒ <sub>2</sub> n			1
b. sep̤hi <sub>1</sub> ɒ <sub>2</sub> n	W1		L
c. sep̤hi <sub>1</sub> ʔ <sub>1</sub> ɒ <sub>2</sub> n		W1	1

On the other hand, splitting a mid vowel to yield a glide is impossible in Farsi because such a mapping would violate IDENT-[high]. Instead, a creaky approximant emerges as optimal since laryngeal epenthesis satisfies the IDENT-[high] thus beating glide insertion (36c). As shown in (36d), an aspirated glottal approximant cannot be inserted because \*[sg] dominates \*[cg].

#### (36) Farsi glottal stop epenthesis after mid vowels

/xɒne <sub>1</sub> a <sub>2</sub> t/	ONS	ID-[high]	*[sg]	*[cg]	ID-[place]	*LAR	INT
 a. xɒne <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub> t				1	1	1	1
c. xɒne <sub>1</sub> a <sub>2</sub> t	W1			L	L	L	L
c. xɒne <sub>1</sub> j <sub>1</sub> a <sub>2</sub> t		W1		L	L	L	1
d. xɒne <sub>1</sub> h <sub>1</sub> a <sub>2</sub> t			W1	L	1	1	1

Finally, next to a low vowel, the competition is fully parallel to (36) except that glide epenthesis violates more IDENT constraints.



It should be pointed out that the Farsi data may be more complex than suggested by the examples in (32). For one thing, the epenthesis patterns in (32) are characteristic of formal Farsi, while vowel elision is operative in daily speech. Furthermore, most existing accounts of Farsi hiatus resolution indicate variation between [j] and [ʔ] epenthesis after a mid vowel, as well as possibly after high vowels (Lazard, 1957; Mahootian, 1997; Picard, 2003; Rohany Rahbar, 2012). The Persian speakers that I consulted, also variably allowed [j] epenthesis after mid vowels, as well as glottal stop after high vowels.<sup>15</sup> They also disallowed [w] after /u/ in most cases. These data clearly call for a thorough investigation of the possible dialectal differences, as well as other possible factors that affect this variation.

To summarize, laryngeal epenthesis in formal Farsi (to the extent that the data from the relevant dialect are robust) illustrates two predictions of the Splitting theory. First, laryngeals can be inserted next to mid vowels, and second, if they are, they will also appear next to low vowels.

### 3.5.3 Are laryngeals low and/or back?

Featural specification of laryngeal consonants has been a matter of a considerable debate. I therefore take a moment to consider the alternative approaches to the features of laryngeals, and see whether they could be compatible with the Splitting theory and with the observed typology of epenthesis.

First, a number of theories assume that laryngeals are placeless, at least in some languages (Bessell & Czaykowska-Higgins, 1992; Bessell, 1993; Rose, 1996; McCarthy, 2008b). However, the placeless status of laryngeals is probably not universal (Rose, 1996; McCarthy, 2008b), and it is mostly relevant to consonantal laryngeals – i.e. the segments that pattern with consonants (unlike the epenthetic laryngeals, which, from the point of view of Splitting, pattern with vowels).

Second, it is often assumed that laryngeals share some feature specification with low, and perhaps back vowels. Evidence for the affinity between laryngeals and low vowels comes from a variety of lowering processes, in which laryngeals often pattern together with uvulars and/or pharyngeals (Herzallah, 1990; McCarthy, 1994; Rose, 1996; Moisić, 2013), as well as some shared phonetic properties (Brunner & Zygis, 2011; Moisić, 2013).

Within the V-Place theory, laryngeals are often assumed to share the Place specification [Pharyngeal] with /a/ which is doubly specified as [Dorsal, Pharyngeal] (Herzallah, 1990; Clements, 1991). However, the analysis of Mongolian in chapter 7 indicates that /a/ is just [Dorsal].

Could it be that laryngeals share the specification [–high; +low] or [RTR] with /a/ (Chomsky & Halle, 1968; Ní Chiosáin & Padgett, 1993; Halle, 1995; Rose, 1996)? No epenthesis pattern known to me bears on this assumption, but the Splitting theory makes a very clear prediction here. If laryngeals are always [+low], then we expect to find an extended epenthesis pattern where nothing is inserted next to mid vowels, but laryngeals are epenthesized next to low vowels. This pattern would arise for example under the ranking IDENT-[low], IDENT-[high] >> ONSET >> \*LAR, IDENT-[place], INTEGRITY. Under

---

<sup>15</sup> I am grateful to Elham Rohany Rahbar and Bahareh Soohani for their help with the Farsi data. They are both speakers of Standard Persian.

this ranking, the IDENT constraints block epenthesis next to mid vowels, but allow laryngeal epenthesis next to low vowels, as illustrated in (37).

(37) Predictions of [low] laryngeals

a. No epenthesis next to mid vowels

/te <sub>1</sub> a <sub>2</sub> /	ID-[high]	ID-[low]	ONSET	*LAR	ID-[PLACE]	INTEGR
a. te <sub>1</sub> a <sub>2</sub>			1			
b. te <sub>1</sub> j <sub>1</sub> a <sub>2</sub>	W1		L			W1
c. te <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub>		W1	L	W1	W1	W1

b. Laryngeal epenthesis next to low vowels

/ta <sub>1</sub> a <sub>2</sub> /	ID-[high]	ID-[low]	ONSET	*LAR	ID-[PLACE]	INTEGR
a. ta <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub>				1	1	1
b. ta <sub>1</sub> a <sub>2</sub>			W1	L	L	L
c. ta <sub>1</sub> j <sub>1</sub> a <sub>2</sub>	W1	W1		L	L	1

Similarly if laryngeals are always specified [+back], then the theory predicts patterns where laryngeals are inserted next to back vowels but glides appear with front vowels. Thus within the Splitting theory, featural specification affects featural faithfulness, and thus various feature theories yield clear implications for the patterns of laryngeal and glide epenthesis.

### 3.5.4 Summary

To summarize, the Splitting theory and the assumption that laryngeals may have different tongue position features make several predictions. Laryngeal epenthesis next to mid vowels is expected to coexist with laryngeal epenthesis next to low vowels, and this correlation is attested in a dialect of formal Farsi. Finally, alternative featural assumptions about laryngeals may be incorporated within the Splitting theory, and they yield a clear change in the predicted typology.

## 3.6 Conclusion

Only high vowels have featurally identical glide counterparts. The Splitting theory treats homorganic glide insertion next to high vowels as a minimal change, involving only INTEGRITY violations. On the other hand, insertion next to non-high vowels has to violate some IDENT constraints. Therefore, the Splitting theory predicts a class of extended epenthesis patterns – these patterns include homorganic glide insertion next to high vowels, and insert some consonant next to non-high vowels.

The patterns of extended epenthesis confirm the theory's predictions and illustrate one of its important properties. Faithfulness constraints from the IDENT family determine epenthetic quality. Next to non-high vowels, the markedness constraints compete with IDENT constraints to determine the outcome of splitting. If faithfulness to the feature [high] is important, then glides will not be inserted next to non-high vowels, and instead

we see laryngeals or rhotics. On the other hand if IDENT-[high] is ranked low enough, glide insertion is generalized to the non-high vowel contexts.

## Chapter 4. Directional restrictions on inserted glides

### 4.1 Introduction

The previous chapter introduced various ways in which homorganic glide insertion next to high vowels may be extended to other vowel contexts. This chapter begins an investigation of the patterns where fully homorganic glide insertion is blocked.

The blocking constraints to be considered here do not block certain inserted segments across the board, but rather prohibit certain glides next to certain vowels – these effects will be referred to as *directional blocking*. There are two fundamentally different kinds of constraints responsible for directional blocking effects: the positional faithfulness constraints, addressed in 4.3, and the phonotactic markedness constraints against homorganic glide-vowel sequences discussed in 4.2.

The two kinds of blocking addressed here are very similar on the surface: in both cases, homorganic glide insertion is possible, but only certain input vowels can split to yield a homorganic glide. However, a detailed investigation of several glide insertion patterns shows that the surface similarity is only apparent, and that the underlying phonological pressures have to be different.

Finally, not all kinds of directional blocking are predicted to be possible. An impossible blocking pattern is described in section 4.4.

### 4.2 Restrictions on glide-vowel sequences

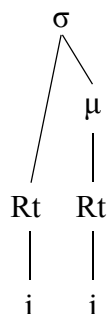
Homorganic sequences of vowels and glides such as [ji], [wu] are often prohibited (Kawasaki, 1982; Hayes, 1989). This phonotactic restriction can be encoded by a markedness constraint, which I refer to as \*ji/wu (1). The constraint blocks insertion of glides which would otherwise be completely homorganic, resulting in asymmetrical patterns like /ia/ → [ija] but \*/ai/ → [aji].

- (1) \*ji/wu: assign a violation mark for every margin-nucleus sequence of two segments which are identical in all features

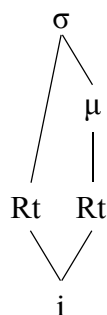
The relation between \*ji/wu and the the Obligatory Contour Principle (Leben, 1973; McCarthy, 1986) deserves a comment. Homorganic glide-vowel sequences are penalized by the OCP only if they are represented as two root nodes dominating identical feature bundles, as shown in (2a) for the sequence [ji]. However if these sequences are represented as in (2b-c), there is no OCP violation (McCarthy & Prince, 1986; Hayes, 1989; Rubach, 2002).

## (2) The representations of the glide-vowel sequence [ji]

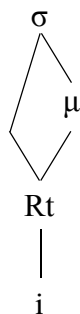
- a. Two root nodes with identical features



- b. Two root nodes dominating the same features



- c. One root node in two structural positions



The relation between the OCP and phonotactic constraints is thus mediated by possible representations. For example, (2c) has widely been used in the analysis of glide epenthesis (McCarthy & Prince, 1986; Keer, 1996; Rosenthal, 1997a; b; Cohn & McCarthy, 1998; Kawahara, 2003), but Rubach (2002) argues that this option is universally unavailable. If the phonotactic constraints on glide-vowel sequences are part of the OCP, and if (2b-c) are possible representations, then we expect languages where these feature-shared structures would escape the phonotactic constraints. This possibility remains to be further explored.

The Splitting theory is in principle compatible with any of the representations above. The fact that the epenthetic glides share features with a neighboring vowel is analyzed in terms of input-output correspondence, which is separate from autosegmental sharing on the surface. For this reason, I will be using the phonotactic constraint  $*ji/wu$  to ban any

surface sequences [ji wu], while noting that this constraint might fall within the family of OCP constraints, and that some of the representational possibilities in (2) may be able to escape the OCP if these representations are indeed allowed. Other influences of the OCP on epenthetic glides will be discussed further in Chapter 5.

Within the Splitting theory, the constraint \*ji/wu plays a crucial role in determining the fate of the sequences of high vowels like /iu/ and /ui/. The theory imposes no restrictions on the choice of the vowel that splits. However, since sequences like [ji] and [wu] violate \*ji/wu, splitting the first vowel is inherently favored. This is illustrated in fpr a hypothetical input in (3). Observe that given the basic constraint set and the constraint \*ji/wu, the candidate splitting the second vowel in the sequence /iu/ (3b) is harmonically bounded by the candidate splitting the first vowel (3a).

(3) The first vowel splits in sequences of high vowels

	/ti <sub>1</sub> u <sub>2</sub> /	ONS	*ji/wu	INTEGRITY
☞ a.	ti <sub>1</sub> j <sub>1</sub> u <sub>2</sub>			1
b.	ti <sub>1</sub> w <sub>2</sub> u <sub>2</sub>		W1	1
c.	tiu	W1		L

This result relies on the assumption that there are no other active positional constraints in the system. The phonotactic patterns discussed by Kawasaki (1982) are consistent with the assumption that glide-vowel sequences are disallowed only if vowel-glide sequences are also disallowed. Thus, there is probably no constraint like \*ij/uw. However, other positional constraints such as positional faithfulness may disrupt the pattern in (3). Some relevant constraints will be discussed in section 4.3.

The asymmetrical behavior of high vowel sequences can be illustrated with the minimal epenthesis pattern of Faroese, which was introduced in Chapter 2 (Lockwood, 1955; Anderson, 1972; Thráinsson *et al.*, 2004; Árnason, 2011). Only sequences with high vowels trigger glide epenthesis in this language. When two high vowels come together the vowel on the left determines the quality of the glide (4a). However, the constraint \*ji/wu is still clearly subordinate to ONSET, since the sequences like [jɪ, wʊ] do emerge when no other homorganic glide can resolve hiatus (4b).

(4) Left-adjacent high vowel determines the glide quality in Faroese

a. /pu:-ɪ/ [pu:wɪ] 'live-PST'

/si:-ʊɪ/ [si:jʊɪ] 'custom'

b. /si:-ɪ/ [si:jɪ] 'to lower-PST.PRT'

/su:-ʊɪ/ [su:wʊɪ] 'south'

The phonotactic restrictions on glide-vowel sequences have many manifestations in the attested patterns of glide insertion. Thus, in Woleaian glide insertion is blocked in front of high vowels (Sohn, 1971, 1975; Sohn & Tawerilmang, 1976). In Madurese (discussed in detail in Chapter 5), these restrictions are extended to both high and mid

vowels.<sup>1</sup> However, perhaps the clearest support for the activity of \*ji/wu comes from the epenthesis patterns of Kalaallisut (also known as West Greenlandic Eskimo), where the reverse of a homorganic glide appears under certain circumstances.

#### 4.2.1 Kalaallisut hiatus resolution: data

Kalaallisut is an Eskimo language of Greenland (also known as ‘West Greenlandic Eskimo’) (Rischel, 1974; Fortescue, 1984). Kalaallisut epenthesis has previously been discussed by Darden (1982), Murasugi (1991), and Rosenthal (1997b). Kalaallisut has three underlying vowel qualities and contrastive vowel length, i.e. [a i u a: i: u:]. There are also two diphthongs [ai ia] which only occur word-finally. The consonantal inventory of Kalaallisut is given in (5). Glides [j w] and fricatives [ɬ v] are distributed allophonically, as discussed below.

##### (5) Kalaallisut consonant inventory

p	t	k	q
m	n	ŋ	ɴ
	ts		
	s ʃ		
	ɬ	ɰ	
v/w	j/j	ɣ	

The data on Kalaallisut hiatus resolution are presented in (6). The default strategy is glide insertion (6a), which applies whenever the sequences [ji] and [wu] can be avoided. Just as in Faroese, the sequence /iu/ is resolved by epenthesis of [j], not [w], hence \*[wu] is avoided in /ajuqi-uwuq/ [ajuqijuwuq] ‘is a catechist’.

For some vowel sequences, such as /au/, homorganic glide insertion would violate \*ji/wu, i.e. \*[awu]. In such cases (6b) the two vowels merge to form a long vowel. In what follows, this process is analyzed as deletion of the second vowel leaving behind its mora – hence /nuna-uvuq/ [nuna:vuq] ‘is land’.

Finally, a particular problem is raised by vowel sequences where one of the input vowels is long and the second vowel is high (/i/ or /u/). Here homorganic glide insertion would create sequences like [ji wu] whereas deletion with mora preservation would yield a trimoraic vowel. In this situation, with neither deletion nor homorganic glide insertion possible, the final resort is to insert an ‘opposite’ or ‘disharmonic’ glide, as in (6c).

##### (6) Kalaallisut glide epenthesis

###### a. Homorganic glide before a low vowel

/ulu-a/	[uluwa] ‘her Greenland woman’s knife’
/ajuqi-uwuq/	[ajuqijuwuq] ‘is a catechist’

<sup>1</sup> Another example is Japanese (Kawahara, 2003), although this case is not perfect since there is no evidence from alternations to support glide epenthesis.

## b. Contraction before a high vowel

/nuna-uvuq/	[nuna:vuq] 'is land'
/sava-innaq/	[sava:nnaq] 'sheep, merely'

## c. Disharmonic glide after a long vowel

/na:-i/	[na:vi] 'his stomach'
/pu:-utsiga/	[pu:ʝutsiga] 'my bag'
/qaʒʒuna:-uwuq/	[qaʒʒuna:juwuq] 'is a Dane'
/qi:-ija <sup>ɕ</sup> ppa/	[qi:vija <sup>ɕ</sup> ppa] 'he removes his white hair'

Some of the forms like those in (6c) also admit contraction to a long vowel (though such variants are not reported for the actual examples in (6c)).

The epenthetic segments in Kalaallisut vary between a glide and a fricative according to the general pattern of the language where [j w] only appear after [i u] respectively, and are replaced by fricatives [ʝ v] in other environments. This general glide-fricative alternation operates on both underlying and epenthetic segments, as illustrated in (7).

## (7) Kalaallisut glide-fricative alternation

/asa-wa-t/	[asavat] 'you love him'
/taku-wa-t/	[takuwat] 'you see him'

The glide-fricative alternation can be analyzed as a relatively late process which applies after insertion has happened, that is in the postlexical stratum in the sense of Stratal OT (Bermúdez-Otero, *forthc.*; Kiparsky, *forthc.*). Establishing the relevant constraints would lead us too far afield, so it will be assumed here that at the stage when insertion happens, all inserted consonants are glides. The Stratal OT analysis also explains why both glides and fricatives are restricted by the constraint \*ji/wu in Kalaallisut: at the stage when \*ji/wu is relevant, all these consonants are glides.<sup>2</sup>

In what follows, I first present the analysis of Kalaallisut homorganic glide epenthesis, and then show how epenthesis is blocked or modified due to \*ji/wu. The constraint set assumed here includes the basic constraints as well as \*ji/wu and the constraints on long vowels: \*LONG and Max-μ, discussed in Chapter 3 (see Appendix A for definitions of all constraints).

#### 4.2.2 Homorganic glide insertion in Kalaallisut

This section considers the default strategy of hiatus resolution in Kalaallisut - homorganic glide insertion. This strategy applies before /a/ - i. e. in sequences where there is no risk of creating [ji] or [wu]. The Kalaallisut epenthesis pattern in this context is the same as

<sup>2</sup> I am grateful to Nick Danis for discussing this with me.



the minimal pattern of epenthesis familiar from Faroese. The relevant tableau is in (8) for /ulu-a/ [uluwa] ‘her knife’ in (6a).

In this context, splitting emerges as optimal because both ONSET and MAX-V dominate INTEGRITY. Thus, tolerating hiatus or deleting one of the vowels is impossible under this ranking. Note that vowel deletion in Kalaallisut always preserves the input moras, and therefore the candidate (8c) considered here has a long vowel. Vowel deletion with mora preservation will be further discussed in 4.2.3.

(8) Homorganic glide insertion in Kalaallisut

	/ulu <sub>1</sub> a <sub>2</sub> /	ONSET	MAX-V	INTEGRITY
✶ a.	ulu <sub>1</sub> w <sub>2</sub> a <sub>2</sub>			1
c.	ulu <sub>1</sub> a <sub>2</sub>	W1		L
d.	ulu: <sub>1</sub>		W1	L

Homorganic glide epenthesis is also attested in sequences of two high vowels. In this case, the constraint \*ji/wu ensures that the first vowel always splits. This is illustrated in (9) for /ajuqi-uwuq/ [ajuqijuwuq] ‘is a catechist’. Splitting the second vowel to yield \*[ajuqiwwuq] is impossible because this would incur a gratuitous violation of \*ji/wu (9b).

(9) Homorganic glide insertion in Kalaallisut

	/ajuqi <sub>1</sub> u <sub>2</sub> wuq/	ONS	*ji/wu	MAX-V	INTEGRITY
✶ a.	ajuqi <sub>1</sub> j <sub>1</sub> u <sub>2</sub> wuq		(1)		1
b.	ajuqi <sub>1</sub> w <sub>2</sub> u <sub>2</sub> wuq		W1 (1)		1
c.	ajuqi <sub>1</sub> u <sub>2</sub> wuq	W1	(1)		L
d.	ajuqi: <sub>1</sub> wuq		(1)	W1	L

The surface sequence [wu] actually appears in the winner (9a): [ajuqijuwuq] ‘is a catechist’, hence a parenthesized violation of \*ji/wu. In Chapters 6 and 7 I discuss some evidence that underlying glides may have a different feature specification from that of vowels and vocalic glides that come from splitting. In Kalaallisut, the underlying glides are consonantal, and hence they do not actually violate \*ji/wu – the parenthesized violation marks do not appear in the actual evaluation. A detailed analysis of the behavior of vocalic and consonantal glides in epenthesis is given in Chapter 6 while in what follows I abstract away from this complication. To summarize, before /a/ Kalaallisut exhibits minimal epenthesis, whereas in sequences of high vowels it shows directional blocking due to the constraint \*ji/wu.

### 4.2.3 Merger to avoid \*ji/wu violation

Contraction to a long vowel illustrates that splitting can interact with other hiatus resolution strategies, which is expected based on Casali (1998). The analysis proposed here relies on deletion with mora preservation within moraic theory (Hyman, 1985; McCarthy & Prince, 1986; Hayes, 1989), but other approaches (e.g. coalescence) would work as well.

On the moraic analysis, the melody of one of the vowels is deleted in violation of MAX-V but its timing slot is preserved to satisfy MAX- $\mu$ . This is illustrated in (10) for /nuna-uvuq/ [nuna:vuq] 'is land'. The winner (10a) violates MAX-V and \*LONG, but it is better than the other alternatives. Thus hiatus is prohibited by ONSET, while faithful splitting violates \*ji/wu in this context. Splitting a high vowel to yield a non-homorganic glide incurs a violation of IDENT-[back] which is worse than deleting vocalic melody in Kalaallisut.

(10) Kalaallisut contraction to a long vowel

/nuna <sub>1</sub> u <sub>2</sub> vuq/	*ji/wu	ONS	MAX- $\mu$	ID-[bk]	MAX-V	*LNG	INT
a. nuna <sub>1</sub> vuq					1	1	
b. nuna <sub>1</sub> u <sub>2</sub> vuq		W1			L	L	
c. nuna <sub>1j</sub> u <sub>2</sub> vuq				W1	L	L	W1
d. nuna <sub>1</sub> w <sub>1</sub> u <sub>2</sub> vuq	W1				L	L	W1
e. nuna <sub>1</sub> vuq			W1		1	L	

### 4.2.4 Disharmonic epenthesis when merger is impossible

Disharmonic glide epenthesis (6c) occurs when homorganic glides cannot be inserted due to \*ji/wu and input moras cannot be preserved because one of input vowels is long. Kalaallisut disallows trimoraic vowels, which I assume is due to the constraint \*OVERLONG in (11).

(11) \*OVERLONG: assign a violation mark for each trimoraic vowel

The analysis of disharmonic glide insertion is illustrated in (12) for /na:-i/ [na:vi] 'his stomach'. Recall that the glide/fricative alternation is assumed to apply post-lexically, and so the actual winner at this stage inserts a [w]. The high-ranked constraint \*ji/wu blocks homorganic glide epenthesis (12c), since it would lead to creation of an illicit sequence. The other epenthetic options are impossible in word-medial hiatus in Kalaallisut: for example, the epenthetic laryngeals are blocked by IDENT-[place] (12d).<sup>3</sup> When one of the vowels is long, it is impossible to preserve all input moras on one of the vowels, since this would create a trimoraic segment (12e), ruled out by \*OVERLONG.

<sup>3</sup> See Chapter 6 for a discussion of word-initial laryngeal insertion in Kalaallisut.

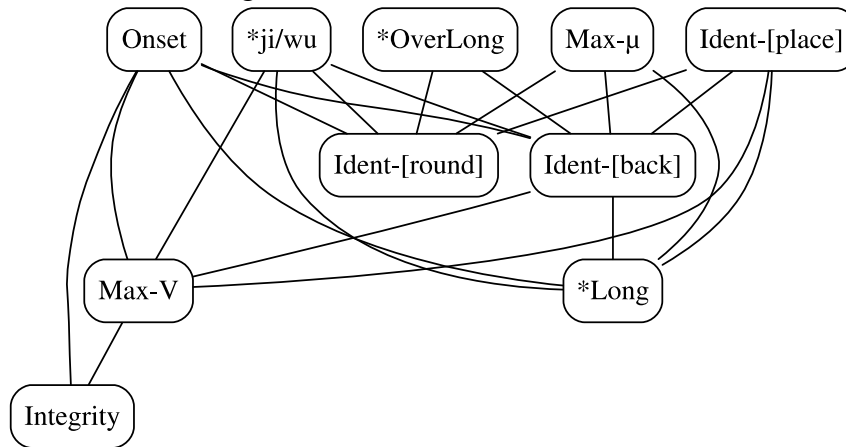
## (12) Analysis of Kalaallisut disharmonic glide epenthesis

	/na: <sub>1</sub> i <sub>2</sub> /	*ji/wu	*OV LNG	*ID- [plc]	ONS	MAX- μ	ID- [bk]	ID- [rnd]	MAX- V	INT
a.	na: <sub>1</sub> w <sub>1</sub> i <sub>2</sub>						1	1		1
b.	na: <sub>1</sub> i <sub>2</sub>				W1		L	L		L
c.	na: <sub>1</sub> j <sub>2</sub> i <sub>2</sub>	W1					L	L		1
d.	na: <sub>1</sub> ʔ <sub>1</sub> i <sub>2</sub>			W1			L	L		1
e.	na: <sub>1</sub>		W1				L	L	W1	L
f.	na: <sub>1</sub>					W1	L	L	W1	L

## 4.2.5 Summary on Kalaallisut

The overall ranking that accounts for Kalaallisut hiatus resolution is given in (13). Only one of the IDENT constraints on backness and roundness has to dominate \*LONG and MAX-V. For an illustration, I assumed here that it is IDENT-[back]. This ranking establishes that in Kalaallisut hiatus is resolved by homorganic glide insertion, unless it is blocked by \*ji/wu. If \*ji/wu is at play, hiatus is instead resolved by vowel deletion, or (if underlying moras cannot be faithfully preserved) – by disharmonic glide insertion.

## (13) Kalaallisut ranking



The following sections present some possible caveats with Kalaallisut data, and briefly discuss the possible analysis of Kalaallisut in the Insertion theories.

## 4.2.6 Kalaallisut: complications

The Kalaallisut epenthesis alternations crucially interact with consonant-zero alternations for many stems (Darden, 1982). These stems exhibit an unpredictable final consonant in isolation (in careful speech) and in compounds, but they act as vowel-final in that they trigger glide insertion and other hiatus repairs when vowel-initial suffixes are added (14). The final ghost consonant is always dorsal or uvular.

## (14) Kalaallisut stem-final ghost consonants

- a. /qimmi(q)/ [qimmiq] 'dog'  
       /qimmi(q)-a/ [qimmija] 'his dog'
- b. /inu(k)/ [inuk] 'human being'  
       /inu(k)-uwuq/ [inu:wuq] 'is a human'

At the addition of consonant-initial suffixes, the behavior of these stem-final ghost consonants depends on the morphological context: certain suffixes trigger final C deletion, while others assimilate the final C to create a geminate.

Thus, many of the stems that trigger glide epenthesis actually have an underlying final consonant. A full analysis of these alternations would take us too far afield. These alternations can be analyzed by postulating stem-final latent segments (Zoll, 1996). Their appearance in phrase-final position can be captured as an effect of the constraint FINAL-C (McCarthy, 1993; McCarthy & Prince, 1994), while in other positions they may exploit a neighboring consonant in order to be realized, but do not show up when surrounded by vowels. Deletion of stem-final latent segments is probably conditioned by their marked place (dorsal or uvular), but it clearly also depends on the morphological environment. While in Kalaallisut the alternations of stem-final dorsals and uvulars are morphologized, Uradhi (Hale, 1976; Crowley, 1983) presents a more clear-cut case where deletion alternations target all final dorsals unless they occur at a phrase edge (see Chapter 9).

#### 4.2.7 Kalaallisut epenthesis and Insertion theories

The peculiar pattern of disharmonic glide insertion in Kalaallisut serves well to illustrate the differences between the Splitting theory and the similarity mechanisms employed in the Insertion theories (Darden, 1982; Murasugi, 1991; Rosenthal, 1997b). From the point of view of Splitting, glides are good candidates for insertion because they are faithful to the input vowel's major class features [consonantal] and [sonorant]. If vocalic glides and all vowels are specified for Dorsal place (Levi, 2004; 2008), then the disharmonic glide insertion also preserves the place specification of the input.

In contrast, within the Insertion theories the disharmonic glides in Kalaallisut have to get their major class features via spreading from vowels, but their tongue position features have to be inserted. For example, the autosegmental theories of insertion (Rubach, 2000; Kawahara, 2003; Uffman 2007a; Naderi & van Oostendorp 2011) would probably have to proceed along the following lines to analyze a mapping like /a:i/ → [a:wi] which occurs (modulo glide-fricative alternations) in [na:vi] 'his stomach' (6c).

The inserted segment has marked feature values [-consonantal +continuant], and probably also [+sonorant]. All of these feature values are relatively marked (de Lacy, 2006), and therefore their insertion cannot be attributed to the markedness component. Consequently, the autosegmental Insertion theories would presumably have to assume that there are constraints DEP-[consonantal], DEP-[continuant], and DEP-[sonorant]. Importantly, these features have to spread onto the inserted consonants without also spreading tongue position features like [high] or [round].

In a similar vein, using AGREE constraints for epenthesis (de Lacy, 2006), we could assume that there are constraints that require a consonant to agree with a neighboring

vowel in the features [consonantal], [sonorant], and [continuant]. For Kitto & de Lacy (1999), a similar effect is achieved via OO-correspondence constraints.

All of these theories share a common implication which is lacking in the Splitting theory. The spreading/agreement processes that affect epenthetic consonants are also expected to be found applying to underlying consonants (though not necessarily in Kalaallisut). Thus if in Kalaallisut a vowel spreads its value of [continuant] onto the inserted consonant, we expect to see languages where an underlyingly unspecified consonant will show up as a continuant next to a vowel, but as a non-continuant elsewhere. On the other hand, within the Splitting theory the epenthesis data yield no such necessary implications since they are handled by regular IO-faithfulness constraints.

Kalaallisut is particularly interesting since it shows that spreading/agreement has to apply to major class features, to the exclusion of other features. The issue of whether such spreading processes are attested is debated. In many feature theories, the features [sonorant] and [consonantal] occupy the root node, and hence cannot spread (McCarthy, 1988; Cho & Inkelas, 1994; Halle *et al.*, 2000). Kaisse (1992) proposes that the feature [consonantal] can spread excluding other features, while [sonorant] cannot (see also Nevins & Chitoran, 2008).

#### 4.2.8 Summary

To summarize, Kalaallisut exhibits a pattern of glide insertion that combines the basic pattern of homorganic glide insertion next to high vowels with blocking from the constraint \*ji/wu. Epenthesis in Kalaallisut interacts with another hiatus repair – contraction to a long vowel.

Independently motivated restrictions on glide-vowel sequences can have a blocking effect on epenthetic patterns. In a sequence of two high vowels, the most faithful pattern of insertion of homorganic glides could lead to splitting either vowel, but it is always the first vowel that splits in such situations (modulo the influence of other blocking conditions), e.g. /iu/ → [iju], \*[iwu] in Faroese and Kalaallisut. Furthermore, in Kalaallisut and Woleaian glide insertion is always systematically blocked if it would lead to the sequences [ji], [wu]. However, as I argue in what follows, the phonotactic restrictions are not sufficient to account for all of the observed directionality patterns in glide epenthesis.

### 4.3 Positional faithfulness: variants of Integrity

Positional faithfulness constraints prohibit input-output mismatches in a prominent position (Beckman, 1998), and they are known to have a profound effect on the typology of hiatus resolution (Casali, 1998). Within the Splitting theory, positional faithfulness constraints may lead to blocking effects by prohibiting splitting in certain positions. In section 4.3.1, I argue for a positional variant of INTEGRITY constraint which refers to the segments within the same syllable. Section 4.3.2 is devoted to the INTEGRITY constraints relativized to word-initial position.

#### 4.3.1 Tautosyllabic integrity

In a number of languages, splitting always operates from a nucleus to a margin (usually an onset of a following syllable). On the surface, the outcome of epenthesis in a sequence  $V_1V_2$  is always determined by  $V_1$  in such cases (Keer, 1996). In this section, I show that

these patterns cannot be due to phonotactic constraints like \*ji/wu described in 4.2. The proposed *directionality analysis* relies on a positional faithfulness constraint formulated in (15) (abbreviated as T-INTEGRITY). This constraint prohibits splitting if both of an input segment's correspondents belong to the same syllable.

- (15) TAUTOSYLLABIC INTEGRITY: assign a violation mark for any input segment which has multiple output correspondents within the same syllable

For example, this constraint is violated in a mapping like /a<sub>1</sub>i<sub>2</sub>/ → [a<sub>1</sub>.j<sub>2</sub>i<sub>2</sub>], but not in the mapping /i<sub>1</sub>a<sub>2</sub>/ → [i<sub>1</sub>.j<sub>1</sub>a<sub>2</sub>].<sup>4</sup> Here I use the dot symbol to show output syllable boundaries.

One relevant pattern comes from Dutch (Zonneveld, 1978; Gussenhoven, 1980; Booij, 1995). The vowel inventory of Dutch is given in (16). The length/tenseness opposition can be analyzed based on either feature, and I assume here that length is phonemic.

- (16) Dutch vowels

*Monophthongs:*

i: ɪ                      u: ʊ

y: ʏ

e: ɛ              ə              o: ɔ

ø:

a: ɑ

*Diphthongs:* ɛi, œy, au

Here I focus only on glide insertion in Dutch, while the other hiatus repairs are discussed in Chapter 6 (glottal stop) and Chapter 9 ([n]). The suffix vowels are limited to [i ə], and thus the only vowel sequences that show alternations end in [i ə]. Foreign roots that could have underlying vowel sequences exhibit the same pattern with regards to the glides (although in these cases the glides could synchronically be underlying).

Hiatus is resolved via glide insertion after high and mid vowels (17a-b). However, vowel sequences starting with /a/ surface faithfully (17c).

<sup>4</sup> At word edges, where only tautosyllabic splitting is possible, T-INTEGRITY is also violated. However, the relationship between 'copying from the left' word-medially and avoidance of splitting at edges is obscured by the fact that there are several additional constraints referring to prosodic edges, e.g. initial faithfulness (section 4.3.2), and the preference for laryngeals at edges (Chapter 6).

## (17) Hiatus resolution depends on the first vowel in Dutch

## d. Glide insertion after a high vowel

/iə/	/kni-ə/	[ <sup>1</sup> kni <sup>j</sup> ə] ‘knees’
/ui/	/hɪndu-ismə/	[hɪndu <sup>1</sup> wismə] ‘hinduism’
/uə/	/barbəkju-ə/	[ <sup>1</sup> barbəkjuwə] ‘to barbecue’

## e. Glide insertion after a mid vowel

/ei/	/fariːzɪs/	[fari <sup>1</sup> zeːjɪs] ‘pharisaic’
/eə/	/zeː-ə/	[ <sup>1</sup> zeːjə] ‘seas’
/oi/	/eːɣoː-ismə/	[eːɣoː <sup>1</sup> wismə] ‘egoism’
/oə/	/jydo-ə/	[ <sup>1</sup> jydoːwə] ‘to judo’

## f. No insertion after a low vowel

/ai/	/proːzaːs/	[proː <sup>1</sup> zaːɪs] ‘prosaic’
/aə/	/rumba-ən/	[ <sup>1</sup> rumbaən] ‘to rumba’

Unlike other vowels, schwa is deleted before another vowel. The quality of the glide after front rounded vowels /y/ ʏ ø/ is variable, at least in some dialects. The variation is between [j], and a glide transcribed as either [w] (Zonneveld, 1978) or [ɥ] (Gussenhoven, 1980; Booij, 1995). The exact quality of the inserted glides after front rounded vowels is irrelevant for our present purposes.

In Dutch, it is always the first vowel that determines the quality of the inserted glide. The second vowel is disregarded, even if it could be split to yield a perfectly identical glide. Witness the contrast between [fariːzeːjɪs] ‘pharisaic’ and [proː<sup>1</sup>zaːɪs], \*[proː<sup>1</sup>zaːjɪs] ‘prosaic’ in (17).<sup>5</sup>

The Dutch pattern presents an extension of high glide insertion to mid vowel contexts (see Chapter 2), and the analysis of directionality can be given in a constraint system which includes TAUTOSYLLABIC-INTEGRITY (15). When the first vowel is high or mid, a homorganic glide is inserted, as illustrated in (18) for the word [fariːzeːjɪs] ‘pharisaic’ (17b). In this tableau, the winning candidate violates \*ji/wu, and therefore ONSET must crucially dominate \*ji/wu (18b). This tableau also illustrates the operation of T-INTEGRITY: this constraint picks which one of the vowels splits. The second vowel cannot split to yield an onset of its own syllable, since this would be tautosyllabic splitting (18d). Similarly, T-INTEGRITY is violated by (18e) where the first vowel splits to yield a coda of its own syllable (of course (18e) is a hopeless candidate because it violates ONSET).

<sup>5</sup> I am grateful to Marc van Oostendorp for the first example in this pair.

## (18) Glide insertion after mid vowels in Dutch

/fa:ri:ze: <sub>1</sub> i: <sub>2</sub> s/	T-INT	ID-[place]	ONS	ID-[high]	*ji/wu	INT
☞ a. ze: <sub>1</sub> .j <sub>1</sub> i: <sub>2</sub>				1	1	1
b. ze: <sub>1</sub> .i: <sub>2</sub>			W1	L	L	L
c. ze: <sub>1</sub> .ʔ <sub>1</sub> i: <sub>2</sub>		W1		L	L	1
d. ze: <sub>1</sub> .j <sub>2</sub> i: <sub>2</sub>	W1			L	1	1
e. ze: <sub>1</sub> .j <sub>1</sub> .i: <sub>2</sub>	W1		W1	1	1	1

Next, let us look at an example where T-INTEGRITY does some crucial work. The sequences where the first vowel is low surface without epenthesis, e.g. [pro:'za:is] ‘prosaic’ (17c). The analysis of such a sequence is illustrated in (19). It is fairly straightforward to explain why the first vowel /a/ cannot split to yield [j]: this would incur a violation of IDENT-[low] since /a/ is [+low –high] while the high glides are [–low +high]. However, T-INTEGRITY is crucial in explaining why the second vowel /i/ does not split to yield a glide. The relevant candidate (19d) does well on faithfulness, and it is only the fact that splitting is tautosyllabic that rules this candidate out. Thus T-INTEGRITY must be ranked above ONSET.

## (19) No glide insertion after low vowels in Dutch

/pro:za: <sub>1</sub> i: <sub>2</sub> s/	T-INT	ID-[plc]	ID-[low]	ONS	ID-[high]	*ji/wu	INT
☞ a. za: <sub>1</sub> .i: <sub>2</sub>				1			
b. za: <sub>1</sub> .j <sub>1</sub> i: <sub>2</sub>			W1	L	W1	W1	W1
c. za: <sub>1</sub> .ʔ <sub>1</sub> i: <sub>2</sub>		W1		L			W1
d. za: <sub>1</sub> .j <sub>2</sub> i: <sub>2</sub>	W1			L		W1	W1
e. za: <sub>1</sub> .w <sub>1</sub> i: <sub>2</sub>			W1	L	W1	W1	W1

Importantly, the failure of the candidate (19d) above cannot be explained with the constraint \*ji/wu. This constraint favors the loser in (18), and therefore it must be ranked below ONSET. The combined ranking requirements of (18-19) are illustrated in (20). The constraint \*ji/wu would have to dominate ONSET if it were to block the insertion of a glide for the input /tai/. However if this was the case, \*ji/wu would also incorrectly block glide insertion for the input /tei/.

## (20) Phonotactic analysis of Dutch is impossible

Input	Winner	Loser	ONSET	*ji/wu
/tei/	[teji]	[tei]	W	L
/tai/	[tai]	[taji]	L	W

To summarize, Dutch hiatus resolution exhibits a pattern where the first vowel always splits, due to the constraint T-INTEGRITY.



A very similar pattern occurs in the dialect of Farsi described in Naderi & van Oostendorp (2011). In this dialect hiatus is resolved by glide epenthesis after a high vowel (21a), but a glottal stop emerges after a mid or low vowel (21b). Note that this example involves two homophonous /i/ suffixes, one with an indefinite meaning, and one marking adjectives.

(21) Glide and glottal stop epenthesis in Farsi (Naderi & van Oostendorp, 2011)

- |    |              |              |                     |
|----|--------------|--------------|---------------------|
| a. | /sep̥hi-ɒn/  | [sep̥hiɟɒn]  | ‘soldiers’          |
|    | /ʔahu-i/     | [ʔahuwi]     | ‘a deer’            |
|    | /bɒzɒri-i/   | [bɒzɒɾiji]   | ‘a businessman’     |
| b. | /xɒne-at/    | [xɒneʔat]    | ‘colloquial’        |
|    | /rɒdijo-i/   | [rɒdijoʔi]   | ‘relating to radio’ |
|    | /bɒlb-i/     | [bɒlbʔi]     | ‘the one above’     |
|    | /mohɒvere-i/ | [mohɒvereʔi] | ‘colloquial’        |

Just like in Dutch, the quality of the vowel on the right does not matter, hence the contrast between [bɒzɒɾiji] ‘a businessman’ and [mohɒvereʔi] ‘colloquial’.

The ranking that produces the Farsi pattern differs from Dutch only in reranking \*LAR. The two languages thus illustrate completely identical blocking effects, but slightly different extensions of the minimal homorganic glide insertion pattern next to high vowels (see Chapter 2).

It should be pointed out that the Farsi data may be more complex than suggested by the examples in (21). For one thing, the epenthesis patterns in (21) are characteristic of formal Farsi, while vowel elision is operative in daily speech. Furthermore, most existing accounts of Farsi hiatus resolution indicate variation between [j] and [ʔ] epenthesis after a mid vowel, as well as after high vowels to some extent (Lazard, 1957; Mahootian, 1997; Picard, 2003; Rohany Rahbar, 2012). The Persian speakers that I consulted also variably allowed [j] insertion after mid vowels, as well as glottal stop after high vowels.<sup>6</sup> These data clearly call for a thorough investigation of the possible dialectal differences, as well as other possible factors that affect this variation.

To summarize, this section has proposed the constraint TAUTOSYLLABIC-INTEGRITY that disprefers tautosyllabic splitting. One of the effects of this constraint is prohibiting the splitting of a second vowel in V<sub>1</sub>V<sub>2</sub> sequences. The data from Farsi and Dutch suggest that a constraint like T-INTEGRITY is needed within the Splitting theory. Furthermore, these data cannot be analyzed with only the phonotactic constraints like \*ji/wu. These arguments, of course, hold to the extent that the data from Farsi and Dutch are robust and represent true epenthesis.

In many cases it proves to be difficult to differentiate between a directionality pattern based on T-INTEGRITY and a phonotactic pattern where the sequences [ji wu] or [ji je wu]

<sup>6</sup> I am grateful to Elham Rohany Rahbar and Bahareh Soohani for their help with the Farsi data.

wo] are avoided. While these constraints make different predictions, the relevant data is often unavailable.

While T-INTEGRITY accounts for some of the observed directionality patterns, it is admittedly a descriptive constraint rather than an explanatory one in the sense that it is not reducible to other independently motivated principles. The problem of capturing leftward directionality is not unique to Splitting theory however. Thus Rubach (2002) discusses the same problem within an autosegmental theory of glide epenthesis. From the point of view of that theory, a configuration where an onset shares features with a nucleus of a preceding syllable (preferred in Dutch and Farsi) violates the CRISP-EDGE constraints of Ito & Mester (1999). Rubach (2002) thus proposes that a constraint antagonistic to CRISP-EDGE may have to be stipulated. Similarly, de Lacy (2006) postulates the constraints AGREE-VC (but no AGREE-CV), with little discussion of the additional motivation for such an asymmetry. Importantly, the observed directionality patterns cannot be reduced to the effects of the phonotactic constraints like \*ji/wu.

### 4.3.2 Initial integrity

In this section I propose that the constraint INTEGRITY, just like other faithfulness constraints, has a positional version referring to the initial position (see also Chapter 7 on INTEGRITY related to the root). The underlying representation is often preserved more faithfully in prominent positions (Beckman, 1998). Furthermore, the positional faithfulness effects are known to be relevant to hiatus resolution (Casali, 1998). Therefore it is not surprising that input vowels avoid being split in prominent positions.

Within Splitting theory, INITIAL-INTEGRITY predicts a blocking pattern where insertion of homorganic glides next to high vowels occurs word-medially, but not word-initially. This happens in a number of languages, including Faroese. Vowel sequences containing a high vowel trigger glide insertion in Faroese, but word-initial high vowels surface faithfully (Lockwood, 1955; Anderson, 1972; Thráinsson *et al.*, 2004; Árnason, 2011).

(22) Faroese glide epenthesis: only word-medially next to high vowels

a. /mi:-aɪ/ [mi:jaɪ] 'middle-PL.FEM'

/tʰu:-a/ [tʰu:wa] 'to say tú (thou)'

/so:-m/ [so:jm] 'boiled'

/kle:-i/ [kle:ji] 'gladness'

b. [ɪtʃi:] 'not';

[uʃkʊr] 'Irish'

The emergence of word-initial onsetless syllables in Faroese was analyzed in Chapter 2. The tableau in (23) presents the general ranking conditions for word-initial non-insertion in languages like Faroese.

## (23) Epenthesis blocked word-initially by positional faithfulness

	/#i <sub>1</sub> /	INI-INTEGRITY	ONSET	INTEGRITY
☞ a.	i <sub>1</sub>		1	
b.	j <sub>1</sub> i <sub>1</sub>	W1	L	W1

Other languages reported to allow vowel-initial words, but resolve word-medial vowel sequences via epenthesis include Dakota (Shaw, 1980), Dutch (Zonneveld, 1978; Booij, 1995), Colloquial Slovak (Rubach, 2000), Polish (Rubach, 2000), Japanese (Kawahara, 2003), Kodava (Ebert, 1996), Madurese (see Chapter 5), Indonesian (Lapoliwa, 1981; Cohn, 1989; Cohn & McCarthy, 1998) and Malay (Onn, 1980; Durand, 1987; Ahmad, 2001, 2005).<sup>7</sup>

Within the Splitting theory, avoidance of word-initial epenthesis is accounted for by positional faithfulness (see also Chapter 2). In Insertion theories, such an account is impossible because the inserted segments have no input correspondent. Consequently, Insertion theories appeal to Alignment or Anchoring (e.g. IO-ANCHOR-L) to explain such patterns (McCarthy & Prince, 1993a; b, 1995; Rosenthal, 1997b; Rubach, 2000, 2002). In contrast, the Splitting Theory cannot appeal to IO-ANCHOR-L because word-initial epenthesis does not violate Anchoring: the epenthetic segment has an input correspondent, and is affiliated with a morpheme. Nevertheless, the Anchoring theory and positional faithfulness theory have essentially equivalent outcomes in their predictions about word-initial epenthesis: word-initial epenthesis can be prohibited without banning word-medial epenthesis.

#### 4.4 Heterosyllabic splitting

All of the blocking constraints examined so far have a common property: they all prohibit splitting a vowel to yield its own onset. TAUTOSYLLABIC-INTEGRITY encodes a general ban on tautosyllabic splitting. INITIAL-INTEGRITY prohibits tautosyllabic splitting in initial syllables. Finally, the constraint \*ji/wu does not directly assess whether splitting is tautosyllabic, but it bans any splitting which yields an onset homorganic to the nucleus.

None of these blocking conditions favor heterosyllabic splitting. Therefore, the theory developed so far predicts that no language will systematically prefer splitting a vowel to yield its own onset over splitting a vowel to yield an onset of another syllable. In terms of the spreading theories, the same generalization can be restated as follows: no language will exhibit systematic ‘copying from the right’ (Keer, 1996). The opposite of Dutch and Farsi, where in  $V_1V_2$  the second vowel determines the quality of inserted glides, is excluded.

This study did not systematically assess this prediction, since the focus of the typological investigation was the inventory of inserted consonants. That said, no clear cases of systematic heterosyllabic splitting appear in my sample.

Some potential counterexamples are clearly confounded by morphological or prosodic factors. Thus, a pattern where glides would be inserted word-initially but hiatus would be tolerated medially could be due to the constraints that disallow onsetless

<sup>7</sup> Indonesian is very closely related to Malay, but the reported patterns of hiatus resolution are slightly different. While Cohn & McCarthy (1998 fn. 33) report ‘something of a glide’ in vowel sequences after a low vowel in Indonesian, there is no comparable evidence for Malay.

syllables specifically in word-initial position (Flack, 2007, 2009; see also Chapter 6).<sup>8</sup> A somewhat more complicated pattern occurs in Shona, where hiatus is resolved by apparent heterosyllabic splitting ('copying from the right'), but only at the right edge of a stem (Mudzingwa, 2010). Within the Splitting theory, this pattern can be treated as resulting from an Alignment requirement: the left edge of a morphological stem (which is recursive, as argued independently by Mudzingwa) has to coincide with the left edge of a syllable in the output. If a /V<sub>1</sub>V<sub>2</sub>/ sequence occurs at a prefix-root boundary, then only splitting V<sub>2</sub> would yield a perfect stem-syllable correspondence: /V<sub>1</sub>|V<sub>2</sub>/ → [V<sub>1</sub>|.C<sub>2</sub>V<sub>2</sub>], \*[V<sub>1</sub>.C<sub>1</sub>|V<sub>2</sub>].<sup>9</sup>

Ukrainian is another possible case of heterosyllabic splitting (Bilodid, 1969; Pugh & Press, 1999). In this language, all V<sub>1</sub>V<sub>2</sub> sequences are reportedly allowed, except for the sequences where the second vowel is [i] (Rubach, 2002). Words of foreign origin which are expected to have a relevant vowel sequence appear with Vji instead (24b). The only suffix which starts with /i/ also shows the relevant alternation (24c).

(24) Ukrainian vowel sequences and glide epenthesis

a. Vowel sequences

[d'ia'l'ɛkt] 'dialect'

b. Vji sequences

[intuʒi'trɪvnɪj] 'intuitive'; [koka'jin] 'cocaine'

g. Vji alternation for the suffix /-ist/

/futbol-ist/ [fudbɔ'l'ɪst] 'football player'

/mao-ist/ [maɔ'jɪst] 'Maoist'

The alternations of the Ukrainian vowel sequences are supported by the distributional generalizations and by the alternations of one affix. There are words which start in an [i], in and these words the first vowel turns into a glide, rather than triggering glide insertion, when preceded by a vowel-final word (Rubach, 2002). It may be possible to reanalyze Ukrainian as a case of non-productive lexical generalization, while the suffix /-ist/ could have a latent segment at the beginning (or perhaps simply be /jɪst/ underlyingly). While the productivity of this case may be questionable, it could be confirmed in a more detailed study.

Finally, the Chungli dialect of Ao described by Gowda (1975) may present an example of heterosyllabic splitting/'copying from the right'. However, little data is available on this dialect, and other hiatus resolution strategies (such as vowel deletion)

<sup>8</sup> Related to vowel insertion, Kenstowicz (1994) also proposes a constraint CONTIGUITY that disallows word-medial epenthesis.

<sup>9</sup> This analysis uncovers a broader prediction of the Splitting theory: since the inserted consonants are underlying, consonant epenthesis may so to speak extend the morphological edge to satisfy ALIGN. A full exploration of this is left for the future.

are recorded as well (Morley, 2013). No comparable pattern of glide insertion is recorded for the Mongsen dialects described by Coupe (2007).

To summarize, no clear cases of heterosyllabic splitting are known. If Ukrainian proves to be a case of true epenthesis, there are several possible routes for analysis within the Splitting theory. First, it is possible that there is a constraint HETEROSYLLABIC INTEGRITY, which would be formulated as a mirror image of T-INTEGRITY. Second, it may be that there is a constraint against the sequence \*[ij] which does not also target [ji].

## **4.5 Conclusion**

The Splitting theory predicts that positional markedness and faithfulness constraints may block the fully homorganic glide insertion pattern. This prediction is borne out in the directional blocking effects, which almost always coexist with homorganic glide insertion. This chapter proposes to analyze the directional blocking effects on homorganic glide insertion with two kinds of constraints: the phonotactic constraints on glide-vowel sequences (Kawasaki, 1982) and the positional faithfulness versions of the constraint INTEGRITY (Keer, 1996; Beckman, 1998; Casali, 1998).

## *Chapter 5. Epenthetic segments and the inventory. Epenthesis in Madurese*

### **5.1 Introduction**

This chapter illustrates several important predictions of the Splitting theory, based on a detailed analysis of epenthesis patterns in Madurese (Stevens, 1968; Cohn, 1993a; b; c; Cohn & Lockwood, 1994; Davies, 2010). Madurese has received some attention in the phonological literature due to its harmony, reduplication, laryngeal features, and nasalization (McCarthy & Prince, 1986, 1995; Trigo, 1991; Cohn, 1993a; b; c).

Madurese presents an example of extended epenthesis (discussed in Chapter 2). Homorganic glides are inserted next to high vowels, and this pattern is extended to mid vowel contexts. Madurese also shows directional blocking in that homorganic glide+vowel sequences are avoided. Just as expected from fact that Splitting theory is implemented in OT, extension and blocking interact in Madurese.

Interestingly, word-medial glides in Madurese only appear in the environments where they are epenthetic. In other words, the glides only appear next to a homorganic high or mid vowel on the surface. Within the Splitting analysis this pattern results from the positional faithfulness constraint V-NUC that requires input vowels to have a nucleus correspondent (see also Rosenthal, 1997b). However, the introduction of this constraint makes the system non-output driven. This consequence of the analysis is discussed in section 5.3.

Finally, the Splitting theory imposes no restrictions on the constraints that trigger insertion of consonants. As a result, we expect to find systems where multiple constraint types are responsible for insertion. Madurese insertion patterns show effects of multiple markedness constraints. In general, ONSET is enforced only after high and mid vowels in Madurese. However, when two identical vowels come together, the resulting sequence could violate the OCP, and such hiatus is always resolved, even if the sequence only contains low vowels.

### **5.2 Extended insertion and blocking in Madurese**

Madurese presents a particularly interesting case where extension and blocking are intertwined. The minimal pattern of glide insertion next to high vowels is extended to mid vowels. In order to repair the sequences of identical vowels, epenthesis is possible even with low vowels. Finally, a general pattern of directional blocking is also present in Madurese.

Since the patterns of Madurese hiatus alternations are fairly complex, the whole picture is first briefly reviewed, followed by a detailed investigation of different aspects of epenthesis.

#### **5.2.1 Overview of the data**

The surface consonant inventory of Madurese is given in (1). The segments in parentheses only occur in loanwords. The coronal stops are dental. The three-way laryngeal contrast in stops is neutralized in codas, where unreleased stops appear.

## (1) Madurese consonants

p	p <sup>h</sup>	b	t	t <sup>h</sup>	d	ʈ	ʈ <sup>h</sup>	ɖ	c	c <sup>h</sup>	ɟ	k	k <sup>h</sup>	g	ʔ
m			n						ɲ						
(f)			s												(h)
			l		r										
			j									w			

Madurese glides are severely restricted in their distribution. With rare exceptions (see 5.3), they only appear after a peripheral vowel (i.e. [i ɛ ɔ u]) and before another vowel. As we shall see, this is precisely the environment where Madurese inserts glides. The relationship between the inventory facts and insertion patterns in Madurese is discussed in detail in section 5.3.

The vowel inventory of Madurese appears in (2). The vowels /i u ɛ ɔ/ are variably realized as [ɪ ʊ e o] in closed syllables. The phonetic studies of these alternations report a good deal of variation both by speaker and by item (Cohn & Lockwood, 1994; Davies, 2010). The vowel transcribed here as [ɣ] (in conformity with my sources), is in fact most often pronounced as [ə] (Davies, 2010, pp 19–20), and it behaves phonologically as a central vowel.

## (2) Madurese vowels

<b>i</b>	<b>ɪ</b>	<b>u</b>
	ɣ	
<b>ɛ</b>	<b>ə</b>	<b>ɔ</b>
	<b>a</b>	

There is a general harmony/spreading process whereby high variants of vowels occur after voiced and voiceless aspirated stops while low variants occur elsewhere (i.e. after voiceless stops and other consonants). This intriguing harmony pattern is complicated by numerous factors, and it has attracted some interest in the theoretical literature (Stevens, 1968, 1980, 1985, 1994; Trigo, 1991; Cohn, 1993b; c; Davies, 2010). Due to vowel harmony, [ɣ ɪ] are the allophones of /a ə/ respectively. In other words, [ɣ ɪ] only occur in the environment where they would result from harmonizing with /a ə/.

The harmony alternations also affect vowel pairs [ɛ ~ i] and [ɔ ~ u], but /i u/ contrast with /ɛ ɔ/ since they may violate the harmony restrictions in loanwords. Many of the loanwords that escape the harmony patterns are fully adapted otherwise. On the whole, Stevens (1968) estimates that harmony is disobeyed in about 5% of the lexicon. To summarize, only the following vowels are contrastive: /i ɛ a ɔ u ə/. These are given in bold in (2).

Madurese syllables are generally of the form (C)CV(C), but onsetless syllables are allowed word-initially as in [abɣlɣ] ‘say’. The patterns of Madurese hiatus resolution are

illustrated in (3) for all vowel sequences for which I could find evidence. No underlying sequences with /ə/ as the first vowel occur. In these examples, many root-internal high vowels could be derived from underlying mid vowels by harmony, but since /i u/ are phonemic in the language as a whole, the underlying form with no alternation is assumed, in accordance with Lexicon Optimization (Prince & Smolensky, 2003). Evidence from alternations is given in (3) wherever it is available.

Sequences of identical vowels are avoided by glottal stop insertion (3a). For non-identical vowel sequences if the first vowel in  $V_1V_2$  is non-central, a glide homorganic to  $V_1$  is inserted (3b). Finally if the first vowel is central and the second vowel is not identical to the first, hiatus is tolerated (3c).

### (3) Madurese glide and glottal stop epenthesis

	VV	Example		Translation
a.	/aa/	/maca-a/	[macaʔa]	‘will read’
	(ʌʌ)	/baa/	[bʌʔʌ]	‘flood’
	/εε/	/mate-ε/	[mateʔε]	‘kill’
	/ɔɔ/	/tɔɔt/	[tɔʔɔt]	‘knee’
	/uu/	/t <sup>h</sup> uum/	[t <sup>h</sup> uʔum]	‘distribute’
b.	/ia/	/libali-an/	[libʌlijan]	‘several times’
		/bariaŋ/	[bʌrijaŋ]	‘feel unwell’
	/iu/	/t <sup>h</sup> iuk/	[t <sup>h</sup> ijuk]	‘commotion’
	/iə/	/diəm/	[dijəm]	‘calm’
	/ea/	/ɔlle-a/	[ɔlleja]	‘will get’
	/eə/	/seər/	[sejər]	‘fall asleep’
	/eɔ/	/ŋeɔr/	[ŋejər]	‘coconut’
	/ɔa/	/ka-ratɔ-an/	[karatɔwan]	‘palace/kingdom’
	/ɔə/	/sɔər/	[sɔwər]	‘notch’
	/ɔε/	/εka-taɔ-ε/	[εkataɔwε]	‘is known’
	/ui/	/bui/	[buwi]	‘fetter’
	/ua/	/ɖuaʔ/	[ɖuwʌʔ]	‘two’
c.	/aε/	/paεʔ/	[paεʔ]	‘bitter’
	/aɔ/	/paɔ/	[paɔ]	‘mango’
	/ai/ (ʌi)	/bʌi/	[bʌi]	‘else’
	/au/ (ʌu)	/c <sup>h</sup> ʌu/	[c <sup>h</sup> ʌu]	‘far’

Hiatus resolution in Madurese can be summarized as in (4), where the examples with no evidence from alternations are given in parentheses. The surface [a]~[ʌ] are distributed allophonically. Because of the harmony requirements of the language, there



are no homorganic sequences of high and mid vowels (no data on /iɛ/, /ei/, /uɔ/, /ɔu/ in (4)). The predictions for such sequences are discussed in section 5.2.5.

(4) Hiatus resolution in Madurese

V1 \ V2	i	u	ɛ	ɔ	a (ʁ)	ə
i		(iju)			ija	(ijə)
u	(uwi)	(uʔu)			uwa	
ɛ			ɛʔɛ	(ɛjɔ)	ɛja	(ɛjə)
ɔ			ɔwɛ	(ɔʔɔ)	ɔwa	(ɔwə)
a	ai	au	aɛ	aɔ	aʔa	

The following sections analyze the various aspects of Madurese hiatus resolution one by one. As we shall see, the analysis of Madurese motivates several additions to the constraint system established so far. First, OCP is clearly active in determining the contexts for epenthesis. Second, the phonotactic constraint \*ji/wu has to be extended to cover non-high vowel contexts. Finally, the distribution of glides in Madurese requires an introduction of a non-output-driven constraint regulating the relation between vowels and nuclei, as discussed in 5.3.

### 5.2.2 Glide insertion after non-central vowels

This section focuses on the sequences of non-identical vowels where the first vowel is a peripheral non-low vowel. All such vowel sequences are resolved by glide insertion. The relevant examples appear in (3b).

Madurese glide insertion pattern shows the properties of extended epenthesis discussed in Chapter 2 and directional blocking discussed in Chapter 3. Thus, just as expected of an OT system, the two kinds of patterns can and frequently do interact.

Homorganic glides are inserted next to high vowels – this is the most faithful minimal epenthesis pattern familiar from Faroese. An analysis of the form /libali-an/ [libɤlijan] ‘several times’ is presented in (5). Note that the winner (5a) does not violate any IDENT constraints. Inserting any other consonant is excluded because it would incur violations of IDENT.

(5) Homorganic glide insertion after high vowels

	libali <sub>1</sub> a <sub>2</sub> n	ONSET	INTEGRITY
✶ a.	libali <sub>1</sub> j <sub>1</sub> a <sub>2</sub> n		1
b.	libali <sub>1</sub> a <sub>2</sub> n	W1	L

This pattern of minimal epenthesis is extended to the mid vowel contexts. As discussed in detail in Chapter 3, glide insertion next to mid vowels implies a ranking of ONSET over IDENT-[high] because mid vowels do not share the value for feature [high] with the glides. This is illustrated in (6) with the form /ɔlle-a/ [ɔlleja] ‘will get’. To rule

out laryngeal insertion in this context, I assume that IDENT-[place] or \*LAR dominates IDENT-[high] (6c). Recall from Chapter 3, that laryngeal approximants can be specified for any height features, and hence the candidate (6c) does not violate IDENT-[high].

(6) Homorganic glide insertion after mid vowels

	$\text{oll}\epsilon_1\text{a}_2$	ID-[place]	*LAR	ONSET	ID-[high]	INTEGRITY
☞ a.	$\text{oll}\epsilon_1\text{j}_1\text{a}_2$				1	1
b.	$\text{oll}\epsilon_1\text{a}_2$			W1	L	L
c.	$\text{oll}\epsilon_1\text{?}_1\text{a}_2$	W1	W1		L	1

When the two vowels differ in backness, it is the first vowel that determines the quality of the inserted glide, thus /eka-taɔ-ɛ/ [ɛkataɔwɛ] ‘is known’; /bui/ [buwi] ‘fetter’. This is an instance of directional blocking, discussed in Chapter 3: splitting the second vowel must be blocked either by the phonotactic constraint from the \*ji/wu family, or by the constraint TAUTOSYLLABIC-INTEGRITY.

Madurese shows effects of the restriction on homorganic glide-vowel sequences, generalized to apply to both high and mid vowels: the sequences [ji jɛ wu wɔ] never appear in the Madurese data available. Similar restrictions are known for Ilokano (Hayes & Abad, 1989) and Japanese (Kawahara, 2003). The relevant constraint will be referred to as \*ji/je/wu/wo (7).

(7) \*ji/je/wu/wo: assign a violation mark for every margin-nucleus sequence of two segments which are identical in all features except feature [high]

This constraint prefers splitting the first vowel not only in sequences of high vowels, but also in sequences of mid vowels. Furthermore, the adoption of this constraint makes some additional predictions, to be discussed in sections 5.2.4-5.2.5. As illustrated in (8) for the word /ɲɛɔr/ [ɲɛjɔr] ‘coconut’, splitting the second vowel in a sequence of two mid vowels is harmonically bounded given the current system of constraints.

(8) Splitting the second vowel is prohibited

	$\text{ɲ}\epsilon_1\text{ɔ}_2\text{r}$	ONSET	*ji/je/wu/wo	ID-[high]	INTEGRITY
☞ a.	$\text{ɲ}\epsilon_1\text{j}_1\text{ɔ}_2\text{r}$			1	1
b.	$\text{ɲ}\epsilon_1\text{w}_2\text{ɔ}_2\text{r}$		W1	1	1

To summarize, glide insertion in Madurese is extended to mid vowels. Furthermore, homorganic sequences of a glide + high/mid vowel are prohibited. Thus, Madurese shows both extended epenthesis and directional blocking.

### 5.2.3 No insertion after central vowels

The Splitting theory crucially relies on faithfulness constraints to account for the epenthetic quality. The role of faithfulness is apparent in Madurese in that glide insertion is blocked in sequences of non-identical vowels where the first vowel is central. The relevant data from (3c) are repeated in (9), recall that the distribution of [a]~[ɤ] is allophonic and depends on the laryngeal features of the first consonant of the stem. Further, [ɤ] behaves as a central vowel phonologically, and is actually commonly pronounced as [ə] (although the sources traditionally transcribe it as [ɤ]). The vowels [ə]~[ɪ] are also distributed allophonically, but they never appear before other vowels.

(9) Hiatus is unresolved after central vowels

- [paɛʔ] ‘bitter’  
 [paɔ] ‘mango’  
 [bɤi] ‘else’  
 [c<sup>h</sup>ɤu] ‘far’

Since Madurese clearly distinguishes three degrees of backness, the feature [back] is insufficient. I therefore assume that the feature [front] is also relevant. Front vowels [i ɛ] are [+front, –back], back vowels [u ɔ] are [–front, +back], and the central vowels [a ɤ ɪ] are phonologically [–front, –back]. Therefore splitting a central vowel to yield [j] violates IDENT-[front], while splitting it to yield [w] violates IDENT-[back].

Both IDENT constraints on the backness features must be ranked over ONSET, since otherwise glide epenthesis could happen after central vowels. This is illustrated in (10) for [paɔ] ‘mango’. The height features of the output vowel are determined by the harmony process which is not analyzed here. The input could be both /pɤɔ/ and /paɔ/ for our purposes, and the evaluation would not change. Therefore the input is written with a capital ‘A’ in (10). The winner in (10a) violates ONSET, and hence the constraints against other candidates must outrank ONSET. Thus inserting a glide homorganic to the second vowel is impossible because of \*ji/je/wu/wo while splitting the central vowel /a/ to yield [j] violates IDENT-[front].

(10) Hiatus after a low vowel before [ɔ]

	pA <sub>1</sub> ɔ <sub>2</sub>	*ji/je/wu/wo	ID-[frnt]	ID-[place]	*LAR	ONSET	INT
✖ a.	pa <sub>1</sub> ɔ <sub>2</sub>					1	
b.	pa <sub>1</sub> j <sub>1</sub> ɔ <sub>2</sub>		W1			L	W1
c.	pa <sub>1</sub> ʔ <sub>1</sub> ɔ <sub>2</sub>			W1	W1	L	W1
d.	pa <sub>1</sub> w <sub>2</sub> ɔ <sub>2</sub>	W1				L	W1

The analysis of [bɤi] ‘else’ is very similar, as illustrated in (11).

(11) Hiatus after a low vowel before [i]

	$bA_1i_2$	*ji/je/wu/wo	ID-[bk]	ID-[place]	*LAR	ONSET	INT
☞ a.	$b\gamma_1i_2$					l	
b.	$b\gamma_{1j_2}i_2$	W1				L	W1
c.	$b\gamma_1\gamma_1i_2$			W1	W1	L	W1
d.	$b\gamma_1w_1i_2$		W1			L	W1

To summarize, the fact that Madurese tolerates hiatus after central vowels shows that faithfulness constraints on frontness and backness features must dominate ONSET, and illustrates, once again, the crucial role of faithfulness within the Splitting theory.

#### 5.2.4 Sequences of identical vowels

Despite the fact that some vowel sequences are allowed in Madurese, the sequences of identical vowels are never allowed. This is captured by a high-ranked constraint from the OCP family (Leben, 1973; McCarthy, 1986) which prohibits two fully identical vowels in a row.

(12) OCP-V: assign a violation for a sequence of two adjacent nuclei which are identical

The Splitting theory predicts that in principle any relevant markedness constraint may trigger epenthesis, and OCP-driven insertion in Madurese corroborates this prediction. This situation is particularly interesting since Myers (2002) claims that tonal OCP never triggers insertion of tones or vowels (this will be further discussed below).

Reference to syllable nuclei in the formulation of OCP in (12) makes a crucial prediction about surface glides: they will escape OCP violations since they are in the syllable margins. Thus, a sequence like [ij] is possible in Madurese, as in /libali-an/ [libɤlijan] ‘several times’ (3). On the other hand, neither the heterosyllabic sequence [i.i] nor the long vowel [i:] occur on the surface.

The OCP is also special in Madurese because it causes insertion of a glottal stop, not glides. This is illustrated in (13), repeated from (3).

(13) Glottal stop is inserted between identical vowels

/maca-a/	[macaʔa]	‘will read’
/baa/	[bɤʔɤ]	‘flood’
/mate-ε/	[mateʔε]	‘kill’
/tɔɔt/	[tɔʔɔt]	‘knee’
/t <sup>h</sup> uum/	[t <sup>h</sup> uʔum]	‘distribute’

To illustrate the operation of OCP, consider first the sequences of identical central vowels in /maca-a/ [macaʔa] ‘will read’ (14). Hiatus after a central vowel would normally be allowed, but here it has to be resolved – because OCP is top-ranked (14b). In

this case glide insertion is not an option because of IDENT constraints on backness features (14c-d). Finally, I assume that the epenthetic [h] is ruled out by \*[spread glottis]. This assumption is consistent with the fact that Madurese only allows [h] in a few loanwords.

(14) Laryngeal insertion between two identical central vowels

macA <sub>1</sub> A <sub>2</sub>	OCP	ID- [frnt]	ID- [bk]	*[sg]	ID- [plc]	*LAR	*[cg]	ONS	INT
☞ a. maca <sub>1</sub> ? <sub>1</sub> a <sub>2</sub>					1	1	1		1
b. maca <sub>1</sub> a <sub>2</sub>	W1				L	L	L	W1	L
c. maca <sub>1</sub> j <sub>1</sub> a <sub>2</sub>		W1			L	L	L		1
d. maca <sub>1</sub> w <sub>1</sub> a <sub>2</sub>			W1		L	L	L		1
e. maca <sub>1</sub> h <sub>1</sub> a <sub>2</sub>				W1	1	1	L		1

This tableau and the analysis of OCP-driven epenthesis in general illustrates a crucial assumption introduced in Chapter 3: laryngeal approximants can take any tongue position features, therefore they do not violate constraints like IDENT-[back].

A more interesting competition happens when two identical peripheral vowels come together as in /tɔt/ [tɔʔɔtʰ] ‘knee’ (15). In this case glide insertion is a serious competitor because glides satisfy OCP and because they are inserted after peripheral vowels. However, glides cannot be inserted *before* a homorganic vowel due to \*ji/je/wu/wo (15d). Furthermore, insertion of a non-homorganic glide that happens in Kalaallisut (see Chapter 4) is not allowed in Madurese due to the high-ranked IDENT constraints on backness features (15c).

(15) Laryngeal insertion between two identical peripheral vowels

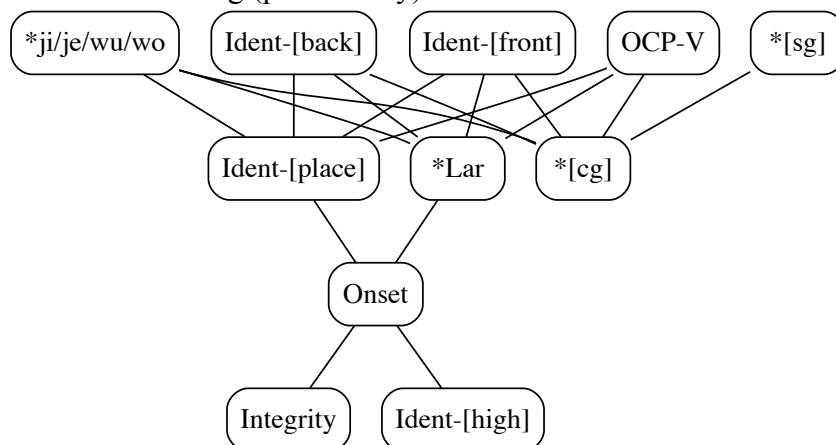
tɔ <sub>1</sub> ɔ <sub>2</sub> t	OCP	*ji/je/ wu/wo	ID- [frnt]	ID- [bk]	ID- [plc]	*LAR	*[cg]	ONS	INT
☞ a. tɔ <sub>1</sub> ? <sub>1</sub> ɔ <sub>2</sub> tʰ					1	1	1		1
b. tɔ <sub>1</sub> ɔ <sub>2</sub> tʰ	W1				L	L	L	W1	L
c. tɔ <sub>1</sub> j <sub>1</sub> ɔ <sub>2</sub> tʰ			W1	W1	L	L	L		1
d. tɔ <sub>1</sub> w <sub>1</sub> ɔ <sub>2</sub> tʰ		W1			L	L	L		1

To summarize, directional blocking interacts with OCP in Madurese to derive glottal stop insertion between identical vowels. Glides are never inserted between identical vowels due to the high-ranked faithfulness to backness/frontness and \*ji/je/wu/wo. Identical vowel sequences may not surface unchanged because of OCP. Thus, segmental OCP can trigger splitting, although tonal OCP is reported not to trigger vowel or tone insertion (Myers, 2002). Importantly, within the present theory the Gen operations involved in vowel insertion or tone insertion may be principally different from what is involved in consonant epenthesis. In other words, vowel insertion and tone insertion may

not be a valid response to OCP because they involve true insertion, but consonant insertion from Splitting may be a valid response.

The ranking responsible for Madurese epenthesis is given in (16). The constraints IDENT-[place] and \*LAR play identical roles in this ranking, and in principle only one of these constraints has to dominate ONSET.

(16) Madurese ranking (preliminary)



### 5.2.5 Predictions for other sequences

The analysis of Madurese presented above yields predictions for some of the vowel sequences for which I have no data. In particular, since \*ji/je/wu/wo is ranked above ONSET, homorganic glide insertion will be blocked when both vowels are front or both vowels are back, i.e. in the hypothetical sequences /iε/, /ei/, /uɔ/, /ɔu/. This prediction is illustrated in (17) for the hypothetical form /tei/ → [tei].

(17) Two front vowels are predicted to surface without splitting

	$t\varepsilon_1 i_2$	*ji/je/wu/wo	ID-[bk]	ID-[place]	*LAR	ONSET	INTEGR
a.	$t\varepsilon_1 i_2$					1	
b.	$t\varepsilon_{12} i_2$	W1				L	1
c.	$t\varepsilon_1 i_1 i_2$			W1	W1	L	1
d.	$t\varepsilon_1 w_1 i_2$		W1			L	1

The relevant vowel sequences are absent because [i]~[ε] and [u]~[ɔ] are distributed allophonically according to the rules of harmony in native words. However, harmony does not apply in borrowings, including those that are fully adapted. Therefore in principle the predictions of the Splitting account can be tested by looking at borrowings or non-words with the relevant vowel sequences.

### 5.2.6 Madurese glottal stop and the Insertion theories

Glottal stop insertion between identical vowels in Madurese is particularly interesting from the point of view of Insertion theories. In these theories, homorganic glides and

laryngeals are inserted for different reasons: glottal stop appears in epenthesis because it is unmarked for place but glides appear in epenthesis because of the emergent effects of assimilation constraints (Lombardi, 2002; de Lacy, 2006).

Consequently, the featural assumptions about glottal stop are different, and the analysis of Madurese OCP-driven epenthesis has to differ considerably. Thus there must be some constraint that prohibits glide insertion between identical vowels, i.e. /εε/ → \*[εje] but allows it with non-identical vowels, i.e. /εa/ → [εja]. For example, the Insertion theories could presumably claim that \*[εje] violates OCP but [εja] does not. Maintaining such a claim would require a balance of allowing feature-shared representation for glides in some cases, but prohibiting it in others (Keer, 1996; Rosenthal, 1997b; Rubach, 2002). The Insertion theories have to rely on some such representational solution (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; b; Naderi & van Oostendorp, 2011).

Another challenge for Insertion theories comes from considering the *non*-homorganic glides. Glottal stop in these theories does not share tongue position with vowels. Therefore there must be some constraint that disallows the mapping /εε/ → \*[εwε] and at the same time allows the actual mapping /εε/ → [ε?ε]. Within the Splitting theory, the inserted laryngeal preserves the backness of the input vowel while [w] does not, but in the Insertion theories glottal stop is epenthesized for very different reasons. Thus, there must be some assimilatory or general markedness constraint on which [?] is better than [w] and [j] between identical vowels. The same constraint should *not* disallow homorganic glide insertion in cases like /εa/ → [εja].

### 5.2.7 Summary

Several predictions of the Splitting theory are instantiated in the analysis of Madurese presented above. All of these predictions follow the fact that Splitting is cast within Optimality Theory (Prince & Smolensky, 2004). First, Splitting imposes no restrictions on constraints that may or may not trigger epenthesis. Thus although in most cases considered so far epenthesis was driven by constraints which enforce well-formed prosodic constituents, it can also be driven by purely segmental constraints like OCP.

Since Splitting theory is cast within OT, we expect that various patterns of extended minimal epenthesis will coexist and interact with blocking and with various trigger constraints. This is exactly what happens in Madurese: within the domain of non-identical vowels we observed an interaction between extended epenthesis (insertion of glides next to high and mid but not low vowels), and directional blocking (non-insertion to avoid homorganic glide-vowel sequences). Directional blocking also crucially affects the outcome for identical vowel sequences, where it interacts with the trigger constraint OCP.

Finally, the analysis of laryngeal insertion between identical vowels crucially relies on the assumption (presented in Chapter 2) that laryngeal approximants can be specified for any backness features. In particular, in the mapping /mate-ε/ [mate?ε] ‘kill’ the inserted laryngeal is front whereas in /tɔɔt/ [tɔ?ɔt] ‘knee’ it is back.

### 5.3 Madurese inventory restrictions and insertion processes

The predictions of the Splitting theory discussed so far relied on the assumption that phonological maps are output-driven, as discussed in Chapter 2. In other words, if a mapping with a number of input-output disparities is grammatical, then a mapping which includes a subset of these disparities will also be grammatical (Tesar, 2008, 2013). Crucially, all output-driven maps have the *identity map* property: well-formed output must map to themselves if they are fed to the grammar as inputs. Madurese presents an interesting exception to output-drivenness, and in this section I argue that this exception follows from an independently motivated constraint regulating the relationship between vowels and nuclei.

Recall that glides are positionally restricted in this language – they appear only in the environments where they are epenthetic, i. e. next to homorganic peripheral vowels. Within the Splitting theory this pattern can be accounted for by the constraint V-NUC that requires each input vowel to have a correspondent in a syllable nucleus (18). The present formulation of V-NUC is very similar to the constraint V-Mora proposed by Rosenthal (1997b), although it is framed within Correspondence Theory (McCarthy & Prince, 1995, 1999) rather than within containment (Prince & Smolensky, 2004) with coindexing (Hayes, 1990). Interestingly Rosenthal treats epenthesis of consonants as true insertion. Thus, a requirement like (18) is motivated by data unrelated to consonant insertion and is required within the Insertion theories as much as in the Splitting theory.

- (18) V-NUC: assign a violation mark for every input vowel which does not have a correspondent in a syllable nucleus

This constraint also shares some important properties with the existential constraints of Struijke (2000). In particular, to satisfy V-NUC, it is sufficient that *some* correspondent of the input vowel occupy a syllable nucleus. The constraint does not require this of *all* correspondents (see Chapter 2 for a discussion of existential IDENT constraints that are not adopted here).

An input vowel which has a correspondent both in a nucleus and in a margin is not penalized by this constraint. With V-NUC high-ranked, we get a situation where an input vowel may split and yield a margin segment, but it may not have a margin segment as its only correspondent. Thus an input like /i<sub>1</sub>a<sub>2</sub>/ maps to [i<sub>1</sub>j<sub>1</sub>a<sub>2</sub>] because both input vowels have correspondents in a nucleus. However, the high ranking of V-NUC in Madurese also predicts that a hypothetical input /i<sub>1</sub>i<sub>2</sub>a<sub>3</sub>/ which is featurally completely identical to the well-formed output [i<sub>1</sub>j<sub>2</sub>a<sub>3</sub>] does not map to [i<sub>1</sub>j<sub>2</sub>a<sub>3</sub>], because the second input vowel /i<sub>2</sub>/ would not have a nucleus correspondent in such a mapping. Instead, as we shall see the Madurese hierarchy will map /i<sub>1</sub>i<sub>2</sub>a<sub>3</sub>/ to [i<sub>1</sub>?<sub>1</sub>i<sub>2</sub>j<sub>2</sub>a<sub>3</sub>]. Thus under the proposed analysis the Madurese system does not have the identity map property: a well-formed output [ija] does not map to itself. However, such a departure from output-drivenness is based on the independently motivated constraint V-NUC.

#### 5.3.1 Positional restrictions on glides and glide insertion

The relation between positional restrictions on Madurese glides and the epenthesis process is best illustrated with inputs that have a sequence of more than two vowels. These inputs provide a potential opportunity for gliding: /taia/ could surface as [taja], but



it does not in Madurese. Note that such inputs cannot be ignored due to Richness of the Base (Prince & Smolensky, 2004).

The tableau in (19) presents an analysis of the hypothetical input /taia/. This input cannot surface faithfully because ONSET dominates INTEGRITY – hiatus is allowed only after low vowels (19c). Crucially, the input vowel /i/ cannot simply surface as a glide – this would violate V-NUC, although it could satisfy ONSET perfectly (19b). As a result, the sequence of three vowels is treated the same as bivocalic sequences: hiatus after a low vowel is tolerated, but it is resolved by splitting after a high vowel.

(19) Input vowels cannot surface as glides in Madurese

	/ta <sub>1</sub> i <sub>2</sub> a <sub>3</sub> /	V-NUC	ONSET	INTEGRITY
☞ a.	ta <sub>1</sub> i <sub>2</sub> j <sub>2</sub> a <sub>3</sub>		1	1
b.	ta <sub>1</sub> j <sub>2</sub> a <sub>3</sub>	W1	L	L
c.	ta <sub>1</sub> i <sub>2</sub> a <sub>3</sub>		W2	L

The high ranking of V-NUC also rules out the featurally identical mapping /tiia/ → [tija], as illustrated in (20). This tableau illustrates that V-NUC can produce a non-output-driven system. Observe also that V-NUC does not refer to the moraicity of the input vowels. Therefore, the result in (20) would hold regardless of which vowels bear a mora in the input.

(20) Splitting is obligatory in trivocalic sequences

	/ti <sub>1</sub> i <sub>2</sub> a <sub>3</sub> /	V-NUC	ID-[place]	*LAR	*[cg]	ONSET	INTEGRITY
☞ a.	ti <sub>1</sub> ?i <sub>2</sub> j <sub>2</sub> a <sub>3</sub>		1	1	1	1	2
b.	ta <sub>1</sub> j <sub>2</sub> a <sub>3</sub>	W1	L	L	L	L	L

Glide insertion in VV sequences is not affected by the constraint V-NUC because all splitting candidates satisfy this constraint. This is illustrated in (21) for the mapping /ɔlle<sub>1</sub>a<sub>2</sub>/ → [ɔlle<sub>1</sub>j<sub>1</sub>a<sub>2</sub>] 'will get' which was analyzed in (6). Note that for bivocalic input sequences gliding would also create a consonant cluster that is impossible in Madurese.

(21) Glide epenthesis satisfies V-NUC in Madurese

	ɔlle <sub>1</sub> a <sub>2</sub>	V-NUC	ID-[place]	*LAR	ONSET	ID-[high]	INTEGRITY
☞ a.	ɔlle <sub>1</sub> j <sub>1</sub> a <sub>2</sub>					1	1
b.	ɔlle <sub>1</sub> a <sub>2</sub>				W1	L	L
c.	ɔlle <sub>1</sub> ? <sub>1</sub> a <sub>2</sub>		W1	W1		L	1
d.	ɔllj <sub>1</sub> a <sub>2</sub>	W1				1	L

To summarize, since V-NUC is high-ranked, an input vowel can never map only to a glide in Madurese. Splitting as in (21) is the only way to create vocalic glides on the surface. However, as shown in 5.2, splitting in Madurese only affects peripheral vowels. As a result, glides can only occur next to peripheral vowels.

### 5.3.2 Positional restrictions and word-final glides

Madurese allows the glide [j] word-finally (22), while the high-ranked V-NUC predicts that the vocalic glide should not occur in this environment. An input like /səŋai/ should surface as [səŋai] since V-NUC is high-ranked in Madurese.

(22) Word-final [j] in Madurese

[səŋaj]	‘river’
[kaʔaŋk <sup>h</sup> uj]	‘for’
[taməj]	‘guest’

The forms in (22) can be analyzed by assuming that right edges in Madurese are special in that they require perfect anchoring of input moras (McCarthy & Prince, 1986, 1993b, 1995). The relevant constraint  $\mu$ -ANCHOR-R is formulated in (23).

(23)  $\mu$ -Anchor-R: the rightmost input mora must have a correspondent which is the rightmost output mora

None of the constraints introduced so far distinguishes between moraic and non-moraic input vowels. In particular, V-NUC is based on segmental features, rather than the presence of a mora – and this is crucial since word-medially any vowel must have a correspondent in the nucleus. Furthermore, V-NUC must dominate the constraint DEP- $\mu$  to ensure that non-moraic vowels do not surface as glides word-medially. However, V-NUC is dominated by  $\mu$ -Anchor-R predicting that mora-less vowels will surface faithfully just in case they are word-final in the input.

The following two forms thus represent a contrast in moraicity: /bu<sub>i</sub>i/ [buwi] ‘fetter’

(3) vs. /tamə<sub>i</sub>i/ [taməj] ‘guest’ (22). The analysis of word-final [i] vs. [j] is illustrated in (24). Since general faithfulness to input moras is low-ranked, all moras except for the final one can be present or absent in the input without visible effects. In this tableau the moras are not marked in the output since they are predictable: nuclei are moraic, margins are non-moraic.

(24) Word-final glides vs. vowels

a. Final glides

	/tamə <sub>i</sub> i <sub>2</sub> /	$\mu$ -ANCHOR-R	V-NUC	ONSET	DEP- $\mu$	INT
☞ a.	tamə <sub>i</sub> j <sub>2</sub>		1			⋮
b.	tamə <sub>i</sub> i <sub>2</sub>	W1	L	W1	W1	⋮

## b. Final vowels

	/bu <sub>1</sub> i <sub>2</sub> /	μ-ANCHOR-R	V-NUC	ONSET	INT
☞ a.	bu <sub>1</sub> w <sub>1</sub> i <sub>2</sub>				1
b.	bw <sub>1</sub> i <sub>2</sub>		W1		L
c.	bu <sub>1</sub> i <sub>2</sub>			W1	L
d.	bu <sub>1</sub> j <sub>2</sub>	W1	W1		L

This analysis assumes that codas are not moraic in Madurese. The stress pattern of the language is not yet well understood – for all we know Madurese might not even have stress (Davies, 2010: 51). This analysis also predicts that a final [w] should be able to appear in Madurese. Thus I assume that the absence of word-final [w] is an accidental gap.

To summarize, all vowels (moraic or nonmoraic) must have a moraic correspondent in a nucleus in Madurese. The only exception is for word-final non-moraic vowels which cannot get their mora because of μ-ANCHOR-R.

### 5.3.3 Exceptional occurrences of glides

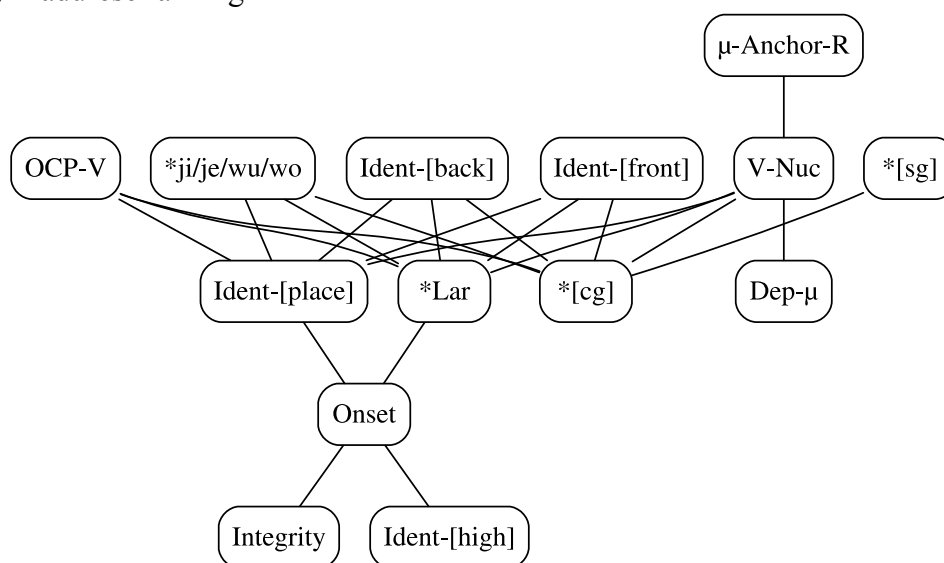
Some loanwords provide exceptions to the distribution of Madurese glides. [j] occurs word-initially in borrowings. [w] can occur in onsets in borrowings as in [wawancara] ‘interview’ (from Indonesian), [wɔrtəl] ‘carrot’ (from Dutch).

Borrowings often have a special status with regard to the phonology of a language, and a full account of their special status would lead us too far afield (see Wolf (2011) for a recent review of the analytical options). For example, it can be assumed that the borrowed words form a separate lexical stratum in the phonology of Madurese, as e.g. in Japanese (McCawley, 1968; Itô & Mester, 1999b). The borrowings could also be subject to a particular co-phonology (Inkelas *et al.*, 1997; Inkelas & Zoll, 2007) or to indexed constraints (Pater, 2000, 2006).

### 5.3.4 Summary

To summarize, the splitting account of the surface restrictions on glides relies on the constraint V-NUC which regulates the relation between input vowels and output nuclei. This constraint is high-ranked in Madurese producing a non-output-driven pattern where word-medial glides are always due to splitting. A complete ranking for Madurese is given in (25).

## (25) Madurese ranking



The analysis of Madurese illustrates the Splitting approach to the non-structure-preserving epenthesis (Kiparsky, 1982, 1985; Mohanan, 1986; Harris, 1987). While in general, the inserted consonants are always predicted to obey the inventory restrictions, they may escape these restrictions due to constraints which prefer certain segments or certain mappings in certain positions. One such positional constraint is the constraint V-NUC.

## 5.4 Conclusion

Epenthesis in Madurese illustrates several predictions of the Splitting theory. Within the Splitting theory the inserted consonants may have a quality which is disallowed in other positions in a given language only if they are subject to a positional constraint like V-NUC (see also Chapter 6). The existence of the constraint V-NUC constitutes a departure from output-drivenness, but it is independently motivated.

Splitting, together with the general properties of OT, predicts that various patterns of blocking and extension may interact – and this is what happens in Madurese glide insertion. Finally, any relevant constraint may trigger splitting – in Madurese it is triggered by OCP, which is a particularly interesting case since it has been claimed that tonal OCP never leads to epenthesis (Myers, 2002).

## *Chapter 6. Dual glides and edge laryngeals. Epenthesis in Washo.*

### **6.1 Introduction**

The Splitting Theory predicts that epenthetic consonants will be as faithful as possible to their underlying sources. However, the theory also predicts that markedness constraints can force deviation from the maximally faithful outcome via blocking. This chapter provides several examples of blocking and enriches the constraint set with new blocker markedness constraints.

General markedness constraints can prohibit some consonant across-the-board. In such a case, the inventory of a language is restricted. Such an inventory restriction is illustrated in section 6.2 for Washo. While the most faithful consonant to underlying /u/ is [w], [j] is epenthesized next to /u/ instead. It is argued that vocalic [w] is banned across-the-board in Washo, so that the less faithful – but still very faithful – [j] is the result of /u/-splitting.

Markedness constraints can also be sensitive to context. Due to position-sensitive markedness, the most faithful epenthetic consonant may occur in some environments, but in others a less faithful option may appear. Again, Washo illustrates the effects of context-sensitive markedness constraints (detailed in section 6.3). A set of constraints that favor laryngeals at prosodic edges (LAR-EDGE) is proposed. The effect of these constraints in Washo is to block epenthetic glides word-initially. Thus a word-initial /i/ cannot faithfully split to [ji] and instead it is required to change to [ʔi].

The analysis of Washo is concluded in sections 6.4 with the analysis of vowel merger and its interaction with epenthesis. Section 6.5 summarizes the analysis of Washo. The predictions of the LAR-EDGE constraints for epenthesis are systematically explored in section 6.6.

### **6.2 Inventory effects on epenthetic consonants: dual glides in Washo**

In Optimality Theory, the inventory of output segments is determined by the interaction of markedness and faithfulness constraints. Such inventory-defining interactions can also affect the outcome of epenthesis: instead of the most faithful consonant being epenthesized, the most faithful permitted in the inventory appears.

This situation is illustrated in a subtle yet striking way in Washo, a severely moribund language spoken around Lake Tahoe on the border of California and Nevada. This section will argue that Washo bans vocalic [w], with the effect that [j] is epenthesized in every context, even between round vowels. The subtlety is that a [w] does appear on the surface in Washo, but it is argued that this [w] is [+consonantal], unlike the [–consonantal] [j].

The principal source on Washo is Jacobsen (1964); page numbers in examples refer to this source unless otherwise noted. Kroeber (1907) and Jacobsen (1996) [abbreviated J96] were also consulted. The Washo Project at the University of Chicago (headed by Alan Yu) is another major documentation effort on the language. The Washo Project website [[washo.uchicago.edu](http://washo.uchicago.edu)] provides a dictionary which will be cited as 'WP'. Some of

the data and results from the Washo Project are reported in Bochnak and Rhomieux (2013); Midtlyng (2005); Murphy and Yu (2007); Yu (2005a; b, 2008a; b, 2011a; b).

### 6.2.1 Washo surface inventory: an overview

The Washo IPA transcription is adopted from Yu (2005b), which is only a slight deviation from the traditional transcription adopted in most Washo sources since Jacobsen (1964). The vowel inventory of Washo is given in (1) and the consonant inventory in (2).

#### (1) Washo vowels

i i:	ɨ ɨ:	u u:
e e:		o o:
a a:		

#### (2) Washo consonants

p b pʰ	t d tʰ	dz tsʰ	k g kʰ	ʔ
	s	ʃ		h
m m̥ (ʔm)	n (ʔn)		ŋ ŋ̥ (ʔŋ)	
w w̥ (ʔw)	l ɭ (ʔl)	j j̥ (ʔj)		

Washo has both [j] and [w], and there are no distributional differences between the two surface glides. Both glides occur voiced, voiceless, and glottalized. The sequences [ij] and [uw] are not allowed within the same syllable, i.e. when followed by a consonant or word boundary.

In section 6.2.4, I argue Washo actually distinguishes between two kinds of surface glides, that I will refer to vocalic and consonantal (Hume, 1995; Levi, 2004, 2008). Most occurrences of Washo surface [j w] are in fact consonantal glides [j<sub>c</sub> w<sub>c</sub>]. However, the glide that shows up in epenthesis is a truly vocalic [j]. Washo does not have vocalic [w] for a good reason – underlying /w/ always surfaces as [j].

The series of voiced and voiceless stops differ phonetically in aspiration while the degree of voicing in voiced stops depends on the context and varies both within and across speakers. The realization of the laryngeal contrast is discussed in detail in Yu (2011a). Since aspiration is not marked in my sources (Jacobsen, 1964; WP) the more traditional transcription is adopted.

The parenthesized glottal stop + sonorant sequences in (2) may be better analyzed as glottalized sonorants (Urbanczyk, 1993; Yu, 2011b). To simplify the presentation of certain alternations, I adopt the traditional transcription, although nothing hinges on this. It should be noted that word-finally and before a consonant glottalized sonorants are realized with postglottalization rather than preglottalization (Yu, 2011b; Jacobsen, 1964, pp. 275-ff). In the intervocalic position, preglottalized sonorants contrast with sonorant + glottal stop sequences.

Washo syllables fit the template CV(C). All syllables begin with a consonant, and this will be analyzed as a consequence of high ranking of ONSET (section 6.2.3). Avoidance of onsetless syllables will be argued to motivate epenthesis and vowel merger.

Codas are allowed. The only complex margins allowed in native words are ? + sonorant, and at least some of these can be reanalyzed as glottalized sonorants (Yu, 2011b). A limited number of otherwise unattested clusters occurs in loanwords where up to three consonants may form a syllable margin as in ['mampʃ] 'mumps'. See Yu (2008a) and Jacobsen (1964) for a discussion of further restrictions on medial clusters.

Stress is assigned to stems, by default to the penultimate syllable. Predictable stress will not be marked in the underlying forms. Long vowels (but not closed syllables) attract stress. Multiple nonadjacent stressed syllables are allowed in morphological contexts where several stems are combined. See Yu (2005a; b, 2008a) for a discussion of metrically-conditioned alternations in Washo.

### 6.2.2 [j] epenthesis in Washo

When two vowels come together across a morpheme boundary, the glide [j] is inserted. The quality of the vowels does not influence the choice of epenthetic glide. Epenthetic [j] is illustrated in (3). For presentational reasons, the examples supporting the underlying shape of the stems and suffixes in (3) are given in the Appendix at the end of the Chapter.<sup>1</sup>

#### (3) Washo [j]-insertion

VV	UR, gloss	SR, translation, source
/aa/	/watʔa-a/ river-LOC	['watʔaja] 'in the river' (261)
/ae/	/Ø-ʔipʔam-e:s-ha-enun-i-g-i/ 3SU-get_there-NEG-CAUS-USI-IPF- 3OB-PRO	['ʔipʔa'me:shajenunigi] '(he) doesn't let (somebody) reach (it)' (623)
/ai/	/l-emtsʔi-ha-i/ 1SU-awake-CAUS-IPF	['lemtsʔihaji] 'I'm waking him up' (262)
/au/	/da-uweʔ/ there-HENCE	['dajuweʔ] 'away' (264)
/oa/	/di-dokʔo-a/ 1P-heel-LOC	[di'dokʔoja] 'at my heel' (261)
/oi/	/Ø-b-alo:go-i/ 3SU-by_holding-tie-IPF	[ba'lo:goji] 'he ties it' (WP)
/ea/	/l-emle-a/ 1P-heard-LOC	['lemleja] 'in my heart' (261)
/ee/	/Ø-kʔeʃe-e:s-i/ 3SU-be_alive-NEG-IPF	[kʔeʃe'je:si] 'he's dead' (263)
/ua/	/l-a:du-a/ 1P-hand-LOC	['la:duja] 'in my hand' (260)

<sup>1</sup> The following abbreviations are used in examples: 1/2/3 - for person; ATAG - attributive-agentive; ATIN - attributive-instrumental; ATTR - attributive; CAUS - causative; DST - distant tense; DPST - distant past; DU - dual; DUR - durative; IFUT - intermediate future; IMP - imperative; INCL - inclusive; INCH - inchoative; IPF - imperfective; IPST - intermediate past; LOC - locative; NARR - narrative tense; NEG - negative; NFT - near future; N - nominal; OB - object; OPT - optative; P - possessor; PL - plural; PPF - pluperfect; PRO - pronoun; Q - interrogative; RPST - recent past; RS - reference switching; SEQ - sequential; SU - subject; SUP - subjective possessor; UND.POSS - unidentified possessor; USI - usitative; V - linking vowel. In some cases a single word is cited which appears in a phrase in the original example. The translation of the word is then stated based on its role in the phrase.

/ue/	/l-emlu-e:s-i/ 1SU-eat-NEG-IPF	[lemlu'je:si] 'I'm not eating' (J96: 17)
/ui/	/Ø-a:hu-i/ 3SU-stand-IPF	[l'a:huji] 'they are standing' (163)
/uu/	/Ø-emlu-uʃ-i/ 3SU-eat-DUR-IPF	[l'ʔemlujuʃi] 'he keeps on eating' (263)
/ia/	/l-aŋal-ʃi-a/ 1P-house-DU.INCL-LOC	[l'aŋalʃija] 'on our house' (262)
/ie/	/Ø-kʔ-i:gi-elem-lul-iʔ-ajtʔiʔi-ʃ-ge/ 3SU-3OB-see-DST-DPST-ATAG-PPF- RS-PRO	[l'kʔi:gijelemluliʔ'ajtʔiʔiʃge] 'what they saw very long ago' (637)
/ii/	/l-emtsʔi-i/ 1SU-awake-IPF	[l'emtsʔiji] 'I'm awake' (261)
/iu/	/ge-sigi:gi-ud-i/ IMP-sizzle-SEQ-IPF	[gesi'gi:gijudi] 'after you sizzle' (613)
/ia/	/Ø-pʔiʔli-aʃaʔ-i/ 3SU-fish_with_hook_and_line-NFT-IPF	[pʔiʔliʔjaʃaʔi] 'he's going to fish with hook and line' (593)
/ii/	/Ø-pʔiʔli-i/ 3SU-fish-IPF	[pʔiʔliji] 'he's fishing with hook and line' (262)

As the examples in (3) show, epenthetic [j] occurs after any vowel and before /a, e, i, u/ (these are the only suffixal vowels). Note that the stem-final vowels are short because the stress is never stem-final and long vowels only occur in stressed syllables (Yu, 2005b). Examples of every VV combination in that range are available, except for /ei, eu, ou, ie/. The sequences /oe/, /iu/ only occur in bipartite stem formation, and are illustrated in (4) below. Interestingly, even sequences of identical vowels (e.g. /aa/, /ee/, /uu/, /ii/) and sequences which do not contain a front vowel (e.g. /au/, /ua/, /oa/, /ia/) undergo [j]-insertion.

[j] epenthesis is not restricted morphologically; it is recorded before all vowel-initial suffixes and with nominal, verbal and demonstrative stems. The morphemes triggering insertion in (3) are: /-a/ 'locative', /-aʃaʔ/ 'near future', /-i/ 'imperfective', /-e:s/ 'negative', /-elem/ 'distant tense', /-enun/ 'usitative', /-ud/ 'sequential', /-uʃ/ 'durative', and /-uweʔ/ 'hence'. Some of the examples in (3) show that [j]-insertion happens between two suffixes, not just after roots. Thus, it occurs after the suffixes /-ha/ 'causative', /-ʃi/ 'dual inclusive'.

Washo verbal stems are often bipartite (Jacobsen, 1980): they consist of two lexical elements termed *lexical prefix* and *dependent stem*. The alternations in bipartite stem formation are partially due to lexical prespecification, and therefore these alternations are considered separately. Bipartite constructions and the status of underlying /ε/ will be discussed in more detail in section 6.4. Within the domain of bipartite stems each lexical prefix usually combines with a number of stems and vice versa. Lexical prefixes may be formed from independent stems by an addition of a vowel morpheme which will be termed *linking vowel* here. The combination of an independent stem + linking vowel + dependent stem may create sequences of vowels which are otherwise unattested. Hiatus sequences occurring at the right edge of the first stem trigger [j]-insertion (4). Vowel merger happens to the VV sequence between the linking vowel and the second stem.



## (4) Washo [j]-insertion in bipartite constructions

/di-mo:k'o-ε-iwe?-i/	[di'mo:k'ojewə?i]
1SU-knee-V-on_the_ground-IPF	'I'm kneeling' (263)
/Ø-p'ɪli-u-i:bi?-i/	[p'ɪli'ju:bi?i] 'he has come from
3SU-fish_with_hook_and_line-V-come-IPF	fishing with hook and line' (264)

The available data on [j]-insertion in Washo is summarized in (5) where the sequences that only occur in bipartite stems are given in *italics*.

## (5) Summary of Washo [j]-insertion patterns

V1 \ V2	a	e	i	u
a	j	j	j	j
o	j	<i>j</i>	j	
e	j	j		
u	j	j	j	j
ɪ	j		j	<i>j</i>
i	j	j	j	j

Washo alternations between [j] and zero cannot be reanalyzed as deletion. There are instances of [j] occurring word-finally on the surface (6a), hence the surface ['wat'a] 'river' could not correspond to underlying /wat'aj/. Furthermore, there are examples of stems which end in an underlying [j] which does not alternate with zero (6b), contrasting with vowel-final stems in (3).

## (6) [j]-final stems in Washo

- a. [daʔmu'k'ajk'aj] 'mosquito' (90)
- b. /Ø-ʔil-kajkaj-i?-i/ 3SU-ATTR-tall-ATAG-IPF [ʔil'kajkaji?i] 'he is tall' (WP)

To summarize, [j]-insertion in Washo is a general phonological process: it creates ample alternations, it is not morphologically restricted, and it is not subject to a deletion analysis.

**6.2.3 Analysis of word-medial [j] epenthesis**

At root-suffix boundary, Washo provides an onset by epenthesizing [j] in all vowel sequences. I illustrate the analysis of this pattern with a context where both vowels disagree with [j] in some features, such as /u+u/, e.g. /Ø-ɛmlu-uʃ-i/ ['ʔɛmlujʊʃi] 'he keeps on eating' (3). Splitting the vowel /u/ to yield an output [j] incurs several violations of IDENT constraints. On the other hand, there are competing candidates which avoid these

IDENT violations. In fact splitting the vowel /u/ to yield [w] in /uu/ → [uwu] is completely feature-preserving.

In order for the candidate [uju] to win, there must be some constraint which disallows [w] epenthesis. Following Rubach (2000), I assume that the relevant constraint prohibits the vowel [u] in the onset (see section 6.2.4 for further discussion of the relevant constraint).

(7) \*ONS-u: assign a violation for every instance of [u] which occurs in the onset

Another prominent competitor for the correct output [uju] involves laryngeal epenthesis: [uhu] or [uʔu]. Building on the discussion in Chapter 3, these competitors are ruled out by the constraint IDENT-[place].

The tableau in (8) illustrates the analysis of the mapping /uu/ → [uju] in Washo.

(8) Washo [j] epenthesis in /uu/ → [uju]

/tu <sub>1</sub> u <sub>2</sub> /	*LNG	ONS	*ONS-u	Id-[place]	ID-[rnd]	ID-[bk]	INT
☞ a. tu <sub>1</sub> j <sub>1</sub> u <sub>2</sub>					1	1	1
b. tu <sub>1</sub>	W1				L	L	L
c. tu <sub>1</sub> .u <sub>2</sub>		W1			L	L	L
d. tu <sub>1</sub> w <sub>1</sub> u <sub>2</sub>			W1		L	L	1
e. tu <sub>1</sub> ʔ <sub>1</sub> u <sub>2</sub>				W1	L	L	1
f. tu <sub>1</sub> h <sub>1</sub> u <sub>2</sub>				W1	L	L	1

Any candidate without splitting, such as (8b-c), has to either have a long vowel, or to violate ONSET.<sup>2</sup> Both of these options are prohibited in Washo, and ONSET is satisfied via INTEGRITY violations instead. The remaining candidates in (8a,d-f) all violate INTEGRITY.<sup>3</sup> The winner (8a) also violates the IDENT constraints on roundness and backness. However, the epenthetic candidates which would satisfy these IDENT constraints are all ruled out by higher ranking markedness constraints: \*ONS-u, and \*ID-[place].

While epenthesis of a homorganic glide or a laryngeal is blocked by markedness constraints, the general properties of the splitting approach are crucial in also blocking the epenthetic true consonants such as [t, n]. These are ruled out by a high ranking constraint IDENT-[consonantal] which prohibits splitting a vowel to yield a [+consonantal] segment.

<sup>2</sup> Long vowels are only allowed in stressed syllables in Washo, while all candidate syllables in (8) are assumed to be unstressed. Creating a long vowel in hiatus and stressing it would go against the stress pattern of the language (Yu, 2005b).

<sup>3</sup> I do not consider other possible repairs here and in the other tableaux in this chapter. I am assuming that the relevant faithfulness constraints all dominate INTEGRITY.

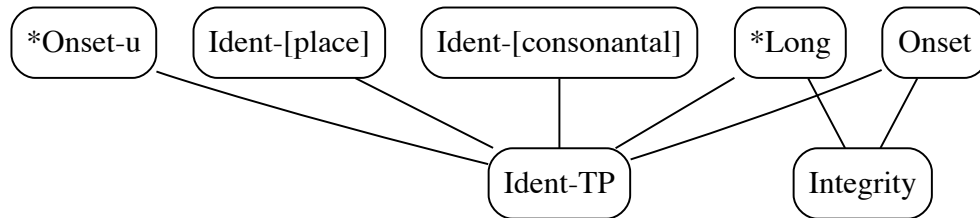
(9) Epenthesis of [+consonantal] segments is not allowed in Washo

	/tu <sub>1</sub> u <sub>2</sub> /	*ID-[cons]	ID-[rnd]	ID-[bk]	INT
☞ a.	tu <sub>1</sub> j <sub>1</sub> u <sub>2</sub>		1	1	1
b.	tu <sub>1</sub> t <sub>1</sub> u <sub>2</sub>	W1	L	L	1
c.	tu <sub>1</sub> n <sub>1</sub> u <sub>2</sub>	W1	L	L	1

Effectively, the splitting account limits the choices of epenthetic segments to approximants, and does so in a principled way.

In all patterns that involve across-the-board blocking, the outcome of splitting is always the same regardless of vocalic context. The blocking ranking of Washo picks [j] as the optimal epenthetic consonant. The ranking arguments in (8-9) will also hold for other input vowels and for IDENT constraints on other tongue position features: [front], [high], and [low]. Since splitting yields the same result for all vowels, the IDENT constraints on all tongue position features are subject to the same ranking conditions. In the interim ranking diagram in (10) IDENT-TP (for 'tongue position') is therefore used as a shorthand for IDENT constraints on [high], [low], [front], [back], and [round].

(10) Ranking conditions for Washo [j]-epenthesis



#### 6.2.4 Two kinds of glides in Washo and glide markedness

Splitting theory predicts that the alternations affecting epenthetic segments will also affect the same segments in the language as a whole. This crucial prediction leads us to expect that /u/ will always be neutralized to [j] in the margins. In this section, I propose that this prediction is correct, and that the non-epenthetic glides are actually underlyingly consonantal.

As I have shown, that analysis of Washo [j] epenthesis requires a markedness constraint that bans vocalic [w] to outrank all those IDENT constraints that would preserve /w/'s features. This constraint is expressed as \*ONS-u in (7) repeated below (Rubach, 2000).

(7) \*ONS-u: assign a violation for every instance of [u] which occurs in the onset

The exact formalization of this constraint is necessarily informed by the facts which are outside of the domain of consonant epenthesis, and thus I will only review the existing alternatives here. Rubach (2000; 2002) proposes that there are constraints which penalize the high back vowel /u/ in margin positions (\*ONSET-u and \*CODA-u). De Lacy (2006) attributes the relative markedness of [w] to the fact that it has labial place of articulation, while the major place of [j] is coronal (but within the current theory they are both Dorsal, see also Levi 2004; 2008). [w] could also be penalized due to its sonority

(Raffelsiefen, 2012). The evidence from epenthetic typology does not differentiate between these formal proposals, thus leaving the exact formal implementation of [w] markedness underdefined. Another open question is whether there is a potential grounding for the markedness asymmetry between [j] and [w], and whether the speakers of languages without this asymmetry show active awareness of it.

So what happens to input /u/ when it has a chance of surfacing in a margin? There are no alternations that provide relevant evidence. However, the ranking of IDENT constraints presented above predicts that it must not map [w] or [w<sub>c</sub>]. The relevant input would have a sequence of more than two vowels, e.g. /taui/ considered in (11). The ranking in (10) predicts that such an input would never lead to a surface [u] in a syllable margin (11b), since changing such a segment to [j] would always be preferred.

(11) Hypothetical trivocalic sequences in Washo

	/ta <sub>1</sub> u <sub>2</sub> i <sub>3</sub> /	ONS	*ONS-u	ID-[rnd]	ID-[bk]
☞ a.	ta <sub>1</sub> j <sub>2</sub> i <sub>3</sub>			1	1
b.	ta <sub>1</sub> u <sub>2</sub> i <sub>3</sub>	W2		L	L
c.	ta <sub>1</sub> w <sub>2</sub> i <sub>3</sub>		W1	L	L

The tableau in (11) serves to illustrate an important point: given the ranking in (10), a surface [w] cannot correspond to an input /u/ in Washo. The surface Washo [w] is featurally different from /u/, and corresponds to a different input. It comes from an underlying consonantal glide /w<sub>c</sub>/. I assume that consonantal glides differ from vowels (and from vocalic glides) in that they are [+consonantal] (Hyman, 1985; Deligiorgis, 1988; Hayes, 1989; Waksler, 1990; Rosenthal, 1997b).<sup>4</sup> Consonantal [w<sub>c</sub>] surfaces unchanged in Washo because it does not incur violations of \*ONSET-u, and there is no other markedness >> faithfulness ranking that would force it to neutralize.

The fact that [w<sub>c</sub>] has a different feature specification from /u/ also makes it an unsuitable epenthetic segment. An input vowel cannot yield [w<sub>c</sub>] when splitting because the constraint IDENT-[consonantal] is high-ranked. The fact that consonantal [w<sub>c</sub>] does not emerge in epenthesis is illustrated in the tableau in (12) that considers an additional candidate for the tableaux in (8-9).

(12) Washo consonantal glide [w<sub>c</sub>] cannot be epenthetic

	/tu <sub>1</sub> u/	ONS	*ONS-u	ID-[cons]	ID-[rnd]	ID-[bk]	INT
☞ a.	tu <sub>1</sub> j <sub>1</sub> u <sub>2</sub>				1	1	1
b.	tu <sub>1</sub> .u <sub>2</sub>	W1			L	L	L
c.	tu <sub>1</sub> w <sub>1</sub> u <sub>2</sub>		W1		L	L	1
d.	tu <sub>1</sub> w <sub>1</sub> <sup>c</sup> u <sub>2</sub>			W1	L	L	1

<sup>4</sup> In addition, there is a difference in [place] (Levi, 2004, 2008). While vocalic glides are [dorsal] like vowels, consonantal [j<sub>c</sub>] is [coronal] and consonantal [w<sub>c</sub>] is [labial, dorsal]. This difference is irrelevant for Washo, but it is crucial for the treatment of Mongolian in chapter 7.

It is also crucial that surface vocalic [j] *is* permitted in Washo. Thus underlying /i/ can surface in the margins. In fact, I claim that there is no constraint that is violated by onset [j] but not by onset [w] (e.g. no \*ONS/i), so predicting that there is an asymmetry in epenthesis. In particular, while across-the-board [j] epenthesis is predicted, a language whose epenthetic consonant is [w] in all environments is impossible.

In addition to Washo, [j] epenthesis in all vowel sequences is also reported for Turkish (Underhill, 1976; Goksel & Kerslake, 2005), Ait Seghrouchen Berber (Guerssel, 1986), and Uyghur (Hahn, 1991, 1992) (although the latter case may be morphologized, see Chapter 9).

On the other hand, no language in my sample inserts [w] in all vocalic sequences (see Appendix B). The only language that comes close to doing so is Chamicuro (Parker, 1989, 1991, 1994, 1995, 2001, 2010). However, in Chamicuro [w] epenthesis appears only after /a/ and only in one morphological context. The relevant alternation can be analyzed as a prespecified latent segment (see Chapter 9), or as a truly epenthetic segment which is required to get its quality from a vowel on the left (see Chapter 3 on glide insertion next to [a] and Chapter 4 on copying from the left).

Additional tentative support for the hypothesis that [w] is more marked than [j] comes from the reported blocking patterns where [j] is inserted next to /i/ but vowel sequences with /u/ surface faithfully: Colloquial Slovak, Standard Polish,<sup>5</sup> Rural Polish, Czech, and Ukrainian (Rubach, 2000, 2002). However, it should be noted that the core evidence in these cases comes from the realization of words of foreign origin, rather than from alternations. It is not clear whether for all the vocalic sequences the relevant languages have a synchronic process of glide insertion, or the surface glides are underlying and were added to the native underlying form via reinterpretation at the time of borrowing<sup>6</sup> (see Chapter 9 for discussion). These cases thus suggest that [w] is inherently more marked than [j], but less straightforwardly than the languages with clear epenthetic alternations.

Thus, there is no markedness constraint that would disallow the vocalic glide [j] but allow [w]. On the other hand, the existing constraint \*ONS-u rules out vocalic [w] but allows [j] in Washo.

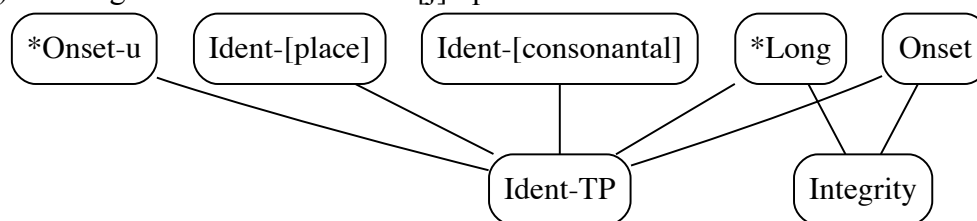
Finally, the analysis presented so far predicts that the consonantal /j<sub>c</sub>/ is also possible in Washo. No constraint prohibits this segment from surfacing, and hence it will appear in surface representations. The consonant-like behavior of Washo non-epenthetic glides is supported by the fact that they appear voiceless and glottalized.

To summarize, Washo has both consonantal glides [j<sub>c</sub> w<sub>c</sub>] but only one vocalic glide [j]. This pattern reflects a universal markedness asymmetry whereby [j] is less marked than [w], encoded here in the constraint \*ONS-u. The ranking in (10), repeated below, is responsible for both glide epenthesis and the inventory of surface glides.

<sup>5</sup> The asymmetry between [j] and [w] in standard Polish relates to gliding (rather than glide epenthesis), and involves an opaque generalization.

<sup>6</sup> The only relevant alternation discussed by Rubach (2000; 2002) involves the suffixes /ism/ and /ist/. No alternations are reported for vocalic sequences where the second vowel is not /i/. Other evidence in favor of the synchronic activity of the relevant patterns comes from acronyms, spelling errors, and the errors in L2 pronunciation.

## (10) Ranking conditions for Washo [j]-epenthesis



### 6.3 Contextual markedness effects on Washo epenthesis

Markedness constraints that refer to specific environments can force epenthetic consonants to be less than perfectly faithful to their underlying forms only in those environments. The effect is that a single phonological system might have several different epenthetic consonants.

This is the case in Washo, where constraints that specifically favor laryngeals at word edges mean that [ʔ], rather than [j], is epenthesized in that position. These constraints are called LAR-EDGE here and are defined in section 6.3.1, followed by an analysis of Washo glottal stop epenthesis.

#### 6.3.1 LAR-EDGE

There is a strong tendency for laryngeal consonants and laryngealized vowels to occur at edges of prosodic constituents (Blevins, 2004, 2008; Garellek, 2013). This tendency has a profound effect on epenthetic typology in the splitting theory. In this section, I propose a family of constraints that prefer laryngealized vocalic segments at prosodic edges (13).

- (13) LAR-EDGE: assign a violation mark for any vocalic segment  $\alpha$  which has modal voicing and occurs at an edge E (R or L) of a prosodic constituent C

These constraints may induce both laryngeal epenthesis next to vowels and laryngealization of vowels themselves. These two options are not easy to draw apart phonetically, but I focus on the cases where there is phonological evidence in favor of the epenthesis solution (e.g. no onsetless syllables otherwise).

In addition to word-medial [j]-insertion, Washo also exhibits laryngeal epenthesis at a word edge (14). While the initial syllable of the word often coincides with the stressed syllable, the glottal stop also appears initially with unstressed prefixes, as shown by the first example in (14a). The vowel-initial words also contrast with underlyingly consonant-initial words which start with a glottal stop. As shown in (14), consonant-initial stems differ from vowel-initial ones in taking a different allomorph of a personal prefix.

#### (14) Washo word-initial glottal stops

##### a. Glottal stop word-initially

/it-diʔju/	ATTR.INS-fire	[ʔit'diʔju]	'stove'	cf. [mit'diʔju]	'your stove'
/aŋal/		[ʔaŋal]	'house'	cf. ['maŋal]	'your house'

## b. Underlying initial glottal stop

/ʔa:tʰu/    ['ʔa:tʰu] 'older brother'    cf. [ʔumʰʔa:tʰu] 'your older brother'

Word-initial laryngeal epenthesis results from the high-ranked constraint LAR-[<sub>wd</sub>], which requires vocalic segments at the left edge of a word to be laryngealized.

The LAR-EDGE constraints are further supported by the typology of laryngeal epenthesis. In section 6.6, I show that laryngeals are preferred over epenthetic glides at all levels of prosodic hierarchy (except perhaps to the level of syllable), and both at the right edge and at the left edge. Furthermore, the LAR-EDGE constraints account for the fact that many languages only allow laryngeals at prosodic edges.

To summarize, laryngeally-specified vocalic segments are preferred at prosodic edges. This preference is encoded in a family of constraints LAR-EDGE, and it is not straightforwardly relatable to sonority.

### 6.3.2 Word-initial glottal stop epenthesis in Washo

Underlying vowel-initial words undergo glottal stop epenthesis in Washo. This process is only marginally reported in Yu (2011a: fn9; 2011b: fn4; 2008a: fn3). Jacobsen (1964) presents an analysis where glottal stop insertion follows from a number of independent morphophonological alternations of affixes and stems. Based on additional results from the Washo Project it is argued here that glottal stop insertion is a general phonological alternation.

Word-initial glottal stops can be difficult to perceive and there is a disagreement in the Washo literature with regard to glottal stop insertion. For these reasons special care will be taken to substantiate word-initial glottal stop epenthesis with phonological evidence (section 6.3.3) and phonetic analysis (section 6.3.4).

### 6.3.3 Phonological evidence

A number of bare noun stems display an initial [ʔ] which alternates with zero (15a). The other classes of stems always appear with a prefix. The 2sg. prefix appears as [ʔum] before consonant-initial stems, including the stems which underlyingly begin with /ʔ/ (15b). The contrast between the vowel-initial and glottal stop-initial stems in (15) thus shows that the underlying form of 'house' could not be /ʔaŋal/, since we would expect a different 2sg. prefix for such a stem. Many other prefixes in Washo have different alternants in prevocalic and preconsonantal position (see also Yu (2011a,b; 2008)).

(15) Washo stems with glottal stop insertion (all examples but one from WP)<sup>7</sup>

	Stem UR	SR	2sg /m-/ , /ʔum-/ 'your'
a.	/aŋal/	['ʔaŋal] 'house'	['maŋal] 'your house'
	/ijeg/	['ʔijeg] 'tooth'	['mijek] 'your tooth'
	/emlu/	['ʔemlu] 'food'	['memlu] 'your food' (415)

<sup>7</sup> Word-final devoicing is variably recorded in my sources, hence the difference in the examples e.g. ['ʔijeg] vs. ['mijek] in (15a) (cf. Yu, 2011a).

- b. /ʃu:/                    [ʃu:] 'chest'                    [ʔumʃu:] 'your chest'  
       /ʔa:tʰu/            [ʔa:tʰu] 'older brother'            [ʔumʔa:tʰu] 'your older brother'

The fact that glottal stop is inserted for prosodic reasons manifests itself perhaps most clearly in the situation when a suffix becomes a separate word or starts a word. This happens when "the speaker belatedly decides he should have added a certain suffix", or when the suffix is added anaphorically to the preceding sentence (Jacobsen 1964: 397). Under these conditions all suffixes receive stress unless followed by an underlyingly stressed morpheme, and vowel-initial suffixes get an initial glottal stop. In (16) the suffixes are shown attaching regularly to a consonant-final stem, and being added as a separate word.

(16) Washo suffix prosodification

- a. /-aʃaʔ/ 'near future':  
       [ʔipʰamʰaʃaʔi] 'he will arrive there, he's just getting there' (593)  
       [bakbagi. ʰaʃaʔi] 'he's smoking -- he's going to.' (597)
- b. /-enun/ 'usitative':  
       [banʃuʃenunigeduk] 'smoked as usual' (622)  
       [tʰanu ʔenunigedun ʰwaʔaʔ] 'people always did it' (624)
- c. /-unil/ 'defunctive':  
       [tuʰgitsʰimunili] 'his eyes were closed' (608)  
       [gaʰpʰaʃuk ʔi:duʃaʔ. ʔuniliʃgi ʰpʰaʃuʰge:skʰeʃaʔ] "'come in!" - he kept saying.  
       But he didn't come in' (610)

Stress assignment and initial glottal stop insertion both clearly serve the same goal: to make a licit prosodic word out of an item which is otherwise not used as a word. Thus suffix prosodification provides additional evidence that glottal stop insertion is a general phonological process.

Glottal stop insertion also applies to prefixed stems. Jacobsen (1964) captures these alternations by assuming a [ʔ]/zero alternation for each relevant prefix. However, the phonological insertion analysis derives all these alternations as well as other facts mentioned above from a single general process.

Thus, the [ʔ]-zero alternation is postulated in the attributive-instrumental prefix /it-/<sup>8</sup>. A [ʔ]-initial allomorph of this prefix occurs only when the prefix is word-initial (17).

<sup>8</sup> One other prefix is reported to undergo similar alternations: the intransitivizer /ʔum/ (Jacobsen 1964: 350). However the following example from the Washo Project suggests an underlying /ʔ/ in this prefix: [deʔumbiʔitsʰiʔ] 'expensive'. More data is needed on the behavior of this morpheme.



## (17) Washo attributive-instrumental /it-/

/it-diʔju/	ATIN-fire	[ʔit'diʔju]	'stove' (468)
/it-maʃu/	ATIN-wash	[ʔit'maʃu]	'soap' (488)
/m-it-diʔju/	2P-ATIN-fire	[mit'diʔju]	'your stove' (415)
/g-it-ŋa:m/	3SUP-ATIN-son	[git'ŋa:m]	'his own son' (425)

Another prefix with similar properties is the 3<sup>rd</sup> person subject marker which according to Jacobsen takes the form [ʔ] before vowels (18a) and zero before consonants (18b).

## (18) Washo marking for 3rd person subject (p 456)

a.	/emlu/ 'eat':	3SU [ʔemluji]
	/i:gi/ 'see':	3SU [ʔi:giʃi]
b.	/ʔeʔʃ/ 'chase'	3SU [ʔeʔʃi]
	/damali/ 'change':	3SU [da'maliʃi]

If no phonological glottal stop insertion process is assumed, the '3SU' morpheme has to be postulated in some cases where its appearance is dubious. First, this morpheme has to be assumed to occur in citation forms (Jacobsen, 1964: 430). Second, the 'third person morpheme' has to be postulated in the locative expressions, even if their meaning includes 1st or 2nd person semantics. The personal prefixes on locatives express location with respect to the interlocutors (19a). However, the initial glottal stop in [ʔiwiʔ] in (19b) thus cannot be the 'third person morpheme' marking agreement, since the reference point is expressed by a first person pronoun.

## (19) Washo location expressions (pp 439-440)

- a. /m-iwiʔ/ [miwiʔ] 'on/over you'
- b. [ʔlewhu        ʔiwiʔ]  
      1PL.INCL    on/over  
      'concerning us (inclusive)' [literally: 'on/over us']

On the present account, glottal stop insertion is a general phonological process and the citation forms present no difficulty. No person agreement morpheme needs to be postulated in the locative expressions such as (19b), since there the glottal stop is inserted for prosodic reasons.

The phonological account also simplifies the analysis of Washo morphology in cases where there is a third person meaning. In verbal inflection both the person of the subject and the person of the object is marked, as shown by (20a).

## (20) Washo verbal inflection for subject and object person

- a. [mi-<sup>l</sup>le-<sup>j</sup>il-hi]      2OB-1SU-give-OPT 'let me give you this' (452)  
      [mi-<sup>l</sup>l-i:gi-ji]      2OB-1SU-see-IPF 'I/we see you' (451)
- b. [ʔm-Ø-<sup>l</sup>i:gi-ji]      2OB-3SU-see-IPF 'he sees you' (460)  
      \*[mi-ʔ-<sup>l</sup>i:gi-ji]  
      [ʔm-Ø-<sup>l</sup>aʃdim-i]      2OB-3SU-hide-IPF 'he's hiding you' (460)  
      \*[mi-ʔ-<sup>l</sup>aʃdim-i]

The 2OB prefix generally takes the shape [mi-] before consonants and [ʔm-] before vowels. When the subject is in third person, no surface marker for agreement with the subject appears (20b). If there was a third person subjective prefix [ʔ] we would expect 2OB to show up as [mi]. On the phonological account the reason that there is no glottal stop in the forms in (20b) is clear: the first vowel of the stem is not word-initial and it gets an onset from the prefix. However, the morphological account (Jacobsen, 1964) has to stipulate that the 'third person marker' does not appear in all cases where the relevant morpheme is not word-initial.

Both the third person prefix /Ø/ and the attributive-instrumental prefix /it/ appear with a glottal stop only when they are word-initial. The phonological account explains this since this is the only environment where an onset is missing.<sup>9</sup> However, the morphological account has to stipulate the alternations of each prefix separately.

To summarize, initial glottal stop insertion is a general phonological process in Washo. This view is supported by converging evidence from citation forms of stems which appear unprefixes, from suffix prosodification, and from allomorphy of prefixes.

### 6.3.4 Phonetic evidence

Acoustic analysis of the recordings which are available from the Washo Project was undertaken with two main goals. First, the analysis confirmed that there are word-initial glottal stops and that there is no significant difference between inserted and underlying glottals. Second, acoustic analysis in this section gives an idea of how Washo glottal stops are implemented.

The recordings analyzed were all from the Washo Project pronounced by one male and one female speaker and recorded as wav files at 44 KHz. No biographical information about the speakers is available. The recordings rarely contained noise from natural sources (e.g. dogs barking) but in some cases there was background noise presumably generated by the recording equipment (e.g. sound card).

All recordings of words and phrases containing word-initial glottal stop were downloaded from the Washo project website. Some of the files to which a link was given on the website were unavailable, these were not analyzed. Out of all downloaded files, several kinds of recordings were excluded. Sound files with too much background noise to allow for reliable identification of cues to glottalization were excluded. Also excluded

<sup>9</sup> No data is available on hiatus resolution between two prefixes. Jacobsen (1964: 350) states that the attributive-instrumental /it/ behaves as if it had the form /t/ in this context, although no examples are given.

were cases where the target word was broken up by a hesitation pause. The files where the target glottal stop-vowel sequence was preceded or followed by another [ʔ] or a glottalized consonant were not analyzed. These cases could contain cues to glottalization even in the absence of a word-initial [ʔ]. The recordings showing signs of creak throughout the utterance were excluded (such cases were rare). Finally, the words for which underlying status of [ʔ] could not be determined were also excluded.

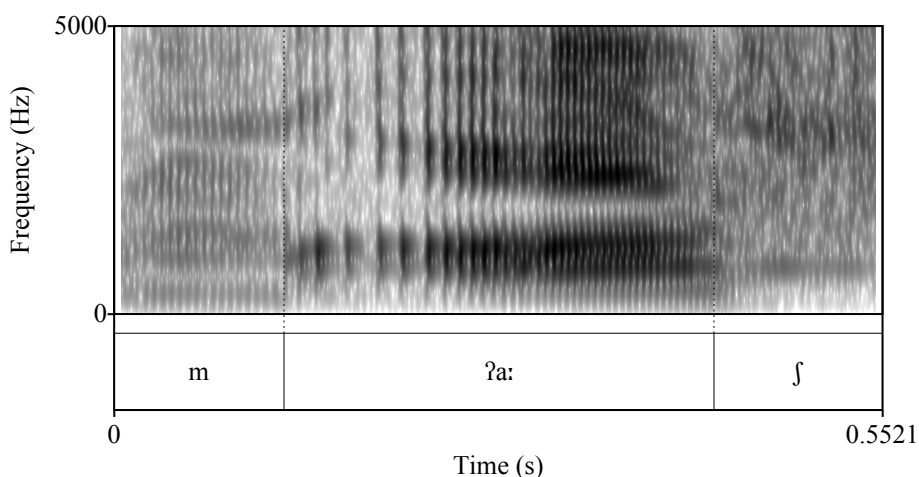
The underlying status of word-initial [ʔ] was determined based on the data in Jacobsen (1964) and in the Washo Project dictionary. Cases where the first morpheme of a given word would appear after a prefix were considered relevant. In addition, the prefix /ʔum-/ '2nd person' only occurs word-initially. The learners of Washo have no reason to postulate glottal stop insertion in this case in accordance with lexicon optimization (Prince & Smolensky, 2004). The words with this prefix were counted as having an underlying glottal stop.

The total number of tokens analyzed was 216 and of these only 34 were produced by the male speaker. The phrasal context is not controlled for in the corpus. The recordings of both sentences and single words are available. Some of the single-word recordings appear to be cut out of a bigger phrase, and in the sentence recordings sometimes there was a hesitation pause between the relevant words.

The existing instrumental measures of glottalization such as the difference between the first and second harmonics (Garellek & Keating, 2011; Garellek, 2012a; b, 2013) rely on the identification of F0, and these measures work best with periodic sound which has some signs of glottalization. However, an examination of the Washo recordings revealed that in some cases the realization of glottal stop involved a period of aperiodic signal which was followed by a more periodic glottalized vowel. F0 could not be reliably identified in the cases which involved the aperiodic realization and therefore the analysis of Washo relied on manual annotation, following the criteria developed in Dilley et al. (1996); Redi and Shattuck-Hufnagel (2001). The annotation was done in Praat (Boersma & Weenink, 2012).

Most commonly, the vowel following initial glottal stop showed high glottalization in its first part and decreasing glottalization in its second part (21). In some cases glottalization was spread more evenly throughout the vowel.

- (21) Washo word-initial glottal stop: fragment from the phrase [<sup>h</sup>ʔiʃim <sup>h</sup>ʔa:ʃugi] 'the sound comes in' (female speaker)



Each glottal stop token was labeled for the presence of a burst. In some cases the beginning of the recording appeared to be cut, these cases were excluded from burst annotation. Each underlyingly initial vowel was labeled for the presence of glottalization. To be conservative, the cues to glottalization were only annotated if they were very clear, and usually multiple cues were present. It is conceivable that some cases for which no glottalization was annotated could still show acoustic correlates of glottalization in an instrumental study.

The table in (22) describes the realization of word-initial glottal stop in Washo. Each cell gives the number of tokens which exhibited the relevant acoustic cue to glottal stop and the total number of tokens in the relevant condition. The "No cue" column lists the number of tokens which did not have a burst and did not have clear glottalization on the vowel. The number of tokens analyzed from the male speaker is small, therefore the percentages are only given for the female speaker. Some of the recordings appeared to be cut in the beginning and were not annotated for burst presence, thus the total number of tokens analyzed for burst is smaller than for glottalization.

- (22) Word-initial glottal stop realization in Washo. Number of tokens with the relevant cue out of the total number of tokens annotated for that cue.

Speaker	UR	Burst	Glottalization	No cue	Total analyzed
M	ur	3/8	8/8	0	8
M	epen	11/23	26/26	0	26
F	ur	12/69 17%	60/72 83%	11/72 15%	72
F	epen	14/107 13%	97/110 88%	12/110 11%	110
Total		40/207 19%	191/216 88%	23/216 11%	216

Overall, the recordings of word-initial glottal stop contained clear acoustic cues (either a burst or glottalization or both) in 89% of all cases. Most often, the glottal stop was realized as glottalization on the vowel although 19% of cases showed a burst. The occurrence of a burst with no glottalization was rare (1% of all tokens).

The data do not support the hypothesis that initial glottal stop is realized differently depending on its underlying status. Out of the tokens with an underlying glottal 15% did not show clear signs of glottalization or burst whereas out of the tokens with an epenthetic glottal only 11% did not have acoustic cues to [ʔ].

An examination of the tokens which did not appear to contain signs of glottalization revealed that in 4 cases the target word was either a clitic or a suffixal morpheme (recall that suffixes may appear as separate words if added belatedly). Although these appear as separate words in the Washo Project transcription, it is likely that they actually form a prosodic word together with the preceding item. Thus these 4 items may not be subject to initial glottal stop epenthesis.

### 6.3.5 Analysis of glottal stop epenthesis

Word-initial glottal stop epenthesis is a common cross-linguistic pattern. In many previous approaches glottal stop epenthesis arises because glottal stop is an unmarked consonant along a featural or representational dimension (McCarthy & Prince, 1994; Lombardi, 2002; de Lacy, 2006; Rice, 2007; Miller, 2012). However, word-initial glottal stop epenthesis in Washo cannot be explained by glottal stop being unmarked because [j] behaves as the unmarked epenthetic option with regard to word-medial hiatus resolution (see 6.2.3). Washo thus provides motivation for the constraint in (23). Further motivation for this constraint is discussed in section 6.6.

- (23) LAR-[<sub>wd</sub>]: assign a violation mark for each segment at a left edge of a prosodic word which does not have a nonmodal laryngeal specification

As discussed in Chapter 4, the typology of attested laryngeal contrasts at edges is described by the interaction of this constraint with the markedness constraints against glottalization and aspiration, and with the faithfulness constraints IDENT-[cg] and IDENT-[sg] prohibiting the changes in the laryngeal specification.

Note that the constraint LAR-[<sub>wd</sub>] has nothing to say about word-initial consonants, and in fact Washo word-initial consonants can have any laryngeal specifications. Further Washo vowels are not contrastively specified for laryngeal features, suggesting that the constraint \*LARV prohibiting the nonmodally specified vowels is undominated. This basic phonotactic ranking will be irrelevant in what follows, and therefore the constraint \*LARV will not play a role. For an analysis of Washo laryngeal alternations in obstruents and sonorants see Yu (2011a; b)

On the splitting account, [j] epenthesis satisfies all IDENT constraints next to a word-initial /#i/. Yet, words like /ijek/ ‘tooth’ surface as [ʔijek] rather than \*[jijek], obeying the preference to have laryngeals at edges. This competition is illustrated in the tableau in (24).

## (24) Word-initial glottal stop epenthesis in Washo

	/#i <sub>1</sub> t/	ONS	LAR-[ <sub>w</sub> d]	*sg	Id-[place]	*LAR	*[cg]	INT
☞ a.	ʔ <sub>1</sub> i <sub>1</sub> t				1	1	1	1
b.	i <sub>1</sub> t	W1	W1		L	L	L	L
c.	j <sub>1</sub> i <sub>1</sub> t		W1		L	L	L	1
d.	w <sub>1</sub> i <sub>1</sub> t		W1		L	L	L	1
e.	h <sub>1</sub> i <sub>1</sub> t			W1	1	1	L	1

The winning candidate (24a) satisfies both ONSET and LAR-[<sub>w</sub>d] by splitting the word-initial vowel to yield a vocalic creaky approximant. This mapping violates INTEGRITY, as well as all constraints against [ʔ]: IDENT-[place], \*LAR, and \*[cg]. On the other hand, the candidate (24c) has epenthetic [j], which is optimal word-medially. However, this candidate does not win word-initially because of the high-ranked constraint LAR-[<sub>w</sub>d]. The candidate with an epenthetic [h] also loses, since the constraint against aspiration (\*[spread glottis]) is higher ranked than the constraint against glottalization. Of course, in the overall Washo hierarchy \*sg is dominated by faithfulness since Washo allows [ʔ h] as well as glottalized and aspirated consonants.

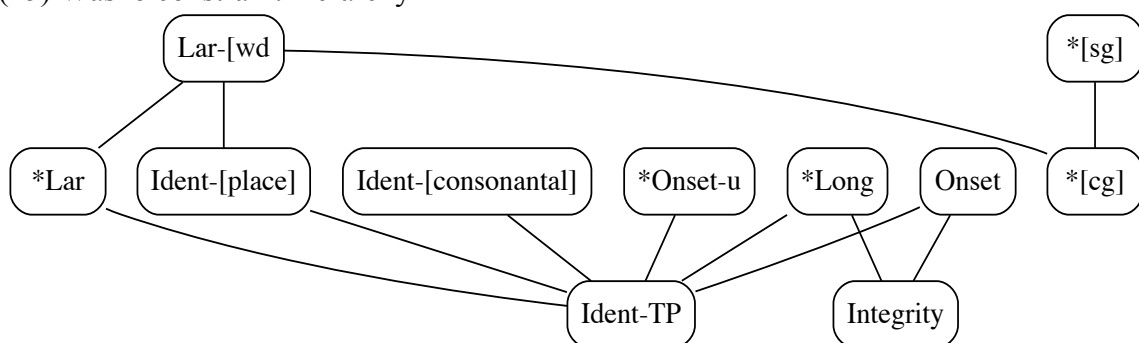
### 6.3.6 Glide neutralization and initial epenthesis

Within the Splitting theory, the analysis of epenthesis has consequences for neutralization processes in the language as a whole. Thus, word-medial [j]-insertion has to coexist with a neutralization process whereby /u/ is neutralized to [j] in margins. Word-initially, vocalic [j w] may never occur, since, as we saw in (24) an initial high vowel would split to yield a glottal stop, rather than changing to a glide or splitting into a glide. However, just as in the word-medial position, the consonantal glides /j<sub>c</sub> w<sub>c</sub>/ are preserved word-initially because they are not penalized by LAR-EDGE. Thus, the Splitting analysis of Washo epenthesis crucially relies on the assumption of dual specification of glides.

### 6.3.7 Summary: Washo ranking

Combining the ranking arguments in (24) with the rankings discussed in section 6.2, we arrive at the following constraint hierarchy for Washo. It is possible that only of the constraints \*LAR and IDENT-[place] dominates the IDENT constraints on tongue position features in this hierarchy. This hierarchy accounts for word-medial [j] epenthesis and word-initial [ʔ] epenthesis, as well as for the neutralization processes that affect vocalic glides in Washo.

## (25) Washo constraint hierarchy



## 6.4 Vowel merger in Washo

When a vowel sequence arises at the left edge of a root, such a sequence is repaired by vowel merger in most cases (de Haas, 1988; Midthlyng, 2005). This section surveys the available evidence for vowel merger. It is argued that merger alternations are morphologized, and thus the existence of vowel merger does not undermine the generality of [j] epenthesis.

### 6.4.1 Vowel merger in inflectional morphology

The vowel merger alternations which appear with inflectional morphology are /ei/ → [e]; /ea/ → [a]; /ee/ → [e]. These occur in two inflectional prefixes /le/ '1st person' and /ge/ 'imperative'.

(26) Washo imperative and 1st person prefixes

/ea/	/ge-ajad/ IMP-spend_night	[ <sup>h</sup> gajat] 'spend the night!' (269)
/ee/	/le-emle/ 1P-heard	[ <sup>h</sup> lemle] 'my heart' (261)
/ei/	/le-iheb/ 1P-head	[ <sup>h</sup> lehep] 'my head' (411)
/eC/	/ge-beju/ IMP-pay	[ge <sup>h</sup> beju] 'pay him!' (296)

However, Washo prefixes are in general subject to a number of suppletive alternations. Thus, the allomorphs in (26) can also be treated as suppletive. To exemplify the suppletion of Washo prefixes, the alternations of personal prefixes are summarized in (27), where l+e means that the first vowel of the stem is changed to [e]. On the suppletion analysis, the allomorph of first person subject prefix before /i/-stems has to be prespecified for some feature which would cause deletion of a following /i/, while preserving the /e/.

## (27) Suppletive allomorphy in Washo personal prefixes

Context:	1	2	3	1OB	2OB	3OB	3N
_C	/di/	/ʔum/	Ø	/le/	/me/	/ge/	/de/
_i	/l + e/	/m/	Ø	/ʔl/	/ʔm/	/k <sup>2</sup> /	/t <sup>2</sup> /
_V	/l/	/m/	Ø	/ʔl/	/ʔm/	/k <sup>2</sup> /	/t <sup>2</sup> /

In fact, even (27) is somewhat simplified. For example, the second person prefix has more suppletive allomorphs which occur before certain morphemes. However, these examples serve to make a general point that prefix allomorphy is highly suppletive in Washo, and thus the alternations in (26) can hardly be treated as general phonological alternations.

#### 6.4.2 Vowel merger in bipartite constructions

Most of the evidence for vowel merger comes from the formation of bipartite verbal stems. Washo bipartite stems usually consist of two elements: the lexical prefix and the dependent stem (Jacobsen, 1980; Bochnak & Rhomieux, 2013). To a certain extent the formation of tri-element stems is also possible, and the term *bipartite stems* will be extended to those cases as well. In these cases the third element comes from the class of dependent stems although it may be analyzable as a suffix (Jacobsen, 1980: 96). The dependent stems always start with a vowel (Yu, 2008b) unless they bear a plural marker.

Bipartite stems in Washo can be analyzed as exhibiting semantically vacuous linking morphemes, which often occur at compound boundaries across languages (see Chapter 10). Such linking morphemes are typically conditioned both morphologically and phonologically (as is the case in Washo), and they do not obey the otherwise general phonological restrictions and processes of the language.

On the linking morpheme analysis, the vowel quality alternations arising in bipartite stem formation are treated as morphologized phenomena due to featural affixation or morpheme-specific phonological constraints. In what follows, I illustrate the relevant alternations and show that bipartite stem formation shows many signs of typical linking morphemes. The proposed linking elements will essentially be encoding a certain combination of alternations imposed on the first vowel of a following stem. A full analysis of these boundary phenomena would have to spell out how exactly these alternations are prespecified in the lexicon (e.g. via cophologies (Inkelas *et al.*, 1997 *et seq.*) or lexically indexed constraints (Pater, 2000 *et seq.*)). However a full analysis is irrelevant to the patterns of consonant epenthesis, and it would lead us too far afield here.

The table in (28) summarizes the effects of the Washo linking morphemes (blank cells meaning no data is available). A zero linking element occurs in some cases as well, although it shows no alternations and hence is irrelevant for the present discussion.

(28) Linking vowels in Washo bipartite stems

Environment Linking V	_a	_e	_i	_ɨ	-C
e	a	e	e		eC
ɛ	a	e	e		C
u	o		u	ɨ	uC

These alternations are illustrated in (29), where the linking elements are underlined in the input. The examples in (29) also show effects of postglottal vowel deletion and of vowel harmony (Jacobsen 1964, pp 300-302; Midtlyng, 2005).



## (29) Washo vowel merger in bipartite stem formation

/ua/	/ge-du-aŋaʔ-ha/ IMP-burn-on-CAUS	[ga'doŋaha] 'burn it!' (289)
/ui/	/Ø-hu-i:biʔ-i/ 3SU-wind-come-IPF	[ʰhu:biʔi] 'wind has come' (290)
/ui/	/Ø-tsʰilu-ijpij-ε-itiʔ-i/ 3SU-hips-narrow-down-IPF	[tsʰi'lijpjetiʔi] 'he has small, even hips' (290)
/uC/	/Ø-maʔagu-d-a:ʃ-ug-i/ 3SU-wood-PL-into-HITHER-ipf	[maʔagu'da:ʃugi] 'they are bringing wood in here' (299)
/ea/	/Ø-kʰule-aŋaʔu-a:ʃ-ug-i/ 3SU-sit-on-into-HITHER-IPF	[kʰulaŋaʔo:ʃugi] 'he's riding in here on it' (289)
/ei/	/Ø-de-iʔiʃ-i/ 3SU-snow-empty_stem-IPF	[ʰdeʔʃi] 'it is snowing' (286)
/εV/	/ge-sebε-ilbε-aʔj-i/ 3OB-blow-push-away-IPF	[geseʰbelbaʔji] 'he's blowing it away' (287)
/εC/	/Ø-kʰujε-ʔ-iʔiʃ-i/ 3SU-swim-PL-empty_stem-IPF	[kʰujʰeʔʃi] 'they (dist.) are swimming' (298)

Out of the linking elements, /u/ and /ε/ can attach to free-standing stems. Thus, when lexical prefixes, such as e.g. /maʔag/ 'wood' in (29), occur as separate stems, without the following [u, ε]. In this case the linking vowels have to be morphemes occurring only in compounds<sup>10</sup>.

Phonologically, the linking vowels in Washo bipartite stems exhibit many properties characteristic of linking morphemes. Their appearance does not optimize surface phonological structure: they create hiatus, which is otherwise strictly prohibited. The linking vowel /ε/ is not a possible segment in Washo, and as such it has to be analyzed as a lexical diacritic for a certain set of alternations. The alternations of all linking vowels go against the phonology of the language as a whole. Vowel sequences are generally resolved by [j]-insertion, and [j]-insertion operates in bipartite stems when a linking vowel attaches to a vowel-final stem. This was illustrated in (4), repeated below as (30). However, the linking vowel always merges with the first vowel of a following stem, thus contradicting the overall phonological pattern of the language.

<sup>10</sup> For the stems which do not occur on their own, the linking vowels may be treated as part of the stem (Jacobsen, 1964). However, regardless of the morphological affiliation of the linking vowels in this case, it is clear that their alternations are idiosyncratic and limited to the bipartite stems.

## (30) [j]-insertion in Washo bipartite stems

/di-mo:k <sup>o</sup> -ε-iwe?-i/	[di'mo:k <sup>o</sup> ojewe?i]
1SU-knee-V-on_the_ground-IPF	'I'm kneeling' (263)
/Ø-p <sup>ʔ</sup> i?li-u-i:bi?-i/	[p <sup>ʔ</sup> i?li'ju:bi?i] 'he has come from
3SU-fish_with_hook_and_line-V-come-IPF	fishing with hook and line' (264)

The choice of a linking vowel for a particular stem is not predictable. Furthermore, the alternations that the linking vowels impose on the following stem-initial vowel are complex and probably idiosyncratic. Thus, the sequence /u+i/ in bipartite stems changes to [u] while /u+i/ changes to [i].

The idea that the alternations of each linking vowel have to be prespecified in the lexicon is further supported by the numerous exceptional or marginal patterns illustrated in (31). A number of lexical prefixes that end in the linking /e/ trigger lengthening of a following vowel (31a). The lexical prefixes /ŋa/ 'descriptive of a belly'; /ha/ 'rain'; /hulbi/ 'pry, lift with a long object' turn a following /i/ into [a, i] and do not occur before other vowels (31b). The lexical prefix /ʃ/ 'to walk (of a single person)' triggers shortening of a following long vowel but does not affect vowel quality (31c). Finally, the dependent stems /i:gi/ 'see' and /ik<sup>ʔ</sup>il/ 'back and forth' always preserve their initial vowel both in bipartite constructions and in inflection (31d).

## (31) Marginal vowel alternations in bipartite stems

## a. Lengthening a following vowel

/Ø-mele <sup>a</sup> -iti?-i/ 3SU-jump-down-IPF	[me'le:ti?i] 'he's jumping down' (307)
---	--

## b. Linking /a, i/

/ŋa-i:bug-i/ belly-bloated-IPF	[ <sup>ʔ</sup> ŋa:bugi] 'he is bloated in the stomach' (291)
/Ø-ha-i:bi?-i/ 3SU-rain-have_come-IPF	[ha:bi?i] 'rain has gotten here' (291)
/di-hulbi-ips-i/ 1SU-pry-up-IPF	[dihul'bi:psi]
	'I'm lifting it with a long object' (295)

## c. Shortening after /ʃ/ 'to walk (of a single person)'

/Ø-ʃ-at <sup>ʔ</sup> i-we?-i/	[ʃat <sup>ʔ</sup> iwe?i]
3SU-walk-uphill-hence-IPF	'he is walking uphill' (310)

## d. Exceptional /i/-initial stems

/le-i:gi-i/ 1SU-see-IPF	['li:gi:] 'I see it' (293)
/Ø-kmu-ahadɛ-ikʰil-i/	['mohadikʰili]
3SU-run-across-back_and_forth-IPF	'he ran back and forth across' (293)

To summarize, the linking vowels appear in Washo bipartite stem formation and lead to a set of vowel quality alternations. These alternations have to be lexically prespecified. These alternations are restricted to one morphological environment, they are not phonologically predictable, and they contradict the overall phonology of the language. Finally, there are numerous exceptions to the behavior of particular linking vowels.

### 6.4.3 Vowel merger and the Washo plural

Washo plural infixation shows vowel quality alternations and the analysis of plural has been debated (Winter, 1970; Broselow & McCarthy, 1983; Urbanczyk, 1993; Yu, 2005b). Different assumptions about the shape of the plural morpheme may lead to different underlying VV sequences. In what follows, I assume the analysis of plural infixation in Yu (2005b), plural infixation is distinguished from full reduplication in accordance with Yu (2008a). I argue that vowel quality alternations in Washo plural do not bear on hiatus resolution (Midtlyng, 2005)

Washo plurals show two alternations in vowel quality (32). In this example both the stem and the plural may be occurring only with additional suffixes or prefixes (Jacobsen, 1964: 322).

#### (32) Vowel quality alternations in Washo plural (pp 340-341)

	Stem	Plural	Transl	Stem-initial vowel
a.	tʰanu	tʰa'nono	'person'	
	ma:gu	ma'go:go	'sister's child'	
b.	itiʔ	'tetiʔ	'down, downwards'	['ʃuʔmitiʔ] 'to throw down' (WP)
	i:jaluʔ	'je:jaluʔ	'relative'	
	iʃl	'ʃeʃl	'to give'	['miʃli] 'you give it to him' (454)

The [u] ~ [o] alternation in (32a) can be analyzed as stemming from the general harmony requirements of the language (Urbanczyk, 1993). On this account the stem-final vowel is underlyingly /o/, i.e. /tʰa-no-no/. Urbanczyk (1993) advocates a similar account for the [i] ~ [e] alternation in (32b), but the forms in the last column show that the stem-initial vowel shows up as [i] elsewhere.

All /i/-initial stems show the [i] ~ [e] alternation in the plural. The instances of non-alternating /i/-initials all come from full reduplication, which is argued to be a separate phenomenon by Yu (2008a). Thus we are likely dealing with a morphologized alternation where the stem-initial /i/ is always changed to [e] in the plural. It should be noted that for

some of the words in (32b), the alternation may be variable across consultants, or even within a single consultant (Jacobsen, 1964: 339). Finally, a number of stems have an irregular plural, see Jacobsen (1964, pp 341-342) for examples.

To summarize, Washo exhibits an idiosyncratic [i] ~ [e] alternation in plural infixation. This alternation does not bear on hiatus resolution (see also Midtlyng, 2005).

#### **6.4.4 Conclusion on vowel merger**

Vowel merger alternations are morphologized, and they do not undermine the generality of [j]-epenthesis. Most instances of vowel merger occur at the formation of bipartite stems, and they can be analyzed as stemming from addition of linking vowel morphemes. The lowering of stem-initial /i/ to [e] in the plural (32) is also morphologically conditioned. Finally, Washo inflectional prefixes show a high degree of suppletion, and it is likely that the vowel quality alternations in these prefixes are suppletive.

### **6.5 Washo: summary and theory comparison**

I have shown that Washo exhibits a general process of [j] epenthesis in all vowel sequences word-medially. Word-initial onsetless syllables are repaired by glottal stop epenthesis. Finally, vowel feature alternations in bipartite stem formation suggest an analysis in terms of linking morphemes.

In Washo, two important predictions of the splitting theory are borne out. First, the epenthetic glides will not always be homorganic to neighboring vowels because there are general markedness constraints pertaining to glides. In Washo word-medial [j] epenthesis, the homorganic glide [w] is blocked by a general markedness constraint \*ONS/u. The proposed analysis also relies on the dual nature of glides to account for the presence of [w] in the Washo inventory.

Second, the splitting theory analyzes the common pattern of word-initial glottal stop epenthesis as a result of positional preference for nonmodal phonation at edges of prosodic constituents (LAR-EDGE). This preference shows up very clearly in Washo, since word-initial glottal stop epenthesis cannot be due to the emergence of the unmarked.

Finally, within the Splitting theory the alternations of the inserted consonants generally apply in the language as a whole. As a result, vocalic glides are neutralized to [j] word-medially and to [ʔ] word-initially in Washo.

#### **6.5.1 Washo and the Insertion theories**

Washo presents a particularly complex case of epenthesis: across-the-board medial [j] epenthesis, and word-initial [ʔ] epenthesis. Having established the generalizations about Washo above, I briefly explore its expression in other theories of epenthesis where Washo must be analyzed in a fundamentally different way.

In Insertion theories, epenthetic consonants have no underlying correspondent (e.g. de Lacy, 2006; Lombardi, 2002). The fact that the epenthetic consonants is similar to its neighbors cannot be due to faithfulness, but must be ascribed to assimilation (Lombardi, 2002; de Lacy, 2006), autosegmental spreading (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011), or OO-correspondence (Kitto & de Lacy, 1999). In contrast, those theories have the epenthetic consonant taking on unmarked features when assimilatory or dissimilatory pressures do not apply.

In de Lacy (2006)'s theory, for example, word-initial [ʔ] epenthesis must be ascribed to markedness constraints that favor [ʔ] over all others. In Lombardi (1999) and de Lacy (2006), these are constraints such as  $\ast\{\text{dors,lab,cor}\}$ , crucially outranking all antagonistic markedness constraints (e.g.  $\ast\text{MAR/glottal}$ ), and all constraints that promote assimilation (e.g.  $\text{AGREE}[\text{consonantal}]$ ,  $\text{AGREE}[\text{place}]$ , and so on).

Medial [j] epenthesis in Washo in such theories must be due to emergent assimilation: i.e. [j] agrees in all features with the preceding vowel, except for place and tongue position.

Unlike the Splitting theory, the Insertion theories make two crucial predictions. First, we expect to find real cases of consonant-to-vowel assimilation where major class features are assimilated, but tongue position and place is not, e.g.  $/t/ \rightarrow [j]/[u]$ . Second, word-initial assimilation must be somehow blocked by some higher-ranking markedness constraint, such as modified sonority (Uffmann, 2007a).

Both the Splitting Theory and the Insertion theories can account for Washo. However, how they do so is fundamentally different. The Splitting theory employs input faithfulness – [j] is inserted because it preserves the input vowel's major class features; unmarked epenthetic consonants are deviations from faithfulness forced by markedness constraints. In contrast, non-splitting theories ascribe glides to assimilation, while deviations from assimilation must be due to the emergent effect of markedness constraints.

## 6.6 A typology of laryngeals at edges

The splitting theory and the family of constraints LAR-EDGE proposed in 6.3.1 yield several important typological predictions. In this section, these predictions are verified with particular reference to the typology of epenthesis, and to the alternations of epenthetic consonants. Four predictions are addressed in particular:

- laryngeal approximants tend to be inserted at both right and left edges and at all prosodic levels
- laryngeal insertion at edges may or may not coexist with medial glide insertion
- laryngeal approximants may be allowed only at prosodic edges
- underlying vocalic segments are expected to turn into laryngeals at edges

### 6.6.1 Laryngeal insertion at a variety of prosodic edges

In Washo, laryngeal insertion at a left edge of a prosodic word coexists with medial [j]-insertion. Laryngeal insertion at prosodic edges also often coexists with the homorganic glide insertion pattern. This is the case in Kalaallisut that has both homorganic and non-homorganic glide insertion word-medially (the glide insertion patterns are discussed in more detail in Chapter 4) (Rischel, 1974; Fortescue, 1984). In addition to glide insertion, Kalaallisut also has word-initial glottal stop insertion, although it is more variable than in Washo.

#### (33) Kalaallisut epenthetic glides and glottal stop

- a. Homorganic glides word-medially before a low vowel

/ulu-a/            [uluwa] 'her knife'

/ajuqi-uwuq/ [ajuqijuwuq] 'is a catechist'

## b. Non-homorganic glides word-medially before a high vowel

/na:-i/	[na:vi] 'his stomach'
/pu:-utsiga/	[pu:ʝutsiga] 'my bag'
/qaʒʒuna:-uwuq/	[qaʒʒuna:ʝuwuq] 'is a Dane'
/qi:-ija <sup>ɕ</sup> ppa/	[qi:vija <sup>ɕ</sup> ppa] 'he removes his white hair'

## c. Glottal stop word-initially

/ima/	[ʔima] 'thus'
cf. /ta-ima/	[ta:ma] 'thus (as referred to)'

Just like in Washo, in Kalaallisut the general epenthetic strategy is to insert glides, not laryngeals. Yet, at the beginning of a word a laryngeal emerges. Within the splitting theory, this pattern follows directly from the ranking of LAR-[<sub>wd</sub>] over faithfulness to place and over constraints against laryngeal insertion. Word-medially (34a) LAR-EDGE is inactive, and hence faithful glide insertion harmonically (ignoring for the moment the complications related to directionality, on which see Chapter 4). However, at a word boundary, the faithful option is blocked, and a laryngeal is picked by LAR-EDGE (34b).

## (34) Glides and laryngeals in Kalaallisut

## a. Word-medial glides

	/tu <sub>1</sub> a <sub>2</sub> /	ONS	INT
☞ a.	tu <sub>1</sub> w <sub>1</sub> a <sub>2</sub>		1
b.	tu <sub>1</sub> a <sub>2</sub>	W1	L

## b. Word-initial laryngeals

	/#i <sub>1</sub> ma/	ONS	LAR-[ <sub>wd</sub> ]	ID-[place]	*LAR	INT
☞ a.	ʔ <sub>1</sub> i <sub>1</sub> ma			1	1	1
b.	i <sub>1</sub> ma	W1	W1	L	L	L
c.	j <sub>1</sub> i <sub>1</sub> ma		W1	L	L	1

The analysis in (34) is similar to the analysis of Washo proposed above. Both of these cases instantiate an important prediction of the Splitting approach: positional markedness may lead to less-than-faithful epenthetic segments. Finally, just like in Washo, glottal stop epenthesis in Kalaallisut cannot be attributed to general markedness (Lombardi, 2002; de Lacy, 2006). If glottal stop was the least marked consonant in Kalaallisut, we would not be able to explain why it does not emerge when homorganic glide epenthesis is blocked by \*[ji/wu].

An interesting variant of this pattern occurs in Malay, where homorganic glides resolve hiatus at root-suffix boundary, glottal stop always appears between a prefix and a root, and onsetless syllables are allowed prosodic word-initially (Onn, 1980; Durand, 1987; Ahmad, 2001, 2005). Prefixes are known to sometimes attach at the prosodic word

level (van Oostendorp, 1994; de Lacy, 2003), and therefore it is not surprising that prefix-root boundary sometimes triggers laryngeal epenthesis just like the edge of a prosodic word.

If we assume that prefixes attach to PWords in Malay, the epenthesis pattern can be treated as completely parallel to Kalaallisut. The absence of insertion word-initially can be attributed to the positional faithfulness constraint INI-INTEGRITY introduced in Chapter 2. At a prefix boundary an onset can be provided by splitting the prefix-final vowel, without violating INI-INTEGRITY. This option is not available word-initially, and hence no splitting happens.

Malay illustrates another important consequence of LAR-EDGE constraints: these constraints may interact with other edge-sensitive constraints such as positional faithfulness and positional markedness. Because there are several families of constraints sensitive to the same prosodic constituents, it is hardly possible to establish any implicational relations between epenthesis at edges and medial insertion. Thus, in Chapter 4 we have seen that epenthesis is generally avoided word-initially because of positional faithfulness. However there are also constraints which require words and phrases to start with unmarked syllables (Bye & de Lacy, 2000; Smith, 2002; Flack, 2007, 2009). Thus, there is a version of ONSET relativized to the first syllable of higher-order prosodic constituents. Together with the LAR-EDGE constraints, the tighter onset requirements at edges predict that epenthesis may happen *only* at a left edge of a word or a phrase, and that in these cases laryngeal epenthesis will be preferred.

This prediction is confirmed. Even in languages where word-medial hiatus is tolerated or resolved via some non-epenthetic repair, laryngeals are often inserted at a prosodic edge. In fact, word-initial glottalization is probably present in some form nearly universally, unless the language has a contrast between vowel-initial and [ʔ]-initial words (Garellek, 2013).

To give some examples from my sample, the left edge of a foot triggers glottal stop insertion in German, where word-medial hiatus is tolerated otherwise (Kohler, 1994; Wiese, 1996; Alber, 2001; Pompino-Marschall & Zygis, 2011). Similarly, in Anejoñ (also known as Aneityum) word-medial hiatus is allowed, but each phrase must begin with a glottal stop (35) (Lynch, 2000; Lynch & Tepahae, 2001).<sup>11</sup>

(35) Anejoñ phrase-initial glottal epenthesis

/aek/	[ʔaek] ‘you (SG)’
/apam aek/	[ʔabam <sup>1</sup> aek] ‘come! (SG)’
/et apam aen/	[ʔeɖ <sub>1</sub> abam <sup>1</sup> aen] ‘he came’

These patterns show the effects of the constraints ONSET(foot) and ONSET(Phrase) combined with the effects of LAR-EDGE.

All of the examples of edge laryngeal insertion discussed so far occur at a left edge. If this was the general pattern, it would probably be possible to reformulate LAR-EDGE constraints in terms of sonority, so that less sonorous onsets (laryngeals) are favored over

<sup>11</sup> Anejoñ laryngeal insertion pattern is supported by alternations, see Chapter 9 for discussion.

more sonorous onsets at an edge (Bye & de Lacy, 2000; Smith, 2002). However, laryngeal insertion also occurs at right edges. Right-edge laryngeal insertion cannot be due to sonority, since codas tend to be of high, rather than of low sonority.

An example occurs in Mabalay Atayal (Lambert, 1999). In this language all words end in a consonant, and a glottal stop is inserted after a word-final vowel. Medial hiatus is resolved by diphthongization or long vowel formation (if the resulting long vowel is in a stressed syllable). In the examples in (36a), the first morphemes are infixes, while the same stems appear with suffixes in (36b).

(36) Laryngeal insertion in Mabalay Atayal

a. Word-final laryngeal insertion

- /-an-βakħa/    [βanakħaʔ] ‘-PFV-break’  
 /-am-satu/    [samatuʔ] ‘-INTRANS-send’  
 /-am-ktri/    [kamtariʔ] ‘-INTRANS-kneel’

b. No laryngeal word-medially

- /βakħa-un/    [βakħeun] ‘break-TRANS.PATIENT’  
 /satu-an/    [satuan] ‘send-TRANS.LOC’  
 /-in-ktri-un/    [kintariun] ‘-PFV-kneel-TRANS.LOC’

The final syllable always bears stress in Mabalay Atayal. Therefore epenthesis can be attributed to the requirement that stressed syllables are heavy, encoded as STRESS-TO-WEIGHT principle below (SWP for short) (Lambert, 1999; de Lacy, 2006). Importantly, splitting does not result in the fully faithful glides because of the constraint LAR-]<sub>Ft</sub> (note that LAR-]<sub>Wd</sub> could also be used). The analysis of Mabalay Atayal epenthesis is illustrated in (37). Unlike LAR-]<sub>Ft</sub>, a sonority constraint would prefer an epenthetic glide (37)

(37) Word- and Foot-final epenthesis in Mabalay Atayal

	/tu <sub>1</sub> #/	SWP	LAR-] <sub>Ft</sub>	ID-[place]	*LAR	INT
☞ a.	tu <sub>1</sub> ʔ <sub>1</sub>			1	1	1
b.	tu <sub>1</sub>	W1	W1	L	L	L
c.	tu <sub>1</sub> w <sub>1</sub>		W1	L	L	1

The data cited above naturally lead to the question of whether laryngeals are ever associated with an edge of the lowest prosodic unit – the syllable. I know of no convincing cases where a laryngeal would either consistently resolve hiatus in all VV sequences, or always appear in coda (although the rarity of the latter pattern may be due to the general dispreference for codas). However, since laryngeal epenthesis is very abundant in the languages of the world, further typological research may be needed to establish if this reflects a true generalization. The two languages which come the closest to having a laryngeal in all onsetless syllables are Ilokano (Hayes & Abad, 1989) and formal Farsi (the dialect documented by Rohany Rahbar (2012) and confirmed by my



elicitations). However, in formal Farsi there is variation between glottal stop and [j] epenthesis,<sup>12</sup> which may partially be governed by lexical factors (although between-speaker variation also occurs for the same items). The Ilokano pattern applies only loanwords and novel words, and there is always variation between homorganic glides and laryngeal insertion.

Within the splitting theory, there may be a number of reasons why the syllable is special with respect to laryngeal epenthesis. For example, unlike the edges of higher order prosodic constituents, the syllable edges do not carry functional load and cannot be used in disambiguation, hence they may not require laryngeal demarcation as much as other constituents. However, the apparent non-existence of languages which resolve all hiatus by laryngeal epenthesis is a serious challenge to the markedness-based approaches (Lombardi, 2002; De Lacy, 2006). In these theories, laryngeals are treated as the least marked along the Place dimension, and thus it is not clear why they do not appear to uniformly resolve hiatus.

To summarize, we have seen that the LAR-EDGE constraints predict that laryngeals may be inserted at edges, even if glides appear in medial hiatus. This is the case in Washo, Kalaallisut, and Malay. The LAR-EDGE constraints also interact with positional faithfulness, and, crucially, with positional markedness. The interaction between LAR-EDGE and ONSET-PCAT predicts that insertion may happen only at edges, and that laryngeals will be preferred in these cases. These predictions are instantiated in German, Anejoñ, Mabalay Atayal, and in many other languages which have word-initial glottalization. Finally, LAR-EDGE effects are attested at both right and left edge, and at all prosodic levels, except perhaps for the syllable.

### 6.6.2 Laryngeals that appear only at edges

Within the splitting theory, laryngeals are epenthesized at prosodic edges because they are preferred in this position in general. This approach predicts that there will be languages where laryngeals are only allowed at edges of prosodic constituents. The prediction is borne out. The examples of this pattern include Kalaallisut, German, English, and possibly Czech (see Appendix B for sources of data).

An analysis of these patterns within the splitting theory is straightforward. While the constraint \*LAR in general outranks faithfulness, it is dominated by LAR-EDGE in these languages. To illustrate, consider the hypothetical language in (38), which is based on Kalaallisut and Czech.<sup>13</sup> (38a) shows that word-medial glottal stops are deleted in this language. In real Kalaallisut there is no evidence that medial laryngeals are avoided via deletion rather than in some other way, so this mapping is hypothesized for the purposes of illustration. Word-initial segments are prohibited from deletion by positional faithfulness (MAX-INT), and initial laryngealization is promoted by the positional

<sup>12</sup> In addition, formal Farsi is only used in official situations and could be influenced by orthography. In daily speech hiatus is resolved by vowel deletion.

<sup>13</sup> Although there are no vowel-initial words in Czech, the words starting with a glottal stop do not lose glottalization after prefixes (in verbs) and prepositions (in nouns). Thus it appears that the glottal stop may be part of the underlying representation, at least in the postlexical phonology of Czech, while it could be inserted at earlier levels (Rubach, 2000). I am grateful to Věra Dvořák for providing some examples and clarifying the extent of initial glottal-zero variation.

markedness constraint LAR-[<sub>wd</sub>. Because of these two pressures, word-initial vowels split to yield a laryngeal (38b), and underlying initial laryngeals survive (38c).

(38) Laryngeals only allowed at edges, as a result of epenthesis

a. Glottal stops prohibited word-medially (hypothesized deletion)

	taʔa	*LAR	*LONG	MAX
☞ a.	ta:		1	1
b.	taʔa	W1	L	L

b. Splitting is allowed word-initially

	a <sub>1</sub> ta	LAR-[wd]	MAX-INI	*LAR	INT	ID-[place]	MAX
☞ a.	ʔ <sub>1</sub> a <sub>1</sub> ta			1	1	1	
b.	a <sub>1</sub> ta	W1		L	L	L	
c.	ta		W1	L	L	L	W1

c. Underlying word-initial laryngeals surface faithfully

	ʔata	Lar-[wd]	MAX-INI	*LAR	MAX
☞ a.	ʔata			1	
b.	ata	W1	W1	L	W1

d. Splitting cannot yield a glottal word-medially

	ta <sub>1</sub> a <sub>2</sub>	*LAR	*LONG	INTEGR
☞ a.	ta:		1	
b.	ta <sub>1</sub> ʔ <sub>1</sub> a <sub>2</sub>	W1	L	W1

Finally, word-medial hiatus is not resolved by glottal epenthesis because the constraints referring to the initial position are irrelevant here, and \*LAR dominates \*LONG (38d).

On the other hand, the non-contrastive laryngeal insertion at edges presents a problem for the markedness-based theories of epenthesis (Krämer, 2012; Iosad, 2013). The splitting theory has a clear advantage here, since it provides a straightforward and unified account of non-contrastive epenthesis (see also Chapter 5).

### 6.6.3 Chumburung: underlying vowels turn into laryngeals at edges

The splitting theory relates the alternations of margin vowels to the alternations in epenthetic consonants, since both kinds of alternations are regulated by the ranking of input-output IDENT constraints (see also Chapter 2). Therefore, we expect to see cases where vocalic glides alternate with laryngeals when they end up at a prosodic boundary. This is what happens in Chumburung (Snider, 1984, 1985, 1986, 1989, 1990; Hansford, 1990). In this language, words ending in a vowel contrast with words which in isolation

end in a glottal stop (39). Tones are not marked in this example, they are identical for both members of each pair. The final glottal stop is analyzed here as an empty V-slot.<sup>14</sup>

(39) Chumburung word-final vowels vs. laryngeals

/da/	[da] ‘to hit’	/daV/	[daʔ] ‘older brother’
/kɔ/	[kɔ] ‘to fight’	/kɔV/	[kɔʔ] ‘to defecate’
/te/	[te] ‘to sit’	/teV/	[teʔ] ‘to pluck’

When glottal-final words occur before vowel-initial words in connected speech, the laryngeal turns into a glide homorganic to a preceding vowel (40a). On the other hand, the words which end in a vowel in isolation trigger vowel coalescence (40b). The alternations in vowel height and [ATR] in (40) reflect the general harmony processes of the language.

(40) Chumburung hiatus resolution across word boundaries

a. Glottal stop alternates with glides

/akɔbɛV asa/	[akɔbɪjasa]	‘three relatives’
/dɔV ɪsɪ/	[dɔwɛsɪ]	‘to hoe soil’
/ibodobodoV ɪsa/	[ibodoboduwesa]	‘three loaves’

b. Vowels coalesce otherwise

/de ɔnarɪ/	[dɔnarɪ]	‘to have a man’
/iteŋkede ɪsa/	[iteŋkedesa]	‘three sieves’
/tɔ ɪsanɪ/	[tʷɛsanɪ]	‘to roast a sheep’ <sup>15</sup>

To summarize, Chumburung has words which underlyingly end in an empty V-slot, and this V-slot normally gets its quality by spreading from a preceding vowel. However, at a phrase boundary the final V-slot surfaces as a glottal stop instead.

This pattern is an effect of the constraint LAR-]<sub>Ph</sub> that requires vocalic segments at the right edge of a phrase to be glottalized. A similar pattern is reported for Guininaang word-initial laryngeals (Gieser, 1970). The data presented in this section provide independent motivation for the constraints LAR-EDGE and support the prediction of the splitting theory that alternations of epenthetic consonants are paralleled by surface alternations of vocalic segments.

#### 6.6.4 Summary of LAR-EDGE

In this section, I have provided extensive evidence in favor of the splitting theory and the LAR-EDGE constraints. Several important predictions of splitting and LAR-EDGE were confirmed:

<sup>14</sup> Historically, this segment corresponds to a vowel (Snider, 1986).

<sup>15</sup> The vowel [a] in this example appears as ‘aa’ in Snider (1986: 134). I assume this is a typo since a single ‘a’ appears in his other articles in this example, and no long vowels are reported.

- laryngeal approximants tend to be inserted at both right and left edges and at all prosodic levels.
- laryngeal insertion may or may not coexist with medial glide insertion
- laryngeal approximants segments may be allowed only at prosodic edges
- underlying vocalic segments are expected to turn into laryngeals at edges

Another property of the epenthetic laryngeals at edges is that their occurrence is often variable, and dependent on the strength of the prosodic boundary (Jongenburger & van Heuven, 1991; Kohler, 1994; Pierrehumbert, 1995; Dilley *et al.*, 1996; Redi & Shattuck-Hufnagel, 2001; Blevins, 2008; Mompeán & Gómez, 2011; Pompino-Marschall & Zygis, 2011; Garellek, 2013 a.o.). A complete account of the variation in the production of edge laryngeals would lead us too far afield, but the constraints in LAR-EDGE family are well suited for such an account if the ranking position of the constraints referring to different prosodic edges can be variable, unspecified or stochastic (Anttila, 1997; Boersma & Hayes, 2001).

## 6.7 Conclusion

This Chapter has proposed a family of constraints LAR-EDGE which prefer laryngeal segments at edges of prosodic constituents. The LAR-EDGE constraints are required to analyze languages like Washo, and are further supported in the typology of epenthesis and featural alternations.

The data from Washo also illustrate the fact that glide insertion is not always homorganic. This is expected on the splitting theory, since even in homorganic glide epenthesis is blocked, glides are still good candidates for epenthesis because they share major class features with vowels. The pattern of [j] insertion in all vowel sequences is analyzed as an effect of a general markedness relation between glides.

Finally, within the splitting theory it is expected that the inventory of epenthetic consonants will depart from the language's inventory when positional constraints are at play. This prediction is borne out in Washo and in the languages where glottal stops only occur at prosodic edges.

## 6.8 Appendix: additional Washo [j]-epenthesis data

(41) lists the available examples of the stems occurring in (3) where they occur without a final [j]. For ease of reference, the relevant vowel-final morpheme is given in bold in each gloss. These examples show that the relevant stems and suffixes are indeed vowel-final. The data in (42) illustrate the attachment of vowel-initial suffixes in (3) to consonant-final stems and show that these suffixes have no initial [j] underlyingly.

### (41) Vowel-final stems

UR, gloss	SR, translation, source
/wat <sup>3</sup> a/ <b>river</b>	['wat <sup>3</sup> a] 'river' (261)
/ge-emts <sup>3</sup> i-ha/ IMP- <b>awake</b> -CAUS	['gemts <sup>3</sup> i-ha] 'wake him up!' (262)
/da-fiʔ/ <b>there</b> -FROM	['daʃiʔ] 'from there' (WP)
/di-dok <sup>3</sup> o/ 1P- <b>heel</b>	[di'dok <sup>3</sup> o] 'my heel' (261)
/ge-alo:go-ha/ IMP- <b>tie</b> -CAUS	[ga'lo:goha] 'tie it!' (WP)

/l-emle/ 1P- <b>heart</b>	['lemle] 'my heart' (261)
/ge-k <sup>2</sup> eʃe-ha/ IMP- <b>be_alive</b> -CAUS	[ge'k <sup>2</sup> eʃaha] 'save his life!' (304)
/l-a:du/ 1P- <b>hand</b>	['la:du] 'my hand' (260)
/m-emlu/ 2P- <b>food</b>	['memlu] 'your food' (415)
/ge-a:hu/ IMP- <b>stand_pl</b>	['ga:hu] 'stand! (pl.)' (262)
/l-aŋal-ʃi/ 1P-house-DU.INCL	['laŋal-ʃi] 'our (du.incl) house' (262)
/ge-emts <sup>2</sup> i/ IMP- <b>awake</b>	['gemts <sup>2</sup> i] 'wake up!' (261)
/m-i:gi-he:ʃ-i/ 2SU- <b>see</b> -Q-IPF	[migi'he:ʃi] 'did you see?' (WP)
/ge-p <sup>2</sup> iʔli/	[ge'p <sup>2</sup> iʔli] 'fish with hook and line!' (262)
IMP- <b>fish_with_hook_and_line</b>	

## (42) Vowel-initial suffixes

UR, gloss	SR, translation, source
/l-aŋal-a/ 1P-house-LOC	['laŋala] 'on/at my house' (502)
/Ø-sesm-'aʃaʔ-i/ 3SU-vomit-NFT-IPF	[sesm'aʃaʔi] 'he's going to vomit' (304)
/le-'iʃm-e:s-i/ 1SU-sing-NEG-IPF	[leʃ'me:si] 'I'm not singing' (314)
/le-imeʔ-elem-ajʔ-i-g-i/	['lemeʔelemajʔgi]
1SU-drink-DST-IPST-IPF-3OB-PRO	'I drank long ago' (637)
/Ø-bakbag-uʃ-enun-i-g-i/	['bakbaguʃenunigi]
3SU-smoke-DUR-USI-IPF-3OB-PRO	'(they) generally smoke' (623)
/di-gamaʔ-ud-i/ 1SU-eat_up-SEQ-IPF	[di'gamaʔudi] 'I will eat up and then' (612)
/Ø-p <sup>2</sup> i-t <sup>2</sup> o-t <sup>2</sup> om-uweʔ-i/	[p <sup>2</sup> i't <sup>2</sup> ot <sup>2</sup> omuweʔi]
3SU-crawl-PL-down_in-HENCE-IPF	'they kept crawling down in' (304)

## Chapter 7. *Mongolian and dorsal epenthesis*

### 7.1 Introduction

Homorganic glide insertion next to a high vowel is the most faithful epenthetic pattern in the Splitting theory. While this pattern may be blocked in certain environments, all the examples of blocking that we have seen so far involved insertion of approximant consonants that share major class features with vowels. However, approximant insertion has no special status within the splitting theory. For languages that have no fully faithful vocalic glides, Splitting theory predicts that the choice of the inserted consonant will depend on the interaction of IDENT constraints that demand preservation of the vowel's features and the markedness constraints restricting the inventory. Thus, epenthesis of [+consonantal] segments is expected to emerge in languages where approximants are blocked.

Halh Mongolian (hereafter HM) corroborates this prediction of the splitting theory. The language is also referred to as Central Mongolian or Khalkha Mongolian (the latter name has figured prominently in phonological literature). HM does not have vocalic glides: while [j w] appear on the surface, they are [+consonantal] (i.e. [j<sub>c</sub> w<sub>c</sub>]). As expected of [+consonantal] segments, they do not alternate with vowels, and pattern with consonants in many phonological alternations. To account for the languages that lack vocalic glides the constraint system is expanded with a markedness constraint against high-sonority onsets.

Despite the absence of glides, the selection of epenthetic consonant in HM is still based on feature sharing with the vowel. In particular, the inserted consonants are required to share place and voicing with their input sources, since ID-[place] and ID-[voice] outrank other IDENT constraints. The inserted consonant changes its place between [g] (Dorsal) and [G] (Dorsal, Uvular) that are precisely the independently motivated place features of vowels in this language. Furthermore, [g] and [G] are the only non-nasal dorsals which are voiced in HM. In short, epenthetic [g]/[G] occur because they are faithful to the input vowels along the most important dimensions, in this case the ranking of IDENT constraints favors preservation of [place] and [voice] over other features.

The proposed analysis relies on the featural assumptions of the Revised Articulator Theory (RAT) (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004; Levi, 2004, 2008). All vowels and vocalic glides are specified for Dorsal place (or Active Articulator) – this is dubbed *vocalic dorsality* in Flynn (2004). As a slight modification on this, I assume that the pharyngeal vowels in Mongolian have a double specification as [Dorsal, Pharyngeal] (Svantesson *et al.*, 2005).<sup>1</sup> The inserted segments share place specification with the vowels. Furthermore, RAT assumes full specification, and thus vowels are specified as [+voice]. The epenthetic [g/G] in HM is selected because it shares Place and voicing with vowels.

---

<sup>1</sup> Alternatively, it could be assumed that a feature like [RTR] is involved in vowel harmony, while [RTR] consonants are required to be [Pharyngeal] by a high-ranked constraint which would have the role of the 'equivalency relations' of Calabrese (1993) employed for a similar purpose by Halle *et al* (2000).

Finally, the consonantal glides are specified as non-dorsal within this theory. As argued by Levi (2004, 2008), the consonantal [j<sub>c</sub>] is Coronal and [w<sub>c</sub>] is Labial. The consonantal glides in HM do not share place with vowels, and therefore cannot be inserted, unlike dorsals and uvulars.

Section 7.5 argues that dorsal insertion in HM provides a way to distinguish the Splitting Theory from certain Insertion theories. For example within the Insertion theories of de Lacy (2006) and Lombardi (2002), the ranking of context-free markedness constraints alone never picks dorsals as optimal inserted consonants. While similarity-enforcing constraints such as AGREE or DEP-feature may be able to replicate the splitting analysis of HM epenthesis, I argue that the required constraints make unfavorable typological predictions. Thus HM illustrates a fundamental property of the Splitting Theory – that faithfulness influences the quality of epenthetic segments, and so might require an epenthetic segment to be relatively marked if less marked segments are unfaithful.

## 7.2 Halh Mongolian: background and segment inventory

The analysis of the phonological system presented here mainly relies on Svantesson *et al.* (2005), with additional examples taken from other sources where necessary (Sanžeev, 1973; Beffa & Hamayon, 1975; Rialland & Djamouri, 1984; Krylov, 2004; Janhunen, 2012). Page references in examples refer to Svantesson *et al.* (2005), unless otherwise noted. There is general agreement about the epenthesis process in the literature, although the inventory facts are debated, main points of disagreement being the analysis of contrastive palatalization in consonants, and presence/absence of schwa in underlying representations (Sanžeev, 1973; Beffa & Hamayon, 1975; Rialland & Djamouri, 1984; Krylov, 2004 a.o.).

The segment inventory of Halh Mongolian (1) thus deserves several comments. Vowels do not contrast for length in non-initial syllables. Following Svantesson *et al.* (2005) I interpret the non-initial vowels as phonologically short (phonetically they are intermediate between short and long vowels of initial syllables). In addition [e] does not occur in initial syllables where it historically merged with /i/. The vowel [ə] occurs predictably only in epenthetic environments (i.e. only in consonant clusters which would otherwise be unsyllabifiable). The initial and medial vowel that phonologically functions as short /o/ is pronounced as centralized [ə]. This phonetic centralization effect is visible for other short vowels, but it is more pronounced for /o/. The surface [ə] is realized as short and centralized with a quality depending on vowel harmony: [ɪ] after palatalized and alveopalatal consonants, in other cases – usually a centralized version of the vowel in the preceding syllable, except that schwa cannot get its quality from a preceding /i/, in which case the preceding vowel spreads its quality. A reduced vowel harmonizing with [u] is a centralized version of [e], rather than [ʊ] (Svantesson *et al.*, 2005: 23).<sup>2</sup>

<sup>2</sup> The traditional approaches which are the basis of Cyrillic Mongolian orthography treat the non-initial full vowels as allophones of initial long vowels, while what is transcribed as schwa here is treated as allophones of initial short vowels (Poppe, 1951 a.o.). This approach does not capture the restricted distribution of schwa.

## (1) Halh Mongolian segments

## a. Vowels in initial syllables

i i:            u u: ui  
                   ʊ ʊ: ʊi  
 e:            o o:  
                   ɔ ɔ: ɔi  
 a a: ai

## b. Vowels in non-initial syllables

i/ɪ            u ui  
                   ʊ ʊi  
 e    ə    o  
                   ɔ ɔi  
 a ai

## c. Consonants (bracketed sounds only occur in loanwords)

(p <sup>h</sup> )	(p <sup>ih</sup> )	t <sup>h</sup>	t <sup>ih</sup>	
p	p <sup>i</sup>	t	t <sup>i</sup>	
				g <sup>i</sup> g   G
		ts <sup>h</sup>	tʃ <sup>h</sup>	
		ts	tʃ	
		s	ʃ	x <sup>i</sup> x/χ
m	m <sup>i</sup>	n	n <sup>i</sup>	ŋ/N
		ʎ (ʈ)	ʎ <sup>i</sup>	
		r	r <sup>i</sup>	
w	w <sup>i</sup>		j	

The aspirated consonants are realized with postaspiration word-initially and with preaspiration word-medially and word-finally. Although the previous sources use [voice] or [fortis/lenis] to describe the contrast (Sanžeev, 1973; Beffa & Hamayon, 1975; Rialland & Djamouri, 1984 a.o.), Svantesson & Karlsson (2012) argue extensively that the main acoustic correlate is aspiration in HM, and that the unaspirated consonants are not normally voiced (see also Svantesson *et al.*, 2005; Karlsson & Svantesson, 2011).

On the other hand, the dorsal stops behave as voiced phonologically – they are the only stops that may occur as a first member of a consonant cluster. [g] and [G] are also reported to have fricative variants, especially the uvular [ɣ].

The distribution of dorsal and uvular continuants is predictable based on the vowel harmony class of the word: [x ɲ] occur only in non-pharyngeal words while [χ ɴ] occur



in pharyngeal words. For dorsal/uvular stops, there is a contrast between [g] and [G], which occurs in stem-final position in pharyngeal-vowel words.

(2) Stem-final contrast between [g] and [G] (Sv: 29,39)<sup>3</sup>

UR	Nominative	Ablative	Accusative	Gloss
/pag/	pag	pagas	pagig	team
/paG/	paG	pagas	paGig	small

HM has a pervasive vowel harmony process whereby word-medial vowels agree with the initial vowel in rounding and ATR/the presence of the feature [pharyngeal]. The harmonizing suffix vowels are written as capital letters in the underlying representation. While the details of rounding harmony are irrelevant to epenthesis, pharyngealization harmony is relevant. According to this process, all vowels in the word may be either from the ‘pharyngeal’ class [a ai u ui ɔ ɔi] or from the ‘non-pharyngeal’ class [e u ui o]. The vowel /i/ is transparent to harmony and occurs in both kinds of words, but it is realized as [ɪ] in pharyngeal words, unless preceded by a palatalized consonant. The words with /i/ in the initial syllable all have non-pharyngeal vowels [e u ui o].

Palatalization is contrastive in consonants, but only in words with pharyngeal vowels. Some phonetic consonant-vowel assimilation processes related to palatalization alter the quality of the vowels, but do not change the harmony class of the word. Thus, the palatalized consonants have a diphthongizing effect on the preceding vowels. The vowels /a: u: ɔ:/ are realized phonetically similar to /ai ui ɔi/ before palatalized consonants, but the contrast is maintained with the underlying long vowels being slightly longer and reaching slightly more extreme formant values than the underlying diphthongs (Svantesson *et al.*, 2005, pp 10–11). Only palatalized consonants occur after *i*-diphthongs. While the consonants after diphthongs are conservatively assumed to be phonologically non-palatalized by Svantesson *et al.* (2005), their tentative evidence suggests that they actually are phonologically palatalized, since the following /i/ vowel appears as [i], not [ɪ]: /aiɬig/ [aiɬʲig] ‘family-ACC’.

Finally, the quality of the underlying /i/ and palatalization on a preceding consonant is relevant to the present discussion. In non-pharyngeal words, palatalization is not contrastive, and Svantesson *et al.* (2005) do not discuss explicitly if the consonants are implemented as palatalized or plain before [i] in these words. The narrow phonetic transcriptions in (3) (Sv: 2) suggest that the consonants are plain. In pharyngeal vowel words /i/ is normally realized as [ɪ], but it appears as [i] after palatalized and alveopalatal consonants. The /i/-initial suffixes /-ig/ ‘accusative’ and /-iŋ/ ‘genitive’ change the phonetic quality of their first vowel depending on the palatalization of the final consonant of the stem in the pharyngeal words (3).

<sup>3</sup> The forms in the second column in (2) are glossed as ‘reflexive’ on page 29 of Svantesson *et al.* (2005). I assume this is a typo, since the same forms are glossed as ‘ablative’ on page 39, and since it is made clear on multiple occasions that the reflexive morpheme is /E/, while the ablative is /Es/.

(3) /i/ and palatalization in Halh Mongolian (Sv: 2)<sup>4</sup>

/taɣ-ig/	[taɣig]	‘seventy-ACC’	(pharyngeal word)
/te:ɣ-ig/	[te:ɣig]	‘robe-ACC’	(non-pharyngeal word)

The transcription adopted in Svantesson *et al.* (2005) is phonemic rather than phonetic. The allophonic properties are not recorded, among them: the exact quality of the inserted schwa and of /i/, the redundant palatalization of consonants after diphthongs and in non-pharyngeal words, and the dorsal/uvular place in continuants. Rather than imposing a particular phonetic interpretation, I will cite the data in the original source’s transcription (slightly modified to adhere to the general use of IPA in this dissertation).

**7.2.1 HM glides are consonantal**

HM has surface glides, but they are consonantal. I follow Levi (2004, 2008) in assuming that consonantal glides do not share [place] with the vowels. The HM glides behave as consonants rather than as vowels in many respects. Just like other consonants, stem-final /j, w/ trigger schwa epenthesis when a sonorant-initial suffix is attached (4), and they do not trigger consonant epenthesis when a vowel-initial suffix is attached (see 7.3 for a discussion of consonant epenthesis). The underlying /j/ thus contrasts with the second member of a diphthong (4c), and therefore the glide must have a different feature specification from the vowel /i/. The glide-vowel contrast is also maintained phonetically (Svantesson *et al.*, 2005: 11).

## (4) Consonantal behavior of HM glides

## a. Stem-final [j] (Sv: 77-78)

/xaj-ɣts <sup>h</sup> /	[xajəɣts <sup>h</sup> ]	‘leave-COOP’	vs. /xaiɣts <sup>h</sup> /	[xaiɣts <sup>h</sup> ]	‘fusibility’
/aj-ar/	[ajar]	‘melody-INSTR’	vs. /ai-ar/	[aigar]	‘category-INSTR’

## b. Stem-final [w] (Sv: 55, 72)

/xarw-Uɣ/	[xarwʊɣ]	‘shoot-CAUS’	vs. /xu:-Er/	[xu:ger]	‘boy-INSTR’
/xarw-n/	[xarwən]	‘shoot-NPST’			

## c. Glide vs. diphthong contrast (Sv: 78)

/ujɣs/	[ujɣs]	‘time’	vs. /uis/	[uis]	‘birchbark’
/pajr/	[pajər]	‘happines’	vs. /pair/	[pair]	‘place’
/xaj-ɣts <sup>h</sup> /	[xajəɣts <sup>h</sup> ]	‘to leave-COOP’	vs. /xaiɣts <sup>h</sup> /	[xaiɣts <sup>h</sup> ]	‘fusibility’

Just like the other consonants, /w/ is contrastive for secondary palatalization, which supports its consonantal status. Finally, [w] is a regular word-medial realization of /p/

<sup>4</sup> Abbreviations used in this chapter: ABL(ative), ACC(usative), CAUS(ative), COM(itative), COOP(erative), GEN(itive), INSTR(umental), NPST (nonpast), PHB (prohibitive), PREC(ative), PRESCR(iptive), PST (past), RFL (reflexive).

(and it comes from \*p diachronically unless it is borrowed). However, [w] and [p] are not allophonic since they contrast word-initially.

I follow Levi (2004, 2008) in assuming that the consonantal glides differ from vowels in the value of Place (or Active Articulator). While vowels are Dorsal, the consonantal glides are Coronal and Labial. This treatment is consistent with /w/ being sometimes pronounced [β], as noted by Svantesson *et al.* (2005: 20), and Janhunen (2012).

Finally, one exception should be noted: the optative suffix shows up as [i] after consonant-final stems, but as [j] after vowel-final stems. This alternation can be analyzed as a case of phonologically conditioned allomorph selection, so that the underlying form of optative contains both allomorphs. No other morphemes show comparable behavior.

### 7.3 Dorsal epenthesis

While word-initial vowels in HM are allowed, all medial VV sequences arising at morpheme boundary are resolved by dorsal epenthesis. The epenthetic consonant is [g] in non-pharyngeal words and [ɣ] in pharyngeal words, except it is always [g] before /i/ (which I analyze as non-pharyngeal).

Hiatus at morpheme boundaries is illustrated in (5a) for all vowel sequences for which examples are available. The suffix-initial vowels are limited to /U,E,i/ by vowel harmony. The sources are listed after each example, and all examples are given in the phonological analysis of Svantesson *et al.* (2005) for consistency. Page numbers refer to Svantesson *et al.* (2005) unless preceded by one of the following: BH for Beffa & Hamayon (1975); RD for Riialland & Djamouri (1984); J for Janhunen (2012).

Dorsal epenthesis is not morphologically restricted, and the examples of epenthesis at different kinds of boundaries (after nominal stem, after verbal stem, after a suffix) are given wherever available. (5b) lists the stems in (5a) in a context where they occur without a final /g/. The examples in (5c) show that the suffixes in (5a) are indeed vowel-initial: when attached to a C-final stem, these suffixes show no initial [g]. If these suffixes had an initial /g/, schwa epenthesis would be expected.

#### (5) Dorsal epenthesis in Halh Mongolian

##### a. Epenthesis

/aE/	/sana-Er/	[sanagar] ‘thought-INST’ (55)
	/xa:-Etʰ/	[xa:gatʰ] ‘close-PREC’ (J:153)
/a-i/	/sana-iŋ/	[sanagiŋ] ‘thought-GEN’ (55)
/eE/	/unE-E/	[unege] ‘cow-RFL’ (55)
	/xuʒE-Etʰ/	[xuʒegetʰ] ‘wait-PREC’ (BH: 85)
/ei/	/tepE-in/	[tepegin] ‘swampland-GEN’ (RD: 368)
/i:E/	/xi:-Er/	[xi:ger] ‘air-INST’ (77)
	/xi:-Et/	[xi:get] ‘do-PFG’ (193)
/oE/	/oto-Es/	[otogos] ‘now-ABL’ (RD: 353)
/u:i/	/xu:-iŋ/	[xu:giŋ] ‘boy-GEN’ (55)
/u:E/	/xu:-Er/	[xu:ger] ‘boy-INST’ (55)

/u:E/	/sʊ:-ErEi/	[sʊ:garai] ‘sit-PRESCR’ (BH: 84)
/ai-E/	/ai-Er/	[aigar] ‘category-INST’ (77)
/Ei-E/	/nɔxEi-E/	[nɔxɔigɔ] ‘dog-RFL’ (56)
	/ɔr-t <sup>h</sup> Ei-E/	[ɔrt <sup>h</sup> ɔigɔ] ‘place-COM-RFL’ (56)
/ɔi-E/	/ɔi-Er/	[ɔigɔr] ‘forest-INST’ (77)
	/pɔmpɔi-Utsai/	[pɔmpɔigutsai] ‘swell-PHB’ (BH: 87 ‘se gonfler’)
/ui-E/	/xui-Er/	[xuiger] ‘group-INST’ (77)

b. Vowel-final stems uninflected (same source as inflected form, unless noted)

/sana/	[sana] ‘thought’
/xi:/	[xi:] ‘air’
/xu:/	[xu:] ‘boy’
/ai/	[ai] ‘category’ (64)
/nɔxEi/	[nɔxɔi] ‘dog’ (49)
/ɔi/	[ɔi] ‘forest’
/xui/	[xui] ‘group’
/sʊ:/	[sʊ:] ‘sit down!’ (J: 152)

c. Vowel-initial suffixes after consonant-final stems

/ar-iŋ/	[ariŋ] ‘back-GEN’
/ar-Er/	[arar] ‘back-INST’
/pag-Es/	[pagas] ‘team-ABL’
/at-E/	[ata] ‘demon-RFL’
/og-Etʃ <sup>h</sup> /	[ogotʃ <sup>h</sup> ] ‘give-PREC’ (J: 153)
/jar <sup>i</sup> -ErEi/	[jar <sup>i</sup> arai] ‘talk-PRESCR’ (J: 153)
/ux-Utsai/	[uxutsai] ‘die-PHB’ (J: 155)

The vowel-final stems illustrated in (5) contrast with /g/-final stems in (6). These examples show that dorsal epenthesis cannot be reanalyzed as deletion: dorsals are not deleted word-finally. Coda clusters may also begin with /g/ as in [t<sup>h</sup>ag<sup>t</sup><sup>h</sup>] ‘balcony’; [pɔgt] ‘holy’ (Sv: 81).

(6) Stems ending in a dorsal consonant in HM (Sv: 29, 39, see also note 3)

UR	Nominative	Ablative	Accusative	Gloss
/pag/	pag	pagas	pagig	team
/paG/	paG	pagas	paGig	small

## 7.4 Analysis

The splitting theory provides an account of dorsal insertion in Mongolian, on the assumption that the epenthetic consonant shares place and voice with the input vowel. I assume that all vowels bear the place feature [Dorsal] (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004; Levi, 2004, 2008). Furthermore, the pharyngeal vowels in Mongolian have a double specification as [Dorsal, Pharyngeal] (Svantesson *et al.*, 2005). In a theory of full specification like RAT assumed here, the vowels are specified [+voice]. Although this specification is non-contrastive it is targeted by the IDENT-constraints just like other feature specifications.

The inserted [g/G] in HM share both Place and voice with neighboring vowels – hence they are faithful to the vowels along these dimensions. No other consonants are available in HM which would be similar to vowels on the same dimensions. HM does not have vocalic glides, and I assume that this is due to the constraint which prohibits vowels in margins, \*MAR/V in (7) (adapted from Prince & Smolensky, 2004).

(7) \*MAR/V: assign a violation for every [–consonantal] segment which occurs in a syllable margin

Insertion of a dorsal obstruent in HM violates the IDENT constraints on features [consonantal] and [sonorant]. Furthermore, just like in Washo, the result of insertion is the same regardless of vocalic context – hence all the IDENT constraints on tongue position features such as [high], [low], [back], and [round] have to be dominated. Since the ranking conditions are the same for all IDENT constraints on tongue position features, all these constraints will be abbreviated as IDENT-TP below.

The selection of epenthetic dorsal stops is illustrated in (8) for /xu:-Er/ [xu:ger] ‘boy-INST’. Vowel harmony is not analyzed here: the suffix vowel could have any value for pharyngeality/RTR, and its quality, as well as the choice between epenthetic [g] and [G] consonant is determined by harmony. Only the candidates splitting the second vowel are considered (the direction of splitting is discussed below). The consonantal glide is marked [j<sup>c</sup>] whereas [j] is a vocalic glide.

HM glides are consonantal, and hence they do not share place with vowels, as argued extensively by Levi (2004, 2008) for all consonantal glides. Thus the consonantal glide [j<sup>c</sup>] cannot be inserted since it is [coronal] while the vowels are [dorsal] (8d). On the other hand, the vocalic glide is generally absent from HM inventory. Thus [j] does not appear in epenthesis due to a high-ranked markedness constraint \*MAR/V (8c).

## (8) Selection of the inserted consonant in HM

/xu: <sub>1</sub> E <sub>2</sub> r/	ONS	*MAR/V	ID- [place]	ID- [nas]	ID- [cons]	ID- [son]	ID- TP	INT
☞ a. xu: <sub>1</sub> g <sub>2</sub> e <sub>2</sub> r					1	1	1	1
b. xu: <sub>1</sub> e <sub>2</sub> r	W1				L	L	L	L
c. xu: <sub>1</sub> j <sub>2</sub> e <sub>2</sub> r		W1			L	L	1	1
d. xu: <sub>1</sub> j <sub>2</sub> <sup>c</sup> e <sub>2</sub> r			W1		1	L	1	1
e. xu: <sub>1</sub> ŋ <sub>2</sub> e <sub>2</sub> r				W1	1	L	1	1
f. xu: <sub>1</sub> ʔ <sub>2</sub> e <sub>2</sub> r			W1		L	L	L	1

All conceivable epenthetic consonants other than [g, ɢ] (or perhaps [ɣ ʁ]) are either absent in HM inventory (like the vocalic glide) or violate a high-ranked IDENT constraint. Thus inserting a dorsal nasal [ŋ/N] would violate IDENT-[nasal], while a dorsal continuant [x/χ] falls short on IDENT-[voice] since it is voiceless.

To be sure, the winner in (8) also seems to differ from the input in the feature [continuant]. However recall that dorsal ‘stops’ are actually often pronounced as continuants between vowels, and therefore it is conceivable that HM epenthetic consonants are actually specified as continuants. This issue has to be further investigated phonetically.

The splitting theory also leads us to expect that patterns like HM should be relatively rare. First, the low ranking of IDENT-[cons] and IDENT-[son] only occurs sporadically (Kaisse, 1992; Cho & Inkelas, 1994; Nevins & Chitoran, 2008). Second, it is not very common for languages to lack vocalic glides. Although these facts are suggestive, there is of course no formal connection between the grammatical ranking and its frequency of occurrence in natural languages.

When the suffix vowel is /i/, the epenthetic consonant is always [g] and never [ɢ], even in pharyngeal words. Thus /sana-in/ ‘thought-GEN’ surfaces as [sanagin] (5) while an underlying uvular stop surfaces unchanged before /i/: /paɢ-ig/ [paɢig] ‘small-ACC’ (6). I take this as evidence that in Mongolian VV sequences it is always the second vowel that splits. All of the relevant sequences occur at the root-suffix boundary, and thus the resistance of V<sub>1</sub> to splitting can be captured by the positional faithfulness constraint in (9).


## (9) ROOT-INTEGRITY: assign a violation mark for every segment in a root which has multiple correspondents in the output

This constraint must dominate any constraints which prefer splitting of the root vowel, such as TAUTOSYLLABIC-INTEGRITY of Chapter 4 which penalizes splitting if it yields two segments in the same syllable. It is further assumed here that [i] is specified as [Dorsal], not [Dorsal, Pharyngeal]. Since IDENT-[place] is high-ranked, an underlying /i/

can only yield a [Dorsal] consonant in a margin as in /sana-iŋ/ ‘thought-GEN’ [sanagiŋ]. However, an underlying pharyngeal consonant /G/ does not correspond to a vowel, and hence does not change as in /paG-ig/ [paGiG] ‘small-ACC’.

The insertion [g] before /i/ is analyzed in (10) with /sana-iŋ/ [sanagiŋ] ‘thought-GEN’. Only the candidates with [g G] insertion are considered here since the other epenthetic options are ruled out just as in (8). Splitting the first vowel /a/ is impossible due to ROOT-INTEGRITY (10d). On the other hand, splitting /i/ to yield a pharyngeal violates IDENT-[place] (10c). While the candidate (10c) is harmonically bounded given the constraints discussed here, this candidate would be preferred by the harmony constraints which enforce the dorsal/pharyngeal alternation in consonants.

(10) [g] insertion before /i/ in HM

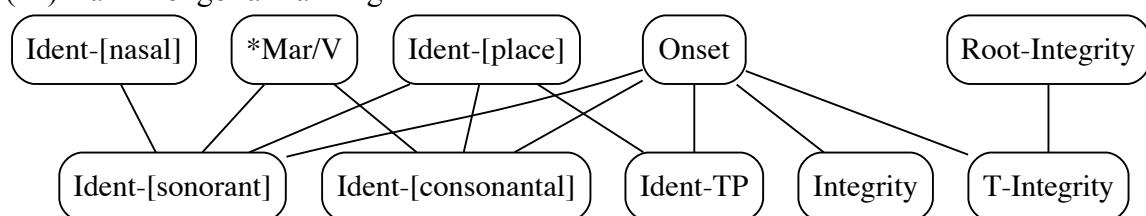
	/sana <sub>1</sub> i <sub>2</sub> ŋ/	ONS	ROOT-INT	ID-[place]	T-INT	INT
 a.	sana <sub>1</sub> g <sub>2</sub> i <sub>2</sub> ŋ				1	1
b.	sana <sub>1</sub> i <sub>2</sub> ŋ	W1			L	L
c.	sana <sub>1</sub> G <sub>2</sub> i <sub>2</sub> ŋ			W1	1	1
d.	sana <sub>1</sub> G <sub>1</sub> i <sub>2</sub> ŋ		W1		L	1

One final issue to address relates to diphthongization. HM allows surface diphthongs, both in roots and in suffixes, but hiatus at morpheme boundaries is never resolved via diphthongization.<sup>5</sup> This may be taken as evidence that diphthongs need to be distinguished from vowel sequences underlyingly (contra Selkirk, 1990; Rosenthal, 1997b). Alternatively, this pattern may be analyzed along the lines of other so-called *derived environment effects* (Łubowicz, 2002; McCarthy, 2003; Wolf, 2008; Burzio, 2011). However the analysis of derived environment effects is a general problem for OT and addressing this problem would lead us too far afield.

The ranking responsible for HM dorsal/uvular epenthesis is given in (11). The complete ranking must also include the constraint IDENT-[continuant], but its place in the hierarchy cannot be fully determined until we have further phonetic data to adjudicate whether the epenthetic consonants are specified as continuants [ɣ/ʁ] or stops [g/G]. The Splitting theory leads us to expect that a continuant specification is more likely.

<sup>5</sup> Long vowels only occur in the first syllable and there are no monosyllabic CV words due to a prosodic minimality requirement. Thus morpheme concatenation never brings together two short vowels in the first syllable, and this is the only environment where hiatus could potentially be resolved by long vowel formation.

## (11) Halh Mongolian ranking



## 7.5 Other theories

In the Splitting theory, epenthetic quality is influenced by faithfulness. In contrast, in Insertion theories epenthetic quality may be determined by markedness alone. Within the theory of markedness advocated by de Lacy (2006) and Lombardi (2002) no general markedness constraints prefer [g] over [t]: the dorsal consonant is more marked on place and voicing, and all other features are the same.<sup>6</sup> Consequently, this markedness theory predicts that epenthetic dorsals must arise through assimilation (de Lacy, 2006), output-output correspondence (Kitto & de Lacy, 1999) or autosegmental spreading (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011).

These formal mechanisms provide a possible account of Mongolian dorsal/uvular epenthesis. The epenthetic similarity account within the Insertion theories also has implications for consonant-vowel assimilation processes. No such implications arise within the Splitting theory because assimilation constraints are not crucial for epenthesis – feature sharing in epenthetic segments is viewed as a consequence of input-output faithfulness.

Within the Insertion theories, the marked feature values of Mongolian epenthetic [g/G] have to come from assimilation. Thus, it could be assumed that vowels and nearby consonants are required to agree in Place (assuming vowels are Dorsal) and voicing (assuming they are voiced). This analysis would lead us to expect consonant-to-vowel assimilation in these features. For example, we would expect a language where consonants are required to be voiced after vowels. Whether such languages are attested is a matter of debate, see e.g. Blevins (2004) and Kiparsky (2006) on Somali.

To summarize, dorsal epenthesis is attested in Mongolian. The Insertion theories (except for Rice (1994, 1996, 2000)) have to account for Mongolian epenthesis with assimilation constraints or other similarity mechanisms. Unlike Splitting, such an account predicts that consonant-to-vowel assimilation processes will target Place and voicing.

Finally, another case of dorsal epenthesis is reported for Buriat (Poppe, 1960), which is closely related to HM. The data from this language are somewhat less robust in that there are several strategies of hiatus resolution, and their distribution is unknown for many of the suffixes (de Lacy, 2006; de Lacy & Kingston, 2013; Morley, 2013; Uffmann, 2014). However contrary to some of the claims in the literature (de Lacy, 2006; de Lacy & Kingston, 2013), it is not the case that alternations between [g/G] and zero are restricted to nominal morphophonology in Buriat. Buriat is in many ways similar to Mongolian, but crucial data are lacking in a number of morphological contexts (Morley,

<sup>6</sup> In an alternative theory of Rice (1994, 1996, 2000), certain dorsals are representationally simpler and thus general markedness can produce epenthetic dorsals.



2013). I therefore leave the full investigation of this case for future research. Other potential cases of dorsal insertion will be discussed in Chapter 9.

## 7.6 Conclusion

The splitting theory does not specify a universally predetermined inventory of epenthetic consonants. Rather, the epenthetic inventory is determined by the general requirement of featural closeness to the input vowel, in competition with a particular ranking of inventory constraints in each language. In languages that lack the vocalic glides, featurally identical epenthesis is impossible, and the theory predicts that epenthetic consonants will be selected based on the features they share with the vowels. Dorsal/uvular epenthesis in Mongolian is a clear confirmation of this prediction. In particular, the HM inserted [g/G] are optimal because they share place and voicing with their input vowel source.

The account of HM relies on the analysis of vocalic place within the Revised Articulator Theory (Halle *et al.*, 2000). All vowels and vocalic glides are assumed to be dorsal, while consonantal glides differ in place from their vocalic counterparts (Flynn, 2004; Levi, 2004, 2008).

HM also shows effects of a positional version of the INTEGRITY constraint – ROOT-INTEGRITY. Just like with any faithfulness constraints, we expect to find the positional variants of INTEGRITY relativized to the prominent positions such as word-initial position (see Chapter 3) and the root (Beckman, 1998; Casali, 1998).

To summarize, within the splitting theory Mongolian dorsal/uvular epenthesis follows from the fact that dorsals are the only voiced segments that share place with the vowels. Other theories of epenthetic similarity have to resort to unattested patterns of consonant-to-vowel assimilation in order to account for this pattern.

## Chapter 8. [t]-zero alternations in Apurucayali

### 8.1 Introduction

The Splitting theory makes precise predictions about epenthesis in cases where some segment  $S_1$  is featurally closer (F-closer) to the vowel  $V$  than  $S_2$ . If in some language both  $S_1$  and  $S_2$  are allowed in a particular position (i.e. they fare equally good on the markedness hierarchy of the language) then  $S_2$  cannot appear as the output of  $V$  splitting because splitting  $/V/$  to yield  $S_1$  incurs fewer IDENT violations than splitting  $/V/$  to yield  $S_2$ .

To illustrate, consider how featural closeness applies to the voiceless coronal stop  $[t]$ . This segment differs from all vowels in the features [voice], [continuant], [place], [consonantal], and [sonorant]. On the other hand, there are possible sounds which are closer to vowels: e.g.  $[\theta]$ , unlike  $[t]$ , shares the value [+continuant] with all the vowels.  $[\delta]$  is even closer – it shares the values [+continuant, +voice]. On the assumption that all vowels are dorsal, the dorsal voiced continuant  $[\gamma]$  is closer to any vowel than  $[\delta]$ . Other segments, such as laryngeal approximants are featurally closer to vowels on other dimensions such as tongue position features and the feature [sonorant]. Finally, the high glides are completely identical to the respective high vowels.

Consequently, the Splitting theory imposes very severe restrictions on  $[t]$ -insertion. In order for  $[t]$  to be inserted, the language must block (i.e. lack completely, or prohibit in a given position) all the segments which are closer to vowels, i.e. vocalic glides, laryngeal approximants, voiced continuants, voiceless continuants, and many others. In effect,  $[t]$  insertion is predicted to be practically impossible.

This prediction is striking because cases of  $[t]$  epenthesis have been reported in previous work. The most well known case is found in Ajiininka Apurucayali (Payne, 1981; Payne *et al.*, 1982). This language has often been referred to as ‘Axininca Campa’ in the phonological literature; however ‘Campa’ is reported as pejorative (Lewis *et al.*, 2013). The language name will be abbreviated as Apurucayali or AA. AA has attracted considerable attention in the phonological literature (Yip, 1983; Levin, 1985; Itô, 1986, 1989; Spring, 1990a; b; c, 1992; Black, 1991; McCarthy & Prince, 1993b), and in many cases has served as a prime example of insertion (Rosenthal, 1997b; Casali, 1998, 2011; de Lacy & Kingston, 2013; Morley, 2013).

I show that  $[t]$ -zero alternations in AA can be analyzed as deletion. The insertion analysis predicts the existence of  $/t/$ -final verb stems, which are not attested. In contrast, the deletion analysis incorporates a morphological restriction whereby all verb stems end in a consonant. A detailed consideration of the patterning of AA suffixes yields additional arguments in favor of a deletion analysis.

The Splitting theory predicts that AA cannot have  $[t]$  epenthesis, because the language also allows a segment which is closer to vowels, namely  $[k]$ . Unlike the coronal  $[t]$ ,  $[k]$  shares the place specification [dorsal] with the vowels. Furthermore, AA has  $[j]$  and if this glide is indeed vocalic, it is closer to  $[i]$  than any consonant including  $[t]$ . Thus only deletion analysis of AA  $[t]$ -zero alternations is consistent with the Splitting theory. For Insertion theories (at least those that recognize a difference between deletion and insertion), both insertion and deletion analysis is possible, and the choice mainly depends

on theoretical considerations. AA then does not falsify the predictions of the Splitting theory. In fact, since the analysis is ambiguous, Apurucayali data can hardly be used to differentiate between theories (see also Morley, 2013).

## 8.2 Apurucayali basics

The principal source on AA is Payne (1981). Page references in examples refer to this source, unless otherwise noted. Page references in the text are abbreviated as ‘P’ for Payne (1981) and ‘Pea’ for Payne *et al.* (1982). The examples that occur in the texts listed by Payne (1981) are noted by the abbreviated name of the text and the number of sentence (since the gloss and the transcription appear on different pages). The following abbreviated text names are used: ‘B’ – Beetle, ‘C’ – conversation, ‘RB’ – red bird.

The segment inventory of AA is given in (1). These segments are used in the phonemic transcription, which abstracts away from the allophonic processes. The relevant allophonic alternations are described below (see Payne *et al.* (1982) for a complete survey). The bilabial approximant /v/ is realized as [w] after /o/, which in this environment changes to [u], so /ov/ is [uw]. /v/ also appears as a fricative [β] in the environments #\_i and i\_i, where [i] must be tense. In addition to the consonants in (1a), Payne (1981) uses the symbol ‘N’ for an underlying unspecified nasal which always appears before consonants and undergoes place assimilation. Surface [ŋ] may result from /N/, but it is never contrastive. The analysis of NC clusters is further discussed in section 8.3. /s/ is realized as [ʃ] before /i/ (and /i/ may be subsequently deleted in this context if unstressed).

### (1) Ajoyinka Apurucayali inventories

#### a. Consonants

p	t, t <sup>h</sup>	k
	ts, ts <sup>h</sup>	tʃ, tʃ <sup>h</sup>
	s	ç      h
m	n	ɲ
	r	r <sup>j</sup>
v	j	ɰ

#### b. Vowels

i i:	
	o o: oi
a a:	ai

Vowels are devoiced utterance-finally. /o/ is raised to [u] before [w] (from /v/) and alveopalatals. Stress is predictable and involves a complicated pattern based on vowel length, the presence/absence and the quality of the coda, and the quality of the onset. The stress rules are described in Payne *et al.* (1982, chapter 10). Stressed /i/ is realized as [i]

after dental fricatives and affricates /s ts ts<sup>h</sup>/, except if followed by /y/. Unstressed /i/ is deleted in this environment, although its presence is recoverable phonetically at least for /s/ which is realized as [ʃ] in this environment.<sup>1</sup>

Word-medial syllables are of the form CV(:). Onsetless syllables are allowed word-initially. The only possible coda is an assimilated nasal (only before obstruents), which may also be treated as prenasalization on a following segment. Word-final consonants are not allowed.

### 8.3 Hiatus and /t/ deletion in Ajoyíninka Apurucayali

This section presents a new analysis of AA, arguing that [t]-zero alternations at root-suffix boundaries in verbal morphology can be analyzed as deletion 8.3.1. Section 8.3.2 shows that the available sources present no evidence of /t/-zero alternations at suffix boundaries. Section 8.3.3 describes hiatus resolution in AA and argues that diphthongization and vowel deletion are two general strategies attested within roots, at prefix-root boundaries, at root-suffix boundaries in nouns, and at suffix junctures in verbs. In what follows, I will refer to this proposal as the ‘deletion analysis’.

#### 8.3.1 /t/ deletion

On the deletion analysis, verbal stems differ from surface words and from nominal stems in that they always end in a consonant. This is required by the constraint FINAL-C (McCarthy, 1993) which is indexed to verbal stems (Pater, 2000, 2006), and which is high-ranked at the stem level (see section 8.6). All consonants are attested stem-finally in verbs except for aspirates and /ts/. The lack of stems ending in /ts/ is regarded here as an accidental gap. The final consonant of the verb stem always appears before vowel-initial suffixes (2a).<sup>2</sup> Before a consonant, a stem-final dental /t/ is deleted (2b), while other consonants survive and the cluster is resolved via [a]-insertion (2c). Some of the surface forms in (2) show the effects of vowel lengthening processes which apply after /ç/ and before the subjunctive suffix /ta/.

<sup>1</sup> Note that /ts ts<sup>h</sup>/ are not reported to become alveopalatal before /i/.

<sup>2</sup> Abbreviations used: 123 (person); 3pm/f (3<sup>rd</sup> person masculine and feminine); 1pi (1<sup>st</sup> person inclusive); ARR(ival); CAUS(ative); CNT(continuative); DIM(inutive); EXCL(amative) FUT(ure); NFUT(nonfuture); NOMZ(nominalization); PL(ural); PRF(perfect); PRG(progressive); RES(olved); RFL(reflexive); VER(ity); SBJ(subjunctive)

## (2) Vowel insertion and consonant deletion after verbal stems

## a. V-initial suffixes (P: 238, unless marked)

/i-N-komat-i/	[iŋkomati] ‘he will paddle’ (P: 108)
‘3PM-FUT-paddle-FUT’	
/i-N-tʰik-i/ ‘3PM-FUT-cut-FUT’	[iŋtʰiki] ‘he will cut’ (P108)
/oNpoh-ak-i-na-vi/	[ompohakinavi]
‘bump_head-PRF-NFUT-1P-EXCL’	‘yes, I bumped my head (excl.)’ (P: 29)
/no-pij-ak-i-ro/	[nopijakiro]
‘1P-lose-PRF-NFUT-3PF’	‘I have lost (to her, it)’
/no-miç-ak-i-ro/	[nomiça:kiro]
‘1P-peel-PRF-NFUT-3PF’	‘I have peeled (to her, it)’
/no-kis-ak-i-ro/	[nokisakiro]
‘1P-be_angry-PRF-NFUT-3PF’	‘I have been angry (to her, it)’
/no-kin-ak-i/	[nokinaki]
‘1P-go_about-PRF-NFUT’	‘I have gone about’
/no-ir-ak-i/ ‘1P-drink-PRF-NFUT’	[niraki] ‘I have drank’

## b. [t]-final stems with C-initial suffixes (P: 55)

/i-N-komat-pirot-i/	[iŋkomapiroti]
‘3PM-FUT-paddle-VER-FUT’	‘he will paddle well’

## c. Other stems with C-initial suffixes (P: 242 unless noted)

/i-N-tʰik-pirot-i/	[iŋtʰikapiroti]
‘3PM-FUT-cut-VER-FUT’	‘he will cut it well’ (P: 108)
/h-oNpoh-vait-ak-a/	[hompohavaitaka]
‘3PM-bump_head-CNT-PERF-NFUT.RFL’	‘he bumped his head’ (B 174)
/o-N-pij-vait-i-ta/	[ompijavaiti:ta]
‘3PF-FUT-lose-CNT-FUT-SBJ’	‘she might lose continually’
/o-N-miç-vait-i-ro-ta/	[omiça:vaitiro:ta] ‘she might
‘3PF-FUT-peel-CNT-FUT-3PF-SBJ’	peel continually (to her, it)’
/o-N-kis-vait-i-ro-ta/	[oŋkisavaitiro:ta] ‘she might
‘3PF-FUT-be_angry-CNT-FUT-3PF-SBJ’	be angry continually (to her, it)’
/o-N-kin-vait-i-ta/	[oŋkinavaiti:ta]
‘3PF-FUT-go_about-CNT-FUT-SBJ’	‘she might go about continually’
/o-ir-vait-i-ta/	[iravaiti:ta]
‘3PF-drink-CNT-FUT-SBJ’	‘she might drink continually’

The deletion analysis of AA alternations requires the introduction of several new constraints. Thus consonant clusters in AA are restricted by the constraint CODA<sub>COND</sub>, which prohibits all codas unless they are homorganic to a following onset (Itô, 1986, 1989).

- (3) CODA<sub>COND</sub>: assign a violation for a coda consonant that does not share place with an onset consonant

The different behavior of /t/ and other consonants in clusters can be attributed to *preservation of the marked* – de Lacy (2006) argues extensively that marked consonants tend to be preserved in neutralization and assimilation processes, and therefore it is no surprise that they resist deletion.<sup>3</sup> /t/ is the least marked consonant in Apurucayali inventory. It is an unaspirated stop, hence unmarked on the [spread glottis] and [continuant] dimensions. It also has a relatively unmarked place – Coronal, while the only Glottal segment of AA is [+continuant] [h]. Finally /t/ has the unmarked value [–sonorant] compared to nasals and glides.

The preservation of the marked hypothesis can be adapted to AA data by assuming that each markedness hierarchy projects a stringent hierarchy of MAX-C constraints. For example, the place hierarchy projects: MAX-C{Dorsal}; MAX-C{Dorsal,Labial}, MAX-C{Dorsal,Labial,Coronal}, MAX-C{Dorsal,Labial,Coronal,Glottal}. Each of these constraints assigns a violation mark if a consonant specified for a particular place has no correspondents in the output, as defined in (4).


- (4) Max-C{*F-Place*}: assign a violation mark for every segment S such that S is specified for a place feature belonging to {*F-Place*} and S has no correspondent in the output

Similarly, the continuancy hierarchy projects MAX-C{+continuant} and MAX-C{+continuant,–continuant}, the latter constraint being equivalent to the general Max-C. Note that these constraints do not necessarily imply that features stand in correspondence (McCarthy, 1995; Pulleyblank, 1998; Lombardi, 1999, 2001; Howe & Pulleyblank, 2004), since they are only violated by deletion of a segment.


The tableaux in (5) illustrate the fact that non-coronal consonants and continuants are not deleted. The stems in /h/ such as /oNtoh/ in [hompohavaitaka] ‘he bumped his head’ (2c) are illustrated in (5a) whereas (5b) shows the analysis of /k/-final stems, such as in [ɪntʰikapiroti] ‘he will cut it well’ (2c). In these tableaux, the insertion of a vowel competes with deletion of a consonant. It is assumed that vowel insertion (unlike consonant insertion) is a possible operation violating the constraint DEP-V.

- (5) Preservation of the marked in Ajyíninka Apurucayali  
a. Glottal-final stems

<sup>3</sup> It should be noted that according to de Lacy (2006, pp. 397-8) there are no clear cases where the least marked segment deletes while the more marked ones are preserved.


/...hC.../	CODACOND	MAX-C { + continuant }	DEP-V	MAX-C { + cont, -cont }
 haC			1	
C		W1	L	W1
hC	W1		L	

## b. Consonant-final stems

/...kC.../	CODACOND	MAX-C { Dor, Lab }	DEP-V	MAX-C { Dor, Lab, Cor }
 kaC			1	
C		W1	L	W1
kC	W1		L	

Although the constraint DEP-V is dominated by MAX constraints responsible for the preservation of marked consonants, DEP dominates all MAX constraints pertaining to the unmarked coronal stop, i.e. MAX-C{Dor, Lab, Cor} and MAX-C{+continuant, -continuant}, the latter being equivalent to MAX-C. The effect of this ranking is deletion of /t/ in consonant clusters and word-finally, observed in AA (6)

## (6) /t/ deletion in Ajiyinka Apurucayali

/...tC.../	CODACOND	DEP-V	MAX-C { Dor, Lab, Cor }	MAX-C
 C			1	1
taC		W1	L	L
tC	W1		L	L

A number of verb stems end in an underlying NC cluster. These stems always retain their final consonant, even if it is [t] (7).<sup>4</sup> Such NC clusters can be analyzed as single prenasalized segments, as indicated in the transcription below. The assumption that NC clusters are prenasalized segments is supported by the fact that NC is the only possible word-medial cluster of the language, and it cannot occur word-finally.

## (7) Verb stems ending in prenasalized coronals (P: 113)

/i-N-ka<sup>n</sup>t-i-ro/ ‘3PM-FUT-say-FUT-3PF’      [i<sup>n</sup>kaka<sup>n</sup>tiro] ‘he will say to her’  
 /ka<sup>n</sup>t-pirot-a:<sup>n</sup>ts<sup>h</sup>i/ ‘say-VER-INF’      [ka<sup>n</sup>tapirota:<sup>n</sup>ts<sup>h</sup>i] ‘to say well’

<sup>4</sup> Although there are stems ending in /<sup>n</sup>k/ such as /t<sup>h</sup>o<sup>n</sup>k-/ ‘finish’, I could not locate any examples of such stems before consonant-initial suffixes. The consonant is trivially retained before vowels.

However, by postulating /t/-deletion we are not forced to assume that AA has prenasalized voiceless stops. The resistance of NC sequences to losing their second member may be due to the fact that /N/ can only surface before consonants. In what follows, I will transcribe NC sequences as clusters for consistency with primary sources, while noting that these sequences behave as single segments.

### 8.3.2 /t/-zero alternations at suffix boundaries?

Payne (1981) implies that the alternations between /t/ and zero should happen after verbal suffixes. However, there is very little data to support this, and in fact the tense/reflexivity suffixes present a counterexample.

A suffix which would exhibit /t/-zero alternations must occur both between vowel-initial and consonant-initial morphemes. To find alternating suffixes, every morpheme that could potentially undergo /t/-zero alternations was searched for throughout Payne (1981), including the texts and paradigms.<sup>5</sup> All such morphemes, barring some exceptions to be discussed below, are not recorded in sufficiently diverse environments to show the /t/-zero alternation. For example, the adverbial /-ra/ appears either in word-final position or before a suffix starting with a consonant – hence there are no examples where it could show up as [rat]. On the other hand, the continuative suffix which is /-vait/ on the deletion analysis and /-vai/ in Payne's original analysis only occurs before vowels where it has the surface form [-vait]. The distribution of each relevant suffix is described in the Appendix (section 8.8).

All such morphemes can be divided in two classes: the [t]-final morphemes that always occur before vowel-initial suffixes, and the vowel-final morphemes that always occur word-finally or before consonant-initial suffixes. For any morphemes in these two classes there is no evidence of an alternation in the available dataset. Thus based on the data in Payne (1981), AA suffixes show no [t]-zero alternations.

A productive class of suffixes that lead to VV sequences involves tense/reflexivity markers. These are all single vowels and they undergo deletion before vowel-initial suffixes. These alternations will be further discussed in section 8.3.3, where I show that vowel deletion applies to other VV sequences in AA. The behavior of tense/reflexivity markers supports the deletion analysis.

Some potential morpheme combinations could lead to hiatus, but are not recorded. For example, the climax marker /-tsi/ is recorded as vowel-final in Payne (1981). In the available data, it only occurs either word-finally, or before a consonant-initial morpheme. However it may in principle also occur before the vowel-initial 1<sup>st</sup> person inclusive non-subject marker /-ai/ (see Payne, 1981, pp 30-35).

The nominal suffix /-ki/ 'location' is recorded both before consonants and before vowels, but /t/ only alternates with zero in verbal morphophonology, and thus no /t/-alternations are expected here. The fate of /-ki/ is illustrated in 8.3.3 (example (9b)).

Finally, the verity marker /-pirot/ is recorded both before vowels on verbal stems, and word-finally after nominal stems, in which case it appears as [piro] (8).

---

<sup>5</sup> The search was performed on the digital version of Payne (1981) using Adobe Acrobat search utility. It is possible that some relevant examples were not found because of the errors in text recognition or occasional inconsistencies in glossing.



## (8) Alternations of the verity suffix /pirot/

/i-N-tʰik-pirot-i/	[ɪntʰikapiroti]
‘3PM-FUT-cut-VER-FUT’	‘he will cut it well’ (P: 108)
/mapi-piro/ ‘rock-VER’	[mapipiro] ‘a real rock’ (P: 44)

However, AA does not allow word-final consonants, and it is possible that any C would undergo deletion in this context, so the alternations of the verity suffix are not necessarily expected to show the same divide between /t/ and other consonants that we see stem-finally in verbs.

### 8.3.3 Hiatus resolution

In this section, I argue that AA exhibits a general pattern of vowel sequence simplification, and that the same principles operate within roots and at suffix boundaries in nouns and verbs (prefixes are exceptional in many ways). Although the existence of vowel hiatus alternations has been previously noted, their generality is somewhat understated by Payne (1981). In fact, the general vowel hiatus processes integrate well with the deletion analysis, but not with the traditional insertion analysis that is summarized in 8.4.

Apurucayali allows surface long vowels and the diphthongs [ai oi]. Not surprisingly, when two identical vowels come together across a morpheme boundary, the result is a long vowel, and /a+i, o+i/ surface as diphthongs.

These alternations at morpheme boundaries are illustrated in (9). Recall, that all nominal stems end in a vowel. The hiatus alternations are recorded between noun stems and the /i/-initial suffix /-iriki/ ‘pluralizing diminutive’. These alternations also occur with nominalized verb stems (9a), where /t/-deletion and the general gliding alternations can be noted. (9b) illustrates another diminutive suffix /ini/ which undergoes long vowel formation after /i/-final suffixes. It should be pointed out that the diminutive /ini/ is limited to these two occurrences, both of which come from the text ‘Red Bird’.

## (9) Hiatus alternations in nouns (P: 141 unless noted)

## a. Pluralizing diminutive /-iriki/ with noun stems

/t <sup>h</sup> oNki-iriki/ ‘ant-DIMP’	[t <sup>h</sup> oŋki:riki] ‘small ants’ (P: 47)
/no-kimit-ri-iriki/	[nojimiri:riki]
‘1P-scrape-NOMZ-DIMP’	‘my little scraped manioc’ (P: 111)
/hito-iriki/ ‘spider-DIMP’	[hitoiriki] ‘little spiders’ (P: 110)
/no-komat-ro-iriki/	[nojomavoiriki]
‘1P-paddle-NOMZ-DIMP’	‘my little paddle’ (P: 111)
/ana-iriki/ ‘black_dye-DIMP’	[anairiki] ‘small black dye plants’ (P: 110)

## b. Diminutive /-ini/ after suffixes

/hipo-ki-ini/	[hipoki:ni]
‘above-LOC-DIM’	‘right up there (in the tree branches)’ (RB: 14)
/ir <sup>j</sup> ani-ini/ ‘small-DIM’	[ir <sup>j</sup> ani:ni] ‘small’ (RB: 6)

When a long vowel or a diphthong comes together with another vowel, the sequence cannot surface faithfully. In such cases, shortening occurs if it can lead to a surface diphthong (10a), and otherwise one of the vowels is deleted (10b).

## (10) Trimoraic sequences simplified via deletion

## a. Vowel shortening with pluralizing diminutive (P: 141)

/mani:-iriki/ ‘ant(izula)-DIMP’	[mani:riki] ‘little ants (izula)’
/saNpa:-iriki/ ‘balsa-DIMP’	[sampa:riki] ‘little balsas’
/ts <sup>h</sup> ivo:-iriki/ ‘cane_box-DIMP’	[ts <sup>h</sup> ivoiriki] ‘little cane boxes’
/no-pai-iriki/ ‘1p-grey_hair-DIMP’	[nopairiki] ‘my little grey hairs’

## b. Vowel deletion with tense/reflexivity markers (P: 37)

/i-tʃ <sup>h</sup> ik-a-ai/ ‘3PM-cut-NFUT-1PI’	[itʃ <sup>h</sup> ikai] ‘he cut us’
/i-N-tʃ <sup>h</sup> ik-i-ai/ ‘3PM-FUT-cut-FUT-1PI’	[ijntʃ <sup>h</sup> ikai] ‘he will cut us’
/i-tʃ <sup>h</sup> ik-ak-i-ai/ ‘3PM-cut-PRF-NFUT-1PI’	[itʃ <sup>h</sup> ikakai] ‘he has cut us’
/i-N-tʃ <sup>h</sup> ik-ak-i-ai/ ‘3PM-FUT-cut-PRF-FUT-1PI’	[ijntʃ <sup>h</sup> ikakai] ‘he will have cut us’

Note that the tense/reflexivity markers in (10b) occur in verbal morphology, and thus if we were to treat /t/-zero alternations as epenthesis, we would expect /i-ai/ and /a-ai/ to surface as \*[itai] and \*[atai] respectively. To resolve this problem Payne (1981: 37) postulates an ad hoc ‘1/PERSON/INCLUSIVE CONSTRAINT’ which states that tense suffixes do not occur with the 1<sup>st</sup> person inclusive suffix (see 8.4 for a discussion of this constraint).

The alternations presented above can be summarized as in (11) where the cells with no available data are left blank.

## (11) Ajiñinka Apurucayali hiatus resolution

V1 \ V2	i	a	o	i:	a:	o:	ai	oi
i	i:	ai	oi	i:	ai	oi	ai	
ai	ai	ai						


The analysis of these patterns below is based on Casali (1998) and Rosenthal (Rosenthal, 1997a; b). In addition to the constraints regulating the distribution of long vowels, namely MAX- $\mu$  and \*LONG introduced in the previous chapters, we need a constraint against diphthongs. This will be referred to as \*DIPH formulated in (12), after Rosenthal (1997a, b); Itô & Mester (1999a), and McCarthy (2008a).

## (12) \*DIPH(THONG): assign a violation for every diphthong


When two monomoraic vowels come together, the outcome is either a diphthong or a long vowel, indicating that ONSET dominates \*DIPH (13a) and MAX- $\mu$  dominates \*LONG (13b).

## (13) Diphthongs and long vowels from vowel sequences in AA

## a. Diphthongs

/tai/	ONSET	Max-V	MAX- $\mu$	*DIPH
 tai				1
ta.i	W1			L
ta		W1	W1	L


## b. Long vowels

/tii/	ONSET	Max- $\mu$	*LONG
 ti:			1
ti.i	W1		L
ti		W1	L


When an input contains more than two vocalic moras in a row, the sequence is resolved by shortening, rather than by deleting one of the vowels. This is illustrated in (14). In (14b) it is assumed that the features of all input vowels are preserved, so the only difference between the input and output is the number of moras.

## (14) Treatment of trimoraic sequences I

## a. Diphthongs

/tai:/	ONSET	Max-V	Max-μ	*DIPH
 tai			1	1
ta:i	W1		L	L
ta:		W1	L	L


## b. Long vowels

/ti:i/	ONSET	Max-μ	*LONG
 ti:		1	1
ti:i	W1	L	1


Finally, in some cases deleting one of the input moras cannot yield a well-formed output syllable. In these cases, vowel deletion occurs, as illustrated in (15). In all such cases an output with a diphthong is preferred over a long vowel output indicating that \*LONG is ranked over \*DIPH (15a).

## (15) Treatment of trimoraic sequences II

## a. Diphthongs + V

/tai + i/	ONSET	Max-V	Max-μ	*LONG	*DIPH
 tai		1	1		1
tai.i	W1	L	L		1
ta:		1	1	W1	L

## b. V + diphthong

/ti + ai/	ONSET	Max-V	Max-μ	*LONG	*DIPH
 tai		1	1		1
ti.ai	W1	L	L		1
ti:		1	1	W1	L

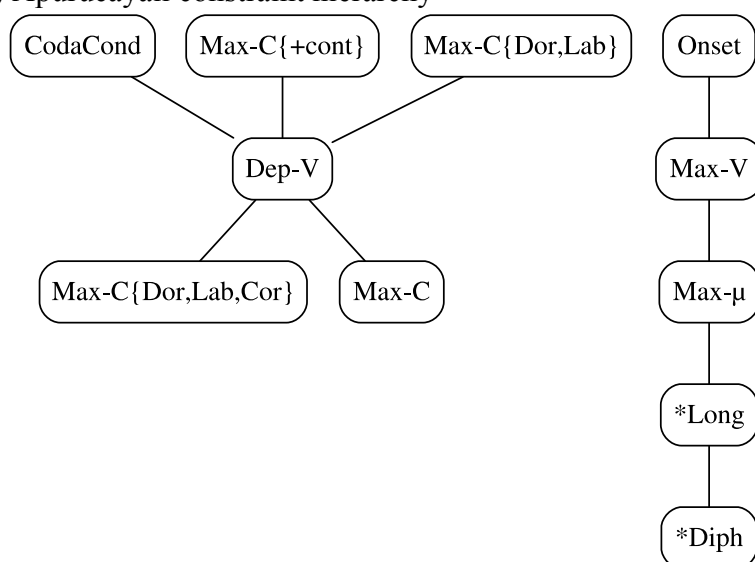
Finally, personal prefixes behave in a special way with regard to hiatus resolution (Payne, 1981: 77-106). Most prefixes lose their vowel before vowel-initial stems and preserve it before a consonant. The prefix-stem boundary also behaves in a special way with regard to word minimality (see section 8.5) and a host of other phonological processes. The fact that prefixes are special with regard to hiatus is in no way unusual (Casali, 1998) and it coincides with other phonological processes in AA. While a complete account of prefix morphophonology would lead us too far afield, a plausible analysis is proposed by McCarthy & Prince (1993b) who argue that prefixes belong to a separate stratum which has its own ranking. This solution will be adopted in integrating the deletion analysis of [t]-zero alternations with an account of back glide alternations in section 8.6.

To summarize, I have argued that AA has several hiatus resolution strategies: diphthongization, long vowel formation, and vowel deletion. These strategies apply consistently with two nominal diminutive suffixes and with the verbal tense suffixes. These strategies are also consistent with the presence of long vowels and diphthongs both within roots and within suffixes. Finally, AA prefixes are special in many ways phonologically, and they lead to a special way of resolving hiatus.

### 8.3.4 Summary

The deletion analysis assumes that all verb stems in AA end in a consonant. /t/ is deleted before consonants, while all other consonants trigger [a] insertion in this environment. Preferential deletion of /t/ is analyzed here as due to preservation of the marked (de Lacy, 2006). Contrary to what is typically reported, there is practically no evidence of /t/-zero alternations between verbal suffixes. Vowel sequences in AA are realized as diphthongs and long vowels whenever possible, or else they are resolved via vowel deletion. The total hierarchy of AA is given in (16). These ranking conditions hold at all levels or strata, as we shall see.

(16) Apurucayali constraint hierarchy



## 8.4 The epenthesis analysis

The analysis presented above contrasts with an epenthesis analysis (Payne, 1981; Payne *et al.*, 1982; Spring, 1990b; McCarthy & Prince, 1993b). In the epenthesis approach, the consonant [t] is inserted between two vowels after a verb stem and before a suffix. Thus the verb stem ‘to paddle’ would underlyingly be /koma/, and it would alternate as in (17).

(17) Epenthesis analysis: [t]-insertion after verbal stems

/i-N-koma-i/ ‘3PM-FUT-paddle-FUT’	[iŋkomati] ‘he will paddle’ (P: 108)
/i-N-koma-pirot-i/	[iŋkomapiroti]
‘3PM-FUT-paddle-VER-FUT’	‘he will paddle well’ (P: 55)

One prediction of the epenthesis analysis is that there should be /t/-final stems, such as hypothetical /pat/ (18). /pat/ would surface as [pat] before vowel-initial suffixes and as [pata] before consonant-initial suffixes. However, no stems of this type are given in Payne (1981). In contrast, the deletion analysis correctly predicts that such stems should not exist since a stem-final /t/ will undergo deletion.

(18) Epenthesis analysis: Predicted /t/-final stems

/i-N-pat-i/ ‘3PM-FUT-PAT-FUT’	*[impatɪ] ‘he will PAT’
/i-N-pat-pirot-i/ ‘3PM-FUT-PAT-VER-FUT’	*[impatapiroti] ‘he will PAT well’

The fact that /t/ does not occur stem-finally in verbs is a shortcoming of the insertion accounts. On the deletion account, all verb stems end in a consonant, which can be enforced through stem-level constraints (see section 8.6). Although the presence/absence of /t/-final stems could be an accidental gap (like the absence of /ts/-final stems), the deletion account treats /t/-zero alternations as a principled restriction on verb stem morpho-phonology.

The epenthesis analysis encounters further challenges in dealing with verbal suffixes. All insertion accounts assume that /t/ is inserted in hiatus between verbal suffixes. However, as discussed in 8.3.2, there is little (if any) data to support /t/ insertion at suffix-suffix boundaries.<sup>6</sup> If the lack of such data reflects the actual distribution of these suffixes, in accordance with Lexicon Optimization the learners of AA will postulate a surface representation of suffixes which is identical to their underlying representation, as shown in the Appendix. Note that this argument is stronger in OT: within the derivational analysis of Payne (1981) the absence of suffix alternations does not necessarily imply that underlying form is identical to the surface form.

Another issue for the insertion analysis comes from the fact that the general hiatus resolution strategies *do* apply to verbal suffixes. First, some verbal suffixes are diphthongal, e.g. /ai/ ‘1<sup>st</sup> person inclusive’. This suffix has an underlying vowel sequence, and it occurs in verbal morphology, so the insertion analysis needs to explain why it does not surface as [ati]. However, this issue can be resolved by invoking a constraint that preserves morpheme-internal adjacency, like CONTIGUITY (McCarthy & Prince, 1993b; Kenstowicz, 1994).

Furthermore, the tense/reflexivity markers are deleted before the vowel-initial suffix /ai/, as shown in (19), repeated from (10b). Within the deletion account, this process is entirely expected and incorporated well with the general hiatus resolution strategies of AA.

---

<sup>6</sup> The only potential exception is the verity suffix /-pirot/ which appears word-finally as [piro]. However, this alternation does not disambiguate between the deletion and insertion accounts since it occurs word-finally where all consonants are disallowed.

## (19) Vowel deletion with tense/reflexivity markers (P: 37)

/i-tʃʰik-a-ai/ ‘3PM-cut-NFUT-1PI’	[itʃʰikai] ‘he cut us’
/i-N-tʃʰik-i-ai/ ‘3PM-FUT-cut-FUT-1PI’	[ɪntʃʰikai] ‘he will cut us’
/i-tʃʰik-ak-i-ai/ ‘3PM-cut-PRF-NFUT-1PI’	[itʃʰikakai] ‘he has cut us’
/i-N-tʃʰik-ak-i-ai/ ‘3PM-FUT-cut-PRF-FUT-1PI’	[ɪntʃʰikakai] ‘he will have cut us’

However, an epenthesis account has no straightforward way to explain why /-i-ai/ does not surface as \*[itai] (e.g. \*[itʃʰikakitai]). Payne’s solution is to assert that tense/reflexivity markers simply do not occur between the 1<sup>st</sup> person inclusive morpheme (the 1/PERSON/INCLUSIVE CONSTRAINT of Payne, 1981: 37). This approach means that it is a mere coincidence that the tense/reflexivity suffixes are banned in the same phonological environment that would show [t] epenthesis.

In contrast, the deletion account eliminates the need for any arbitrary stipulation about tense/reflexivity and 1<sup>st</sup> person inclusive co-occurrence. The surface forms are simply due to the general hiatus resolution strategies of the language, and to the fact that all personal suffixes except the ‘1<sup>st</sup> person inclusive’ are consonant-initial.

Finally, on the deletion analysis, it can be assumed that hiatus is generally resolved the same way in nominal and verbal morphology (see section 8.3.3). Vowel deletion in (19) is thus a part of a general pattern. In contrast, on the epenthesis analysis hiatus resolution has to operate differently in nouns and verbs.

In conclusion, it is worth mentioning that Payne (1981) is quite aware of the possible deletion account (although the analytic options he considers are different from what is proposed in 8.3). He picks the insertion analysis based on overall theoretical expectations: “if a consonant is epenthesized to break up a vowel cluster, it is quite natural that the consonant would be a highly unmarked consonant such as /t/” (p. 57). In other words, AA alternations are analyzed as insertion *because we expect* to find [t]-insertion. Clearly, such a case cannot be used to arbitrate between different theories of insertion, particularly when theories differ on just this point – i.e. whether [t] can be epenthetic.

## 8.5 Subminimal words in the deletion analysis

In this section, I show that the deletion analysis encounters no difficulty in capturing the special behavior of verb roots which are shorter than two moras. These roots can have two possible shapes on the deletion analysis: C- and CVC- (all verb roots end in consonants).

Observe that the final /t/ of a CVC root /nat/ ‘carry’ is not deleted before a C-initial suffix. The vowel inserted after the monoconsonantal root /p/ ‘feed’ is long [a:] rather than short [a]. These examples are representative of a larger set of stems, including, for example, /tʰot/ ‘kiss, suck’; /it/ ‘precede’; /tʃ/ ‘carry (with tump line)’; /p/ ‘feed’.

## (20) C- and CVC- verb roots

/i-N-tʃ <sup>h</sup> ik-pirot-i/	[ɪntʃ <sup>h</sup> ikapiroti]
‘3PM-FUT-cut-VER-FUT’	‘he will cut it well’ (P: 108)
/nat-pirot-a:nts <sup>h</sup> i/ ‘carry-VER-INF’	[natapirota:nts <sup>h</sup> i] ‘to carry well’ (P: 145)
/ɲ-pirot-a:nts <sup>h</sup> i/ ‘feed-VER-INF’	[ɲa:pirota:nts <sup>h</sup> i] ‘to really see’
	(Spring, 1990c: 149)

AA has a minimality requirement on prosodic words: all surface words must be at least bimoraic. This requirement is enforced by the constraint FT-BIN in (21) (adapted from Prince & Smolensky, 2004)

## (21) FT-BIN: assign a violation for every foot that is not binary at the moraic or syllabic level


Furthermore, as argued by McCarthy & Prince (1993b), the morphology of AA dictates that the base of suffixation must be a prosodic word. I follow McCarthy & Prince (1993b) in encoding this requirement as the constraint in (22).

## (22) SFX-TO-PRWD: the base of suffixation is a prosodic word

Deleting a stem-final consonant of /nat/ ‘carry’ or inserting a short vowel after /ɲ/ ‘feed’ would violate this constraint since the suffix would attach to a subminimal CV sequence. Thus, the constraint SFX-TO-PRWD and the constraint FT-BIN enforcing the bimoraic minimum must dominate DEP-V and DEP-μ, as shown in (23) for /nat-pirot-a:nts<sup>h</sup>i/ ‘carry-VER-INF’ surfacing as [natapirota:nts<sup>h</sup>i] and /ɲ-pirot-a:nts<sup>h</sup>i/ ‘feed-VER-INF’ surfacing as [ɲa:pirota:nts<sup>h</sup>i]. In this and the following tableaux I use the vertical line to indicate the root boundary and the right square bracket to indicate a word-internal PrWd boundary. The ranking DEP-V >> MAX-C{Dor,Lab,Cor} was established in 8.3.1 (responsible for /t/-deletion).


## (23) Subminimal roots trigger vowel epenthesis

## a. /t/-final CVC root

/nat-pi/	FT-BIN	SFX-TO-PRWD	Dep-V	MAX-C{Dor,Lab,Cor}
 nat a]pi			1	
na pi]		W1	L	W1
na ]pi	W1		L	W1



## b. Single C root

/n-pi/	FT-BIN	SFX-TO-PRWD	Dep-V	DEP-μ	*LONG	MAX-C {Dor,Lab,Cor}
 na:]pi			1	1	1	
na pi]		W1	L	L	L	W1
na ]pi	W1		L	L	L	W1

The root can form a prosodic word together with a prefix. In this case the bimoraic minimum requirement is satisfied, and the subminimal roots behave just like the longer roots ending in the same consonant (24).

## (24) Prefixes satisfy the minimality requirement

## a. Subminimal roots with prefixes

/nō-nat-uait-i/	[nonavaiti]
‘1P-carry-CNT-FUT’	‘I will continue to carry’ (P: 145)
/ir-N-p-uait-i-ro-ta/	[impavaitirota]
‘3PM-FUT-feed-CNT-FUT-3PF-SBJ’	‘He might continue feeding her?’ (P: 149)

## b. Longer roots

/i-N-komat-pirot-i/	[iŋkomapiroti]
‘3PM-FUT-paddle-VER-FUT’	‘he will paddle well’
/h-oNpoh-uait-ak-a/	[hompohavaitaka]
‘3PM-bump_head-CNT-PERF-NFUT.RFL’	‘he bumped his head’ (B 174)

Interestingly, the personal prefixes (which are underlyingly bimoraic) need to already have a mora, in order for the prefix-root complex to satisfy the bimoraic requirement. Thus, the attachment of personal prefixes has to occur at an earlier stratum than the attachment of suffixes. This assumption is independently motivated in McCarthy & Prince (1993).

Finally, the subminimal roots exhibit no special behavior before vowel-initial suffixes, as illustrated in (25). Inserting a vowel in this context would lead to the disallowed medial onsetless syllables.

## (25) Subminimal roots before vowel-initial suffixes

/nat-a:nts <sup>hi</sup> / ‘carry-INF’	[nata:nts <sup>hi</sup> ] ‘to carry’ (P: 79)
/p-a:nts <sup>hi</sup> / ‘feed-INF’	[pa:nts <sup>hi</sup> ] ‘to carry’ (P: 238)
/t <sup>hi</sup> ik-a:nts <sup>hi</sup> / ‘cut-INF’	[t <sup>hi</sup> ika:nts <sup>hi</sup> ] ‘to cut’ (P: 238)
/ts <sup>hi</sup> itok-a:nts <sup>hi</sup> / ‘hit-INF’	[t <sup>hi</sup> itoka:nts <sup>hi</sup> ] ‘to hit, kill’ (P: 239)

## 8.6 Back glide alternations

No analysis of AA is complete without a treatment of the peculiar alternations of the back glide (Payne, 1981; Black, 1991; Spring, 1992; McCarthy & Prince, 1993b). The account in this section follows McCarthy & Prince (1993) rather closely, but it incorporates a few new ideas. First, the back glide is phonologically specified [+high –low], and it only occurs after /a/ because it is underlyingly representationally deficient. An underlying /a/ in the margins would not survive due to V-NUC. Finally, the back glide changes to [j] before /i/, since assimilation is possible only at the Word level, and only as a last resort.

The back glide alternations are opaque. To capture this fact, McCarthy & Prince (1993) propose that different levels of AA morphophonology can have different rankings. I follow this proposal. The analysis of back glide alternations below will be first presented in a derivational sequence (‘prefix level’ of McCarthy & Prince first and ‘word level’ last), pointing out the aspects of the glide's behavior that cannot be captured in parallel OT. In the end of this section, the surface generalizations regarding the back glide are presented and discussed.

### 8.6.1 First stratum: prefix level

As argued above, all verb stems in AA end in a consonant. This morphological generalization is enforced at the earliest level of derivation, where prefixes are combined with stems. Following McCarthy & Prince (1993), I will refer to this level as ‘Prefix level’. At this level, the back glide comes from an underlying vocalic root node (symbolized ‘R’ below) which is not linked to a mora and which is underspecified for backness and rounding. This root node is specified [+high, –low] in consistency with the our general assumption that Gen does not produce non-high glides. The behavior of the empty root node is similar to the stem-final underspecified V of Chumburung (see Chapter 6). The stem-final (and stem-medial) empty R gets its backness and rounding from a preceding stem vowel, as illustrated in (26). The intermediate outputs are presented within two sets of brackets, to indicate that this is not the ultimate output.

(26) Stem level: empty R filled via spreading


/taR/	/[tau]/ ‘burn’
/ojaR/	/[oja:u]/ ‘insert’
/osaRa:Nt/	/[osauqa:nt]/ ‘stick in to pull out’

At this level, the final consonants are allowed in the output due to the morphological requirement that verbs end in a consonant. This requirement will be encoded here as a constraint FINAL-C<sub>VB</sub> (27) which penalizes verbs that end in a vowel. This constraint utilizes the schema of morphologically indexed constraints (Pater, 2000, 2006) whereby the general phonological constraints can be linked to particular morphemes or morpheme classes.

(27) FINAL-C<sub>VB</sub>: assign a violation for a prosodic word which is morphologically a verb which does not end in a consonant


The tableau in (28) illustrates the emergence of back glides at Prefix level. Crucially, FINAL-C<sub>VB</sub> must dominate \*SPREAD, the constraint that penalizes spreading features onto the empty root node.

(28) Back glide emerges at Prefix level

/taR/	FINAL-C <sub>VB</sub>	*SPREAD
 tauɥ		1
ta:	W1	L

An empty R may occur after non-low vowels at the stem level, in which case it will surface as a corresponding glide. This is illustrated in (29) with a hypothetical input /tiR/.

(29) Underlying empty R after non-low vowels

/tiR/	FINAL-C <sub>VB</sub>	*SPREAD
 tij		1
ti:	W1	L

The back glide is allowed if it stems from spreading /a/ quality onto empty R. However, an underlying /a/ may never surface in a margin. The distribution of glides at Prefix level is enforced by a slightly more fine-grained version of the constraint V-NUC, which is familiar from Chapter 5. The relevant constraint a-NUC penalizes any instance of the most sonorous vowel /a/ which does not correspond to a syllable nucleus in the output.

(30) a-NUC: assign a violation for an input /a/ which does not have a correspondent in a syllable nucleus

No data is available on what would happen to an input which has a non-moraic /a/ after a non-low vowel. Presumably, /a/ would be deleted in this case. This is suggested by the alternations of prefixes, which happen at Prefix level and which involve deletion of vowels.

To summarize, at the first stratum, corresponding roughly to the Prefix level of McCarthy & Prince (1993), all verb stems end in a consonant. Furthermore, the back glide emerges at this level from an underspecified input. The back glide distribution is enforced by the constraint a-NUC. Postulating a separate Prefix level is necessary to account for the fact that prefixes count towards the minimality requirements (section 8.5), and to account for the distribution of the back glide.

### 8.6.2 Later strata: suffix level and word-level

The suffix level of McCarthy & Prince (1993) involves attachment of suffixes and /t/-zero alternations. Nothing happens to the back glide at this level. Just like other velar consonants /uɣ/ triggers [a]-insertion before consonant-initial suffixes (31). In this example the personal prefixes are already part of the stem, since they were attached at Prefix level.

## (31) Suffix level: back glide behaves as other consonants

/oja:ɯ-ɯait-i-ro-ta/	/[oja:ɯavaitiro:ta]/
‘3PF.insert-CNT-FUT-3PF-SBJ’	‘she might continually insert it’ (P: 243)
/ontaɯ-ɯait-i-ro-ta/	/[ontaɯavaitiro:ta]/
‘3PF.FUT.burn-CNT-FUT-3PF-SBJ’	‘she might continually burn it’ (P: 242)
/ontsiŋkauɯ-ɯait-i-ro-ta/	/[ontsiŋkauavaitiro:ta]/
‘3PF.FUT.break-CNT-FUT-3PF-SBJ’	‘she might continually break it’ (P: 242)

Crucially, at this level the underlying back glide has to be preserved. Thus, the constraint against high back unrounded vocalic segments has to be low-ranked.

Finally, the Word level of McCarthy & Prince (1993) is where back glide deletion happens. The back glide is deleted unless it is preceded or followed by a long vowel or a diphthong. This is illustrated in (32).

## (32) Back glide deletion and the output

## a. Back glide deleted between two short vowels

/pintsiŋkauɯiro/	[pintsiŋkairo] ‘you will break it’ (P: 240)
/itaɯakiro/	[ita:kiro] ‘he has burned it’ (P: 67)
/ontaɯavaitiro:ta/	[onta:vaitiro:ta] ‘she might continually burn it’ (P: 242)

## b. Back glide preserved if one of the vowels surrounding it is bimoraic

/tauq:nts <sup>hi</sup> /	[tauq:nts <sup>hi</sup> ] ‘to burn’ (P: 67)
/intaɯaijironi/	[intaɯaijironi] ‘they will burn it’ (P: 67)
/oja:ɯavaitiro:ta/	[oja:ɯavaitiro:ta] ‘she might continually insert it’ (P: 243)
/oja:ɯa:nts <sup>hi</sup> /	[oja:ɯa:nts <sup>hi</sup> ] ‘to insert’ (P: 67)

Note that the distinction between Word level and Suffix level is absolutely crucial to accounting for the back glide alternations. This is because /ɯ/ triggers [a]-insertion at Suffix level but is deleted at Word level. If /ɯ/ deletion could occur at Word level, there would be no motivation for [a]-insertion, and something like /ontaɯ-ɯait-i-ro-ta/ ‘3PF.FUT.burn-CNT-FUT-3PF-SBJ’ would simply surface as \*[ontavaitirota] at that level.


Unlike at the Prefix level, the dispreference for back glide at the Word level is due to the constraint against high back unrounded vocalic segments, formulated in (33). Note that the margin sonority constraints also play a role in the analysis of Mongolian (Chapter 7).

## (33) \*HiBkUNRND: assign a violation for every vocalic segment that is [+low –high +back –round]


At the Word level, this constraint dominates  $\text{MAX-C}\{\text{Dorsal}\}$ , as illustrated in (34). However, back glide deletion is blocked if it would result in an illicit syllable violating ONSET.

(34) Analysis of back glide deletion

a. Preservation next to bimoraic vowels

/tauɰai/	ONSET	*HiBkUNRND	MAX-C{Dor}
 ta.ɰai		1	
ta.ai	W1	L	W1

b. Deletion otherwise

/tauɰi/	ONSET	*HiBkUNRND	MAX-C{Dor}	*DIPH
 tai			1	1
tauɰi		W1	L	L

The constraint \*HiBkUNRND can also be responded to by changing the quality of a margin glide. This happens if a back glide precedes /i/ (35).


(35) Back glide assimilates to a following /i/

/poja:ɰiro/      [poja:jiro] ‘you will insert it’ (P: 241)


In this case, the assimilation of a back glide to /i/ violates the identity constraint the feature [back] (36). Note that assimilation of a back glide does not block its deletion, hence IDENT-[back] has to be ranked above MAX-C{Dorsal} (36b).

(36) Assimilation of a back glide

a. Assimilation before /i/ if the glide is preserved

/ta:ɰi/	ONSET	*HiBkUNRND	IDENT-[back]	MAX-C{Dor}
 ta:ji			1	
ta:ɰi		W1	L	
ta:.i	W1		L	W1

b. Assimilation does not block deletion

/ta:ɰi/	*HiBkUNRND	IDENT-[back]	MAX-C{Dor}
 tai			1
tauɰi	W1		L
taji		W1	L

To summarize, the alternations of the back glide in AA can be analyzed within the deletion approach. However, an additional complication should be mentioned. The back glide is preserved in cases where its deletion would lead to a fusion of two morphemes

into a single syllable. The relevant data are extensively analyzed by Black (1991); Spring (1992); and McCarthy & Prince (1993). The analysis presented here is fully compatible with McCarthy & Prince's approach which relies on postulating a morphological distinctness constraint.

The stratal analysis outlined above captures the following generalizations about AA back glide:

- the back glide only occurs next to /a/ (because it is underlyingly unspecified)
- a stem-final back glide is not deleted in verbs when consonant-initial suffixes are attached. Instead, the back glide triggers [a]-insertion
- the back glide is always deleted on the surface if its deletion does not violate the syllable structure of the language or morphological distinctness constraints

## 8.7 Conclusion

The Splitting theory predicts that [t]-insertion should be very restricted. This chapter has argued that the prime case of reported [t]-insertion – Ajiyinka Apurucayali – can be analyzed as deletion. Consequently, [t]-zero alternations in Apurucayali do not falsify the Splitting theory. In fact, since the analysis is ambiguous, Apurucayali data can hardly be used to differentiate between theories of epenthesis (see also Morley, 2013).

The deletion analysis of Apurucayali relies on the idea of preservation of the marked (de Lacy, 2006), and is supported by the fact that there are no verb stems which would show up with a /t/ before vowel-initial suffixes and trigger [a]-insertion before consonant-initial suffixes. Further support for the deletion analysis comes from a detailed study of Apurucayali suffixes. It is shown that no suffixes show clear evidence of [t]-zero alternations, and in fact the tense/reflexivity markers which are all single V in form undergo deletion before vowel-initial suffixes. This deletion process is in line with the strategies of hiatus resolution that Apurucayali employs elsewhere: diphthong formation, long vowel formation, and vowel deletion.

Finally, the back glide in Apurucayali can be analyzed as phonologically [+high – low] supporting the idea that all glides are high.

## 8.8 Appendix: Ajiyinka Apurucayali suffixes

To find out if any of the AA suffixes show alternations between [t] and zero, each suffix which is listed as vowel-final in Payne (1981, pp. 264-266) was searched for throughout the grammar. The search was performed using the Adobe Acrobat search utility based on the electronic version of Payne (1981) available from Summer Institute of Linguistics ([www.sil.org](http://www.sil.org)). It is possible that some of the relevant occurrences were not found due to text recognition errors. In general, each suffix either always occurred before vowels or always occurred before consonants, with only a couple exceptions discussed in detail in sections 8.3.2-8.3.3 above and summarized below.

First, the verity suffix /pirot/ occurred as [piro] in word-final position, but this alternation is not informative since no consonants are allowed word-finally. Second, the future/reflexivity markers undergo deletion before vowel-initial suffixes. These markers present a complex set of allomorphs and are not shown in (37), see section 8.3.3 for a detailed discussion.

Finally, the allomorph [pai] of the plural suffix only attaches to nouns, and the location suffix [ki] only occurs before vowels in nouns. These occurrences do not bear on [t]-zero alternations because the alternations only occur in verbs.

The table in (37) gives the underlying form of the relevant AA suffixes. Under the deletion analysis, the surface form is the same as underlying form. The table also lists the environment where these suffixes occur, and a page reference for an example of each suffix (numbers of sentences are given for texts, since glosses appear separately from phonological form in the texts section).

## (37) Ajiyinka Apurucayali suffixes

Suffix	Gloss	Environment	Example page ref.
-ra	adverbial	_#, _C	Conversation 12, 19
-mats <sup>h</sup> it	affectionate	_V	p. 46
-t <sup>h</sup> ori	classificatory	_#, _C	p. 52
-tsi:	climax	_#, _C	p. 33
-taki	comparative	_#	p. 47
-vait	continuative	_V	paradigms
-akot	dative	_V	p. 11
-iriki	diminutive	_#	p. 47
-(i)ts <sup>h</sup> it	distributive	_V	p. 45
-ma	dubitative	_#	p. 29
-tʃa	emphatic	_#	p. 28
-vi	exclamatory	_#	p. 29
-vit	frustrative	_V	Canoe 7; Beetle 44
-ka	indefinite	_#	p. 11
-a:nts <sup>h</sup> i	infinitive	_#	paradigms
-imat	interruptive	_V	p. 123
-ki	location	_# (_V in nouns only)	p. 48
-ts <sup>h</sup> i	non-possessive	_#, _C in nouns only	p. 50
-ait	passive	_V	p. 40
-ni	plural	_#	paradigms
-ri,-ni	possessive	_#	p. 51
-asit	purpose	_V	p. 43
-ri	relative	_#, _C	p. 27, 29
-a:t	repetitive	_V	p. 108
-ts <sup>h</sup> i	stative	_#, _C	p. 30
-ta	subjunctive	_#	paradigms
-akit	there/and/back	_V	p. 47
-pirot	verity	_V, _#	p. 44, 55



## *Chapter 9. Non-epenthetic mappings that look like epenthesis*

### **9.1 Introduction**

The Splitting theory makes restrictive predictions about the inventory of possible epenthetic consonants. In particular, a segment may not be epenthetic if in a given environment the grammar also allows some other segment which is more faithful to the vowel from which it split. Consequently, for each possible epenthetic segment, the grammar in question must disallow all segments which are more faithful to the vowels. For example, in Mongolian [g/G] is inserted because the language has no segment which would be closer to the vowels on the relevant dimensions: place and voicing.

For some segments, conditions imposed by the Splitting theory mean that in practice they cannot appear in epenthesis. This is the case for [t] discussed in Chapter 8 and for other voiceless obstruent stops. Thus [k] differs from vowels in the features [voice], [continuant], [consonantal], and [sonorant], and it differs at least from some vowels in tongue position features like [high], [low] and [back]. The only feature that [k] shares with the vowels is Place. There are many segments that are closer to the vowels than [k], such as [g], [x], [ɣ], and the glides. Therefore, the Splitting theory predicts that [k] may only be epenthetic if a language ranks IDENT-[place] above other IDENT constraints, and prohibits other dorsals (including vocalic glides) in the given environment or across-the-board. These conditions are also fairly tight, making it practically impossible to find a system where vowels would split to yield [k].

On the other hand, some segments are relatively close to the vowels, but they do not appear as epenthetic in my sample. This is the case for [ŋ]. The dorsal nasal shares the values for [Place], [sonorant], and [voice] with the vowels. Therefore, the Splitting theory predicts that there could be a grammar with [ŋ]-epenthesis, where glides would be blocked (as in Mongolian) and where preservation of input nasality would be less important than preserving such features as [Place], [sonorant], or [voice].

This chapter considers all the remaining epenthetic segments attested in my sample (see Appendix B) and argues that the relevant patterns are ambiguous in their analysis. Thus the reported pattern of [k]-epenthesis in Koḍava (Ebert, 1996) does not falsify the predictions of the Splitting theory. Similarly, reported [ŋ]-epenthesis in Uradhi (Hale, 1976; Crowley, 1983) does little to confirm the theory's predictions about epenthetic [ŋ]. Both cases admit alternative non-epenthetic analyses, and therefore it is hard to use these cases to argue for or against any theory, including the Splitting theory.

The chapter is organized around several common kinds of patterns which often look like epenthesis, but which admit alternative analyses. Section 9.2 looks at the cases where 'epenthesis' is reported between different grammatical systems, rather than between input and output in the same grammar. These cases include the correspondence between different stages of the same language, different dialects of the same language, and different registers of the same language. Section 9.3 is devoted to the potential cases of

epenthesis which are not supported by alternations, and which could instead come from non-productive lexical generalizations. Section 9.4 considers the ways in which reported ‘epenthetic’ segments get their quality from morphological specification. Section 9.5 discusses the patterns of deletion that look like epenthesis (one such pattern involving the [t]-zero alternations in Apurucayali has been discussed in Chapter 8). Finally, section 9.6 is devoted to the cases where all existing sources do not give enough data to adjudicate between the possible analyses. Section 9.7 concludes.

## 9.2 ‘Epenthesis’ between grammatical systems

The Splitting theory (and Generative phonology in general) is concerned with the mental representation of sound alternations. The alternations that occur in the synchronic grammar of a language have to be somehow represented in the brain. In theories that assume a grammatical mapping, such a representation involves an *input*, an *output* and the relationship between the two (non-productive ‘alternations’ may be represented differently, see 9.3).

Apart from the input-output relationship, the phonological strings of segments may be related in many other ways. One such way is a diachronic relation where a form of a proto-language corresponds to a modified form at a later stage of the language. Another way involves correspondence between ‘the same word’ in different varieties of a language that synchronically coexist: dialects or registers. In both cases, the correspondence is not between a phonological input and a phonological output, but rather between ‘the same’ forms in two distinct grammatical systems. If two forms *A* and *B* are connected by this relation, there is no guarantee that there is (or can be) a synchronic grammar which has a phonological mapping /*A*/ → [*B*], represented in the minds of the speakers. Therefore the diachronic cases of ‘epenthesis’ do not necessarily bear on how the synchronic alternation is represented in the human mind.

Of course, it is conceivable that the range of possible historical changes coincides with the range of possible synchronic patterns. This possibility is debated, and I do not attempt to settle the issue here (see Bermúdez-Otero, 2006 for a review). On the one hand, we may assume that all possible historical changes are also possible synchronic alternations. This general view is advocated, for example, in Ohala (1974 et seq.); Bybee (2001b); Blevins (2004), and applied to consonant insertion in Vaux (2001); Blevins (2008), and Morley (2012). On the other hand, there are arguments that synchronic phonologies are restricted by factors which do not influence historical change, and hence the range of possible synchronic alternations is smaller than the range of possible historical changes (Bermúdez-Otero & Börjars, 2006; Kiparsky, 2008; de Lacy & Kingston, 2013).

Until this debate is resolved, we do not know to which extent the diachronic patterns of epenthesis are relevant to how epenthesis is represented in the brain. For this reason, the historical change involving consonant insertion is not studied here. The reported cases of ‘epenthesis’ that happens between different stages of the same language rather than within the same grammatical system include various ‘inserted consonants’ in Basque dialects (Hualde & Gaminde, 1998); [x] and [s] in Land Dayak languages (Blust, 1994);

[t] and [k] in Maru (Burling, 1966); and initial [l] in Motu (Crowley, 1992: 45).<sup>1</sup> These cases were excluded from the main sample and thus they do not appear in Appendix B.

A particularly interesting case of ‘epenthesis’ in correspondence between different grammatical systems involves ‘hypercorrect [s]’ in Spanish dialects, which is well documented for Dominican Spanish. This case, considered in detail in section 9.2.1 below, presents a situation where the same language may have multiple grammatical systems or registers related to different circumstances of use. The speakers of such a language are relating several grammatical systems, and correspondence between multiple systems may involve addition of consonants. Nonetheless, there is no evidence that the speakers are postulating an epenthetic mapping within any of the grammatical systems that they master.

### 9.2.1 Dominican Spanish and reported [s] epenthesis

In Dominican Spanish, coda /s/ is variably weakened to [h] or lost, and the speakers (mostly those who are semi-literate) tend to sometimes pronounce [s] or [h] in the words which do not have an underlying fricative (Terrell, 1982, 1986; Morgan, 1998; Bullock & Toribio, 2010). The phenomenon has attracted considerable attention in the theoretical literature (Harris, 1983, 2002; Núñez-Cedeño, 1988, 1989, 1994; Vaux, 2001; Bradley, 2006).

Most examples of the non-underlying [s] occur word-finally before a word beginning in a voiceless stop (1a). Hypercorrection also occasionally occurs word-medially before voiceless stops and at word boundaries before a vowel (1b).

#### (1) Dominican Spanish hypercorrected [s] (Bullock & Toribio, 2010, pp 20–21)

##### a. Most common environment

<i>Ya[s] tenía</i>	‘it already had’
<i>era[s] plumas</i>	‘were feathers’

##### b. Other environments

<i>Eri[s]ka</i>	‘Erika’
<i>repi[s]ten</i>	‘they repeat’
<i>de[s] animales</i>	‘about animals’

The nature of this phenomenon is relatively clear from the two existing quantitative studies of Dominican [s] hypercorrection in natural speech, which agree in many respects (Morgan, 1998; Bullock & Toribio, 2010). The speakers who are partially literate and trying to speak in the educated register of Dominican Spanish produce the [s] or [h] in the environments where they could have deleted a spelled ‘s’. These productions probably occur when the speakers mimicking Educated Dominican, that they have not fully mastered, postulate an underlying form which is incorrect from the point of view of the Educated Dominican. The speakers are probably taking the spelling, which they are not sure about, as a shortcut to the underlying form, since they know that faithful reproduction of spelled ‘s’ is a property of the Educated register. Note, that this account

<sup>1</sup> Crowley (1992: 321) indicates that the Motu facts are based on his own field notes.

does not imply that hypercorrecting Dominican speakers are unsure about the underlying form in their own colloquial idiolect. Rather, they are not sure about the spelling.

The proposed account implies that hypercorrection rates will be the highest among Dominican speakers who know some orthography, but do not fully master it. This is precisely what is found (Terrell, 1982; Morgan, 1998; Bullock & Toribio, 2010). Thus, in a controlled study of 69 children of different age and literacy, Bullock & Toribio (2010) found that only semi-literate boys and girls (grades 4-8) produced hypercorrection. High school girls who are in grade 8 or further exhibited almost no hypercorrection, which can be explained by the fact that they already master spelling. Similarly, illiterate boys (grade 4 and under) showed no occurrences of non-underlying [s], presumably since they were not yet aware of the spelling.<sup>2</sup>

The phonological context of hypercorrection is often described as the coda, but most instances occur in narrower circumstances – before voiceless stops. Morgan (1998) finds disproportionately few examples of non-underlying [s] word-finally before a stressed vowel in the speech of an adult male Dominican from Santo Domingo. This is related to the fact that underlying /s/ is weakened only rarely before stress (Morgan, 1998). Thus, the environment where hypercorrection occurs mimics the environment where deletion could have occurred, suggesting that the speakers are indeed uncertain only about the positions where they could have deleted /s/.

Finally, the hypercorrected [s] is subject to various morphological reinterpretations. Thus, Morgan's (1998) speaker consistently produced an [s] in the word *jesui[s]tas* 'Jesuits', presumably by analogy to the productive agentive suffix *-ista*. Several speakers interviewed by Bullock & Toribio (2010) seem to be in the process of reinterpreting [s] as a marker of the end of a phrase.

One final puzzle of Dominican hypercorrected [s] relates to its highly variable frequency. Thus, the speaker recorded by Morgan (1998) produced about as many instances of non-underlying [s] as *all* 69 children and 5 adults reported on by Bullock & Toribio (2010) combined. The length of the recording was about 16 minutes for Morgan (1998), comparable to the time that Bullock & Toribio obtained from each of their subjects. It is hard to speculate about the nature of this difference, but the rates of hypercorrection recorded in Bullock & Toribio (2010) are probably comparable to the overall rates of spelling errors.

To summarize, Dominican Spanish hypercorrect [s] arises when the speakers try to learn an educated register of their language, but do not yet fully master it. This process does not involve synchronic epenthesis. Rather it is similar to the diachronic 'epenthesis' cases in that it involves correspondence between multiple grammatical systems.

### 9.2.2 Summary

To summarize, some cases of correspondence between different grammatical systems have been cited as epenthesis. However, these cases do not necessarily involve a phonological input-output mapping, and therefore they do not necessarily bear on how epenthesis is represented in the brain. Most of these cases involve diachronic correspondence between a modern form and its shape in the proto-language. However, very similar correspondence relations may arise between different synchronic dialects or registers of the same language, as is the case in Dominican Spanish.

<sup>2</sup> The results for illiterate girls are not reported.

### 9.3 Non-productive lexical generalizations: an example from Cantonese

The Splitting theory focuses on the cases of epenthesis that are supported by alternations. If there are no alternations available, the generalization is about phonotactics, e.g. ‘all words begin with a consonant’. In these cases it can be unclear whether such a generalization is really enforced by some productive phonological process, or whether it is purely an accidental fact about the lexicon. In other words, the speaker grammars may allow vowel-initial words, but historically no (or very few) such words may have made it into the native lexicon. A particularly interesting kind of lexical generalization that has been analyzed as epenthesis occurs in Cantonese (Hashimoto, 1972; Yip, 1993b). In what follows I describe the data and discuss the two possible analyses.

The vowel phonemes of Cantonese are given in (2). The length contrast in mid vowels is marginal. /e o/ are raised to [ɪ ʊ] in closed syllables before dorsal consonants /k ŋ/ (Hashimoto, 1972; Yip, 1993b), illustrated by the last two forms in (5b) below. In what follows, the tones are marked with superscript numbers and are listed only when relevant.

#### (2) Cantonese vowel inventory

i y	u
e e:	o o:
ø œ:	
a a:	

Cantonese only allows onsetless syllables in a limited range of circumstances. No syllables begin with a high vowel. Underlying high vowel-initial syllables are repaired by glide insertion which applies before the interrogative particle/suffix /a<sup>33</sup>/ that is used sentence-finally in the interrogative construction,<sup>3</sup> e.g. /haj/ ‘be’: /haj m haj ja/ ‘is it?’. Only the last part of the interrogative construction is given in (3a), and only the verb root is glossed. Glide insertion is also indirectly supported by the loanword data in (3b) and by the fact that high glides [j w ɥ] are always homorganic to a following high vowel (3c).

<sup>3</sup> There are no other prefixes in Cantonese, and all other particles/suffixes begin with /a/.

## (3) Syllables with high vowels in Cantonese must have an onset

## a. Root-affix boundaries (last part of the interrogative construction shown)

/tsi<sup>53</sup> a<sup>33</sup>/      [tsi ja] ‘know’/fu<sup>35</sup> a<sup>33</sup>/      [fu wa] ‘bitter’

## b. Loanwords

[jin tsi] ‘inch’<sup>4</sup>

[jin sɔ] ‘insurance’

## c. Possible roots

[ji] ‘two’;    [wu] ‘lake’;    [ɥy] ‘fish’

\*[wi], \*[ju] etc

In what follows, I will not focus on the fate of underlying high vowel-initial syllables. The data in (3) serves as background for comparison with potential non-high vowel-initial syllables.

In contrast to high vowels, onsetless syllables beginning in non-high vowels are allowed in Cantonese, arising under affixation and in loanwords. The examples in (4a) illustrate this with the prefix /a<sup>33</sup>-/ which attaches to personal names, and with the particle/suffix /a<sup>33</sup>/ that is used sentence-finally in the interrogative construction. As in (3a), only the last part of the interrogative construction is given in (4a), and only the verb root is glossed.

## (4) Onsetless syllables beginning in non-high vowels in Cantonese

## a. Prefixes and suffixes

/a-tseŋ/      [a.tseŋ] ‘a-Cheng’

/ta<sup>35</sup> a<sup>33</sup>/      [ta a] ‘hit’/t<sup>h</sup>ɔ<sup>24</sup> a<sup>33</sup>/      [t<sup>h</sup>ɔ a] ‘fine’/ts<sup>h</sup>e<sup>35</sup> a<sup>33</sup>/      [ts<sup>h</sup>e a] ‘go away’

## b. Loanwords

[ej si] ‘ace’

[ɛn tsin] ‘engine’

In spite of the fact that non-high vowels may begin a syllable, certain distributional patterns are suggestive of a potential epenthesis process whereby a [ʔ] is inserted before front non-high vowels and [ʔ ~ ŋ] appears before back non-high vowels. Thus glottal stop only occurs word-initially before non-high vowels (5). The words with a glottal stop before a front vowel are rare, and in these words the glottal stop never alternates with [ŋ]

<sup>4</sup> Yip (1993a: 270) transcribes no initial glide in *inch*.

(5a). On the other hand, before back vowels, glottal stop is in free variation with [ŋ] (5b). [ŋ] does not occur in onsets before high vowels, but it is attested in codas.

(5) Distribution of initial glottal stop and [ŋ] in Cantonese

- a. Laryngeal before front vowels  
[ʔɛ], \*[ŋɛ] ‘hesitating particle’
- b. Laryngeal or [ŋ] before back vowels  
[ŋɔ] ~ [ʔɔ] ‘I, me’  
[ŋak saw] ~ [ʔak saw] ‘shake hands’  
[ŋa:m] ~ [ʔa:m] ‘correct’  
[ŋuk] ~ [ʔuk] ‘house’  
[ŋuŋ] ~ [ʔuŋ] ‘push’

To summarize, [ʔ] and [ŋ] are restricted in their distribution: they only occur before non-high vowels; [ŋ] also occurs word-finally. Based on this generalization, Yip (1993b) proposes that word-initial [ʔ] and [ŋ] are epenthetic. The nasal is analyzed as the phonetic realization of a phonological back glide target i.e. [w], and the epenthetic glide results from splitting. In Yip’s account, nasalization arises as a phonetic side effect of the back glide production, and is not phonologically specified (cf. Trigo, 1988). The forms in (5) are thus vowel-initial underlyingly, and they get their onsets from epenthesis.

Of course, such an account has to explain why ONSET is violated by the forms in (4). For example, the absence of splitting under affixation (4a) can be explained by postulating two levels in the sense of Stratal OT (Bermúdez-Otero, *forthc.*; Kiparsky, *forthc.*) such that ONSET is strictly enforced only at an earlier level, while affixes are attached at a later level (see also Rubach, 2002).

While this approach accounts for the core data, it is not clear if the distributional generalizations outlined above are productive in Cantonese. In fact the loanword data (4b) suggest that the novel words beginning with non-high back vowels may not be pronounced with an initial [ʔ] or [ŋ]. An alternative non-epenthetic analysis of these facts could run as follows. In this analysis, the fact that all roots start in a consonant is an accidental property of the lexicon. Although it is true of the native lexicon, there is no evidence that it is productively enforced, and the loanword evidence suggests that it might not be productive. This lexical generalization perhaps stems from an earlier historical stage where onsets were required and filled by glides or laryngeals (see Bourgerie (1980) for evidence that [ʔ] and [ŋ] were previously in complementary distribution word-initially, rather than in variation). The initial [ʔ, ŋ] in Cantonese roots are present underlyingly, but these consonants neutralize to some other quality before high vowels. The variation between [ʔ] and [ŋ] can be explained as stemming from variable or underspecified underlying forms.

The two analyses treat the speaker knowledge differently and make different predictions. On the epenthesis approach, the speakers of Cantonese know that onsetless syllables with non-high vowels are not allowed at some level, and thus we expect them to show this knowledge in production experiments. On the other hand, in the underlying /ʔ, ɲ/ approach, the speakers actually know that syllables may begin with non-high vowels, and thus no onset-filling is expected. The data available to me at present do not allow to test these predictions. However, it is clear that there is a non-epenthetic analysis of Cantonese.

The ambiguous analysis of the distribution of [ʔ, ɲ] can be compared to the situation with high vowels. Here, the evidence from alternations and distributional generalizations converges on glide epenthesis next to a high vowel.<sup>5</sup>

To summarize, we have seen that Cantonese is a possible case of [ɲ] epenthesis, but it is not clear if the process is (or ever was) productive. The Splitting theory predicts that dorsal nasal epenthesis should be possible since [ɲ] shares the values for [sonorant], [voice], and [place] with the vowels. Furthermore, if Cantonese initial [ɲ] is indeed a glide (or perhaps a nasalized glide) phonologically, then such an epenthesis pattern is even more likely from the point of view of Splitting – a glide would share backness with the back vowels. However, the Cantonese case does not provide clear support of the predictions of the Splitting theory because it admits an alternative analysis. It is possible that the patterning of [ɲ] in Cantonese is due to non-productive lexical generalizations rather than epenthesis.

#### 9.4 Morphological patterns similar to epenthesis

The Splitting theory proposes that consonant epenthesis involves a mapping where an input segment has multiple output correspondents. Within the Insertion theories, an epenthetic segment corresponds to no input segments.

Both of these situations have to be distinguished from a mapping where an output segment simply faithfully reproduces the input, without splitting or insertion. The distinction becomes non-trivial in many cases of morphological prespecification (de Lacy & Kingston, 2013). For example, morphology may identify a particular segment as *latent* (Zoll, 1996) leading to its realization only in particular environments. Morphology may also specify a particular morpheme as suppletive, i.e. as having multiple underlying forms which may be partially phonologically selected (Paster, 2006; Wolf, 2008 a.o.). Finally, another morphological pattern confusable with epenthesis involves monosegmental morphemes.

In many such cases, the segment in question may be analyzed as stemming from either morphological prespecification or phonological epenthesis. However, all of the cases which admit a morphology-based analysis involve the following properties:

- the ‘inserted segments’ are specific to a particular morpheme or morphological class

---

<sup>5</sup> No affixes start with a high vowel, but Yip (1993b, pp. 23-24) reports that “two native speakers who were asked to pronounce hypothetical /ta i/ inputs agreed that [taji] was the only possible output”.



- the ‘inserted segments’ are conditioned in part phonologically and in part morphologically
- the phonological conditions on such alternations do not match the overall phonology of the language

This section presents a survey of the kinds of morphological patterns which have previously been analyzed as phonological epenthesis.

#### 9.4.1 Latent segments and suppletion in French and beyond

Two kinds of morphological prespecification lead to patterns of consonant-zero alternation which are similar to epenthesis. First, in suppletive allomorphy, a morpheme has different underlying forms in different environments. Second, some morphemes contain a latent segment which alternates with zero according to special conditions (Zoll, 1996). In both cases, the consonant-zero alternation is restricted to a particular morpheme or morphological class. Consequently, for all the cases of morphologically restricted ‘epenthesis’, it is almost impossible to tell whether the alternation is specified in the phonology or in the morphology.

Because of this confound, the cases of morphologically-restricted ‘epenthesis’ cannot be used to support or refute a theory that (like the Splitting theory) deals with phonological epenthetic mappings (de Lacy & Kingston, 2013; cf. Morley, 2013).

The morphophonology of French presents a particularly rich system of morphologized consonant-zero alternations, referred to as *liaison* (Fouché, 1959; Selkirk, 1972, 1974; Rotenberg, 1978; Tranel, 1981, 1996; Morin & Kaye, 1982; Kaisse, 1985; Encrevé, 1988; Bybee, 2001a; Féry, 2004; Bermúdez-Otero, 2014). In fact, it is hard to find an affix in French which does not contain latent segments. A comprehensive treatment of all such alternations is not attempted here. For the purposes of illustration I will focus on just one kind of morpheme – the person/number markers in verbs. The plausible underlying forms for the relevant morphemes are as follows: 1sg /(z)/, 1pl /ō(z)/, 2pl /e(z)/, 3pl /(t)/.

At word boundary, the morpheme-final latent segments are optionally realized only before vowel-initial words. The appearance of linking consonants depends on speech rate and style, as well as on frequency factors (Tranel, 1981; Bybee, 2001a). The realization of latent segments may lead to marked clusters such as [vt, tt] (6a). However, the latent segments are never realized after /κ/ in this context, even though French does in general have [κz, κt] clusters (6b).

#### (6) French liaison with personal endings (Tranel, 1981: 224)

##### a. Before a following vowel

<i>ils arrivent ensemble</i>	[ilzakiv(t)āsābl] ‘they are arriving together’
<i>ils chantent en chœur</i>	[ilʃāt(t)ākœκ] ‘they sing in chorus’
<i>nous arriverons ensemble</i>	[nuzakivκō(z)āsābl] ‘we will arrive together’
<i>vous chantiez encore</i>	[vuʃātje(z)ākœκ] ‘you were still singing’
<i>je chantais une chanson</i>	[ʒəʃātε(z)ɯ̃ʃāsō] ‘I was singing a song’

b. But not after /ʁ/ (Tranel, 1981: 228)

<i>je dors encore</i>	[ʒədɔʁ(*z)ɑ̃kɔʁ] ‘I am still sleeping’
<i>il dort encore</i>	[ildɔʁ(*t)ɑ̃kɔʁ] ‘he still bites’

There are also morphological restrictions on the realization of French person markers. Thus, the latent segment of the 1<sup>st</sup> person singular marker is not realized in the future and in the so-called *Passé Simple* forms. This leads to the existence of verb forms which only differ in the possibility of liaison (7).

(7) Morphological restrictions on word boundary liaison in person endings

- |    |   |                         |     |
|----|---|-------------------------|-----|
| a. | <i>je chantais une chanson</i>            | [ʒə̃ʁɑ̃tɛ(z)ynʃɑ̃sɔ̃]   | vs. |
|    | ‘I was singing a song (imperfect)’        |                         |     |
|    | <i>je chanterai une chanson</i>           | [ʒə̃ʁɑ̃tɛ(*z)ynʃɑ̃sɔ̃]  |     |
|    | ‘I sang song (passé simple)’              |                         |     |
| b. | <i>je chanterais une chanson</i>          | [ʒə̃ʁɑ̃trɛ(z)ynʃɑ̃sɔ̃]  | vs. |
|    | ‘I would sing a song (conditional pres.)’ |                         |     |
|    | <i>je chanterai une chanson</i>           | [ʒə̃ʁɑ̃trɛ(*z)ynʃɑ̃sɔ̃] |     |
|    | ‘I will sing a song (future)’             |                         |     |

Finally, at a clitic boundary (in the interrogatives and imperatives), realization of the latent segments becomes obligatory, even in the phonological and morphological contexts where it does not occur across word boundary. Observe, again the otherwise unattested cluster [sz].

(8) The latent segments are obligatorily before personal clitics

- |                 |                            |
|-----------------|----------------------------|
| <i>passes-y</i> | [paszy] ‘go by there’      |
| <i>dort-il?</i> | [dɔʁtil] ‘is he sleeping?’ |

To summarize, the realization of latent segments in French person/number markers depends on a variety of factors (phonological, morphological, stylistic, frequency-related), and does not match the general phonological alternations of French. The latent segments in other morphemes can have a different quality. For example, the consonants that alternate with zero in masculine-feminine nouns and adjectives include almost all consonants of French: /t/, /d/, /k/, /g/, /n/, /ɲ/, /v/, /s/, /z/, /ʃ/, /ʁ/, /l/, /j/ (Durand, 1936; Tranel, 1981). Furthermore, the conditions on the realization of the French latent segments are specific to particular morphemes (Tranel, 1981).

The French data are clearly suggestive of an account in terms of latent segments. The realization of such segments is only partially phonologically conditioned, and the phonological conditioning may be arbitrary (e.g. the non-realization of the latent consonants in personal markers after /ʁ/ at word boundary). These alternations can

probably be described as either suppletion or morphologically-restricted latent segment ‘deletion’ or ‘epenthesis’. In any case the morphologized alternations are handled by prespecification and special constraint families in OT (Zoll, 1996; Inkelas *et al.*, 1997; Pater, 2000, 2006; Inkelas & Zoll, 2007).

An important property of the French consonant-zero alternations considered above is that each alternation is restricted to a particular class of morphemes. Several cases of reported consonant epenthesis share this property with French, and thus admit a suppletion or latent segment analysis. Thus in Odawa Ojibwa [t]-zero alternations are restricted to the boundary between personal prefixes and noun stems from a certain morphological class (Piggot, 1980). In Dutch, reported ‘[n]-epenthesis’ only occurs before the short form of clitics (and only after /ə/) (Booij, 1995, 1996; van de Velde & van Hout, 1998, 2000; van Oostendorp, 2001; Nazarov, 2009). Booij (1995; 1996) argues that the short forms of clitics also occur in a special syntactic configuration, hence the relevant [n]-zero alternations are restricted syntactically. The situation is very similar for [n] and [ʀ] ‘insertion’ alternations occurring between clitics and in clitic-host combinations in German dialects (Ortmann, 1998; Kabak & Schiering, 2006). In Uyghur a segment which alternates in quality between a rhotic and [j] is reported as ‘epenthetic’ but only before possessive suffixes (Hahn, 1991, 1992). Finally, in Trukese ‘inserted [k]’ appears only with causative and stative prefixes (Goodenough & Sugita, 1980).

To summarize, certain cases of reported epenthesis admit an analysis where the relevant segment is underlying rather than epenthetic, but the segment is morphologically specified as latent, or comes as part of a suppletive allomorph. The Splitting theory does not make predictions about such cases because it is a theory of phonological epenthesis, not of the morphology-phonology interface. On the other hand, these cases cannot be used to support or refute the Splitting theory, or other theories of epenthesis for that matter.

It is worth pointing out that the restriction to morphologically unrestricted cases is motivated by the fact that the Splitting theory is formulated within OT. Within OT, the realization of latent segments is governed by a special set of constraints (Zoll, 1996), and hence the morphological alternations between consonants and zero are expected to be less restricted than the purely phonological general ones. However, in rule-based approaches the same basic mechanism is used to handle the general consonant insertion/deletion rules, and the ‘minor rules’ that are linked to particular morphemes and morphological classes (Chomsky & Halle, 1968). On this view, we would expect that the range of consonants ‘inserted’ with particular morphemes will be the same as the range of consonants in general phonological insertion rules.

#### 9.4.2 Monosegmental morphemes

Another case where a non-epenthetic segment may be confused with an epenthetic one involves monosegmental morphemes. The relevant morphemes, often referred to as *linking elements*, are sometimes semantically vacuous. Nevertheless, such morphemes usually appear in very narrow morphologically-defined circumstances. If the appearance of linking morphemes is phonologically conditioned, the conditioning is often arbitrary, rather than achieving a well-formed phonological structure. In this section, I will consider three kinds of such morphemes: linking elements in compounds, fixed segments in reduplication, and syntactic phrase markers.

It should also be pointed out that in some cases a latent segment analysis is hard to distinguish from monosegmental morpheme analysis. Thus Bermúdez-Otero (2014) proposes a monosegmental morpheme analysis for a subset of French liaison cases. Similarly, in Maori, reported '[t]-epenthesis' only applies with two suffixes (Hale, 1973; Bauer, 1993; de Lacy, 2003). Although these are the only suffixes of the language, nothing in principle rules out an analysis where these suffixes both have a latent segment. On the other hand 'epenthesis' in Maori is conditioned by a morphological factor – it only appears when suffixes form a separate prosodic unit. Thus the 'epenthetic [t]' could be a marker of suffixes serving as a separate word, i.e. a monosegmental morpheme. The alternations of Maori [t] are mirrored very closely by Hawaiian [ʔ] (Elbert & Pukui, 1979; Pukui & Elbert, 1986).

### 9.4.3 Linking consonants in compounds

Compound formation often involves linking elements which historically may evolve from genitive or possessive markers. For example, in Anejoñ (also known as Aneityum) linking [r] appears in verbal compounds after a back (rounded) vowel and before another vowel (Lynch, 2000; Lynch & Tepahae, 2001). The transcriptions in (9) abstract away from a number of allophonic processes, and do not mark stress (since it is predictable and not marked in the source). Onsetless syllables are generally allowed in this language, and sequences of any non-identical vowels are allowed (9b), while identical vowel sequences surface as long vowels. Thus, the 'insertion' of linking [r] (9a) contradicts the overall phonology of the language which freely allows hiatus.

#### (9) Anejoñ linking [r] in compounds

##### a. Linking [r] in verbal compounds

/awo-upni/ 'do-good'	[aworupni] 'do well'
/awo-itai/ 'do-things'	[aworitai] 'to garden'

##### b. Vowel sequences are allowed

[niom <sup>w</sup> ]	'house'
[ʔaek]	'you (SG)'

The appearance of linking [r] is morphologically restricted: it only occurs in compounds and only if the first member (the head) is a verb.<sup>6</sup> In nominal compounds, the hiatus may be left unresolved, or it may be resolved based on the idiosyncratic properties of the head stem (Lynch 2000: 110). Anejoñ [r] thus bears all signs of a monosegmental morpheme, rather than a general phonological process.

---

<sup>6</sup> There is also one example where [r] is inserted in VV sequences across word boundaries. However "this appears to be a variable or infrequent rule, and is not well understood at this stage of research" (Lynch, 2000: 29).

Similarly, in German the linking morphemes in compounds are [s] and [t] (among others) (Wiese, 1996). In Korean, the linking consonants [t] and [n] appear in compounds (Kim-Renaud, 1974; Lee, 1998).

#### 9.4.4 Fixed segmentism in reduplication

Another common type of monosegmental morpheme involves the cases of reduplication where one of the segments has to take a particular quality (Alderete *et al.*, 1999; Nevins, 2005; Zimmermann & Trommer, 2007). These *fixed segments* can be analyzed as morphemes which subcategorize for a particular environment where the reduplicants appears (Alderete *et al.*, 1999; Zimmermann & Trommer, 2007). Consequently, these segments are underlying rather than epenthetic, and hence they do not bear on the theory of epenthesis.

A number of fixed segments in reduplication has been reported as epenthetic (Flynn, 2004; Blevins, 2008; cf. de Lacy & Kingston, 2013). Thus, Sm'algyax (also known as Coast Tsimshian) exhibits CVk reduplication in plural (Dunn, 1979). The fixed segment in reduplication is dorsal [ɣ] in Murut (Prentice, 1971). Southern Oromo (Stroemer, 1987) and Mongolian (Svantesson *et al.*, 2005) exhibit patterns of reduplication with the fixed segment [m]. Kaingang has reduplication with a fixed segment [ŋ] (Wiesemann, 1968, 1972). Out of these cases only the latter (Kaingang) was included in the main sample because the correlation between 'epenthesis' and reduplication in this language was previously only sporadically reported.

#### 9.4.5 Syntactic category markers in Tunica

An interesting example of a monosegmental morpheme appears in Tunica where the relevant segment only appears in a particular syntactic position (Haas, 1940). A phonological phrase always corresponds to a syntactic constituent in Tunica (though not all XPs form phrases of their own). To outline the basic picture, the P-phrases which are vowel-final and are not headed by a verb receive a final [n] which is typically devoiced in this context ((10b), devoicing is not shown in Haas's transcriptions). While other vowel-final P-phrases are typically transcribed with a final vowel, Haas (1940: 1.31) notes that such vowels "are accompanied by a strong aspiration". Final aspiration is not shown in the transcriptions, but the text makes it clear that the example in (10a) exhibits it (for clarity the original transcription has been modified). Haas (1940) also states that the [n]-final phrases like those in (10b) do not exhibit final aspiration. So far as I can see, the phrase types which trigger aspiration of a final vowel are precisely the predicate phrases VP and/or vP. A precise characterization of these facts is possible if Tunica has two morphemes /-n/ and /-h/ that attach at a right edge of a phonological phrase according to the syntactic category of the phrase head: /-h/ for predicate phrases, and /-n/ for all other phrases.

## (10) Phrase-final morphemes in Tunica

## a. Verb phrases with final aspiration

[<sup>h</sup>lotakúh] ‘he runs’

## b. Other phrases with final [n]

/hatika/      [<sup>h</sup>hatikǎn] ‘again’/sahku/      [<sup>h</sup>sahkǔn] ‘one’

The final word of the predicate phrases (which is typically the head) also bears the distinctive tonal melody, modifying the whole sentence. The distinctive tonal melodies mark illocutionary force such as indicative, quotative, interrogative, and imperative. Other phrases within the sentence also bear final tones, but these tones are non-contrastive: rising tone is used sentence-medially while low tone is used sentence-finally. The distinction between phrases headed by a predicate and non-predicate phrases is thus important, and it is not surprising that this distinction is marked morphologically.

The phonology of Tunica does not allow final C+[n] or C+[h] sequences, and thus we may assume that the phrase-final category markers are deleted in this context (parallel to cluster simplification that occurs within words and within phrases).

Finally, it is clear that the category markers /n, h/ are attached in the syntax. For example, a phrase-final vowel /i/ is subject to optional apocope, in which case the category marker /n/ is deleted, just as it would be after true C-final stems (11). Thus /n/ attachment does not block apocope.

## (11) /-n/ attachment and apocope of a final /i/

/<sup>h</sup>sinriʃi/    [<sup>h</sup>sinrǐʃ] ‘to their home’/<sup>h</sup>?amari/    [<sup>h</sup>?amǎr] ‘enough’

A phrase-final /u/ may undergo optional devoicing, in which case a phrasal tone is realized on the penultimate syllable. The category marker /n/ is not reported to attach to a devoiced final /u/, but in this case its primary realization would be nasalization on the vowel, which may be hard to discern if the vowel is devoiced.

As a final precautionary note, it should be pointed out that all Tunica data come from a semi-speaker, i.e. a consultant who “could repeat what he had heard but was unable to make up new expressions of his own accord” (Haas, 1940: 2). At the time of recording, the consultant had not used the language in daily conversation for several decenniums.

**9.4.6 Summary**

Unlike the phonological epenthetic segments, the monosegmental morphemes appear in well-defined morphosyntactic environments. In fact, most examples of such morphemes occur either as linking elements in compounds or as fixed segments in reduplication. In some cases the environment is different – this is the case in Tunica where a monosegmental morpheme marks nominal constituents. The monosegmental morphemes do not involve an epenthetic mapping, and therefore they do not bear on the theory of epenthesis.

### 9.4.7 Minimality morphemes and syllable insertion

It is traditionally assumed that phonological epenthesis may occur to satisfy minimal word requirements (Broselow, 1982; McCarthy & Prince, 1986, 1993b; Hayes, 1995; Prince & Smolensky, 2004; Blumenfeld, 2011). However, at least some cases of reported minimality epenthesis admit a morphological analysis, where the inserted material belongs to a semantically vacuous and prosodically conditioned morpheme (Moore-Cantwell, 2013). The attachment of such vacuous morphemes does not necessarily coincide with the footing pattern of the language (Piggot, 1993, 2010; Garrett, 1999) and their segmental content may be arbitrary. For these reasons, it is hard to tell whether the ambiguous cases of reported minimality epenthesis really bear on the inventory of epenthetic consonants. The cases of minimality insertion were excluded from the typological study, and they probably deserve a separate study in their own right, in order to determine whether some (or all) of such cases instantiate minimality morphemes.

For example, a number of Western Pama-Nyungan languages of Australia are reported to exhibit a semantically vacuous string /pa/ which is attached to all consonant-final stems. Perhaps the best known example is Pitjantjatjara, where /-pa/ attachment is synchronically productive (Hale, 1973). /pa/ attaches to the uninflected stems, but does not appear when inflectional affixes are attached (12).

(12) Pitjantjatjara [pa] augmentation (Hale, 1973: 451)

Uninflected	Ergative	Dative	Gloss
ta:npa	ta:nŋu	ta:nku	‘outcrop’
punpupa	punpuntu	punpunku	‘fly’
caljnpa	caljncu	caljнку	‘tongue’
cukurpa	cukurŋu	cukurku	‘dreamtime’

/pa/ attachment is practically exceptionless. It operates on C-final stems which can occur both uninflected and with affixes (nouns and adjectives),<sup>7</sup> and it is also responsible for a surface-true generalization: all words in Pitjantjatjara end in a vowel. /pa/ augmentation fails to apply only to the 2<sup>nd</sup> person singular clitic pronoun /-n/, and to the vocatives of nouns.

On the one hand, /pa/-augmentation could be analyzed as a general phonological process, in which case we would probably have to admit that – because of the [p] – there is no restriction on phonologically added material. On the other hand, it may be assumed that /pa/ is a semantically vacuous morpheme whose appearance is phonologically conditioned (or, equivalently, /pa/ has a zero allomorph after vowels) (Wolf, 2008; Moore-Cantwell, 2013). Both of these analyses handle the data equally well, and so the choice largely depends on the theory and typology. Therefore this case cannot be used to argue for or against a theory of epenthesis. Other reported semantically vacuous

<sup>7</sup> The behavior of verbs in Pitjantjatjara is not discussed in detail by Hale (1973), though he makes it clear that in other related languages the verbal forms augment as well. Also, “in all dialects there are nonnominal forms which have the augment” (Hale, 1973: 450).

morphemes can have a variety of phonological shapes such as [ji] in Navajo (Young & Morgan, 1980).

Crucially, the morphological treatment of Pitjantjatjara /pa/ also opens up the possibility of treating many other augmentative patterns as involving semantically vacuous thematic morphemes. It is well known that morphemes may have different shape depending on the number of syllables in the stem. Thus, the non-possessive suffix in Ajiyinka Apurucayali appears as [ts<sup>hi</sup>] after stems which are bimoraic or shorter but as [nts<sup>hi</sup>] after longer stems (Payne, 1981).

It is possible, then, that ‘minimal word epenthesis’ stems from semantically vacuous morphemes that only show up (or have a non-zero allomorph) after stems shorter than some prosodic constituent, such as a foot. Consider for example the pattern of noun augmentation in Lardil, where (with some caveats) the nouns attach a [Ca] augment if they end in a possible coda (13a), or [a] if they do not (13b) (Hale, 1973; Ngakulmungan Kangka Leman, 1997).

(13) Lardil augmentation

	Stem	Nom	Non-future acc	Gloss
a.	maɭ	maɭa	maɭin	‘hand’
	kaɳ	kaɳa	kaɳin	‘grass’
	kaŋ	kaŋka	kaŋin	‘speech’
b.	jak	jaka	jakin	‘fish’

To account for these data one could postulate a vacuous morpheme with the form /(C)a/ that would attach only to bisyllabic stems. Compared to the phonological augmentation analysis (McCarthy & Prince, 1986; McCarthy, 2003; Prince & Smolensky, 2004), such an account would arguably even fare better since it can account for additional data. For example, nouns and verbs which are CV in shape behave differently with regard to augmentation (14).

(14) Lardil augmentation in vowel-final verbs and nouns

- a. Verbs
- |      |        |         |
|------|--------|---------|
| /ca/ | [caɳa] | ‘enter’ |
| /ma/ | [maɳa] | ‘get’   |
| /ŋe/ | [ŋeɳa] | ‘hit’   |
| /ti/ | [tiɳa] | ‘sit’   |



## b. Nouns

/ca/	[ca:] ‘foot’
/ɬa/	[ɬa:] ‘south’
/lu/	[luwa] ‘fat’

While nouns and verbs are expected to attach different morphemes, the phonological account has to appeal to additional restrictions to explain these data. It should be pointed out however, that there are only a few examples of subminimal nouns that end in a vowel.

A similar morphological account is possible for other cases of ‘minimal word epenthesis’ such as Bugis [ŋ] (Mills, 1975). In summary, the cases of ‘minimal word epenthesis’ are often subject to both a phonological and a morphological analysis. The phonological approach to minimal word augmentation is in principle compatible with the Splitting theory. However, we have seen that the quality of ‘epenthetic segments’ that satisfy minimal words or appear in other phonologically-conditioned dummy morphemes can constitute a radical departure from the quality of the surrounding vowels, e.g. [t] in Lardil or [p] in Pitjantjatjara. From the point of view of the Splitting theory, such cases have to be analyzed as morphemes rather than as true epenthesis.

#### 9.4.8 Summary of morphology-driven patterns

Morphologically prespecified segments often look like epenthesis, and many reported cases of epenthesis can be analyzed as stemming from morphological prespecification. The Splitting theory imposes severe restrictions on epenthetic consonants. Thus in most reported cases of obstruent insertion, the languages also allow other segments which are closer to the vowel. Therefore within the Splitting theory these cases have to be treated as morphologically prespecified segments, rather than phonologically epenthesized material.

### 9.5 Deletion that looks like epenthesis: Uradhi

The Splitting theory predicts that the dorsal nasal may occur in epenthesis, because it shares place, voicing, and sonorancy with the vowels. However, all the reported cases of dorsal nasal insertion admit alternative non-epenthetic analyses. This section considers one other case of reported [ŋ] epenthesis – from Uradhi. It is argued that this case can be analyzed as deletion, and hence it does not serve to confirm the predictions of the Splitting theory.

The data on Uradhi comes from two descriptions that pertain to slightly different dialects. I will refer to the whole dialectal group as ‘Uradhi’. Hale (1976) describes what may be called ‘Uradhi proper’ while Crowley (1983) describes three other dialects: Atampaya, Angkamuthi, and Yadhaykenu. Most data and the most detailed description is available for Atampaya Uradhi, and I will present the data from this dialect first.

The alternations of interest involve the utterance-final dorsal nasal. In what follows, I propose that these alternations can be analyzed as deletion, and briefly comment on the epenthesis analysis.

In Atampaya, utterances can only end in a limited set of segments: nasals and glides, where the utterance-final [w] stems from underlying /l/. Phonetically, the utterance final

[ŋ] is fronted after /i/, but it remains contrastive with [ɲ] which is a possible segment in Uradhi dialects. I follow Crowley (1983) in transcribing fronted dorsal nasal as [ŋʲ].

All words which end in [ŋ] utterance-finally (15a) lose their final consonant when attaching suffixes or utterance-medially (15b,c). Hiatus is typically resolved by vowel deletion. All phonetic transcriptions are given for utterance-final forms, unless otherwise noted.

(15) Atampaya Uradhi dorsal nasal alternations

a. Utterance-finally (C: 324)

/wampan/ ‘float.PRES’      [wampan] ‘is floating’

/ana-<sup>h</sup>luŋ/ ‘go.PRES-HERE’      [ana:luŋ] ‘is coming’

/a:niŋ/ ‘what.ABS’      [a:niŋʲ] ‘what’

b. Word-medially and utterance-medially before a vowel (C: 324)

/uŋjeŋ-al/ ‘eat.PRES’      [uŋjaw] (no translation given)

/matan-uðuruŋ/ ‘hand-thick’      [matuðuruŋ] ‘palm of hand’

/ipiŋ-acanaŋ/ ‘water-spring’      [ipacanaŋ] ‘spring’

/jukuŋ ana-<sup>h</sup>luŋ/ ‘tree.ABS go.PRES-HERE’      [juk ana:luŋ] ‘the tree is coming’

/uraŋ a:niŋ/ ‘this.ABS what.ABS’      [ur a:niŋʲ] ‘What is this?’

c. Word-medially and utterance-medially before a consonant (C: 324-5)

/majiŋ-wapun/ ‘fruit-ABS’      [majiwapun] ‘fruit’

(utterance-medial)

/yukuŋ wampan/ ‘tree.ABS float.PRES’      [yuku wampan] ‘the tree is floating’

Note that there are no /ŋ/-final words which would keep their final nasal utterance-medially. Thus, these alternations are better analyzed as deletion, rather than epenthesis. On the insertion analysis, we would expect that there would be words which end in [ŋ] that does not alternate with zero.

The deletion analysis also allows for a more elegant account of morphological restrictions on word shape. In all Uradhi dialects, words must end in a nasal /n ɲ ɲ ŋ/ or lateral /l/. On the insertion analysis, we would have to assume that words may underlyingly end in a vowel or all nasals, but crucially not /ŋ/.

The Angkamuthi and Yadhaykenu dialects described by Crowley (1983) provide further support for the deletion analysis. In these dialects, /ŋ/ deletion operates according to the same basic rules as in Atampaya, only it is variable utterance-finally and word-medially before a vowel. This is illustrated in (16) with data from Yadhaykenu Uradhi. The segments which can optionally be deleted are presented in parentheses

(16) Dorsal nasal deletion is variable in Yadhaykenu

/ajuŋ	atal	ja-maŋ/	[aj(uŋ) atal jama(ŋ)]
1sg.NOM	fishing_line.ABS	throw-PRES	'I am fishing'
/uraŋ	aɬumuŋ	atal/	[ur(aŋ) aɬum(uŋ) ata:]
'this.ABS	1sg.GEN.ABS	fishing_line.ABS	'This is my fishing line'

The epenthesis analysis would have to assume that Angkamuthi and Yadhaykenu differ from Atampaya Uradhi not only in variability of /ŋ/-insertion, but also, for some reason, in positions where the process happens.

The dorsal nasal is presumably deleted because it bears the marked place Dorsal, compared to all other final segments (de Lacy, 2006). Why is it preserved utterance-finally, or (in some dialects) intervocalically? The answer lies in the constraints which were observed throughout this dissertation in motivating epenthesis: FINAL-C and ONSET. Deletion of stem-final dorsal consonants in all-but-utterance-final position is also observed in Kalaallisut (with some complications, which are irrelevant here), where the process also targets uvulars (17) (see also Chapter 4 on Kalaallisut glide insertion) (Rischel, 1974; Fortescue, 1984).

(17) Kalaallisut dorsal and uvular consonants survive only utterance-finally

/qimmi(q)/	[qimmiq] 'dog'
/qimmi(q)-a/	[qimmija] 'his dog'
/inu(k)/	[inuk] 'human being'
/inu(k)-uwuq/	[inu:wuq] 'is a human'

To conclude, I have argued that a deletion analysis of [ŋ]-zero alternations in Uradhi is possible. One final caveat that should be mentioned: word-final nasals (including /ŋ/) can assimilate to a preceding oral consonant and become unreleased [t̚, k̚]. In Uradhi proper this process is obligatory and only recorded for dorsals (no data is available for coronals). In the dialects described by Crowley (1983), this assimilation process is optional.

Thus, although the Splitting theory predicts that [ŋ]-epenthesis should be possible, the patterns of Uradhi are ambiguous, and they do not necessarily confirm the predictions of the theory. A similarly ambiguous case of Apurucayali has been discussed in Chapter 8.

## 9.6 Cases with insufficient data

In the preceding sections we have seen that many phenomena may look like epenthesis, but admit an alternative analysis upon a closer look. It is thus important that the epenthetic analysis can be defended against alternative analyses such as morphological suppletion (section 9.4.1) or lexical generalization (section 9.3). However, in some cases there is not enough data to decide whether the relevant cases are true examples of epenthesis, or whether one of the alternative analyses is more appropriate. Given the

available data, it is premature to conclude that such cases support or refute the Splitting theory (or other theories of epenthesis).

For example, for Southern Tati Yar-Shater (1969) reports a possibility of “*r* as a connective element” but comments that “Further study is needed to determine the circumstances of its occurrence, which is probably fixed by usage” (Yar-Shater, 1969: 54). Clearly, it is hard to judge whether this case involves epenthesis, because the environment is not precisely defined and because the putative [r]-insertion competes with other hiatus resolution strategies. Similarly, the epenthetic [k] in Kodava (Ebert, 1996) is only supported by a handful examples, and it is hard to tell whether it represents a general alternation (cf. de Lacy & Kingston (2013) who speculate on one alternative analysis). Thus, the cases which are not supported by sufficient data cannot be used to support or refute a theory of epenthesis.

## 9.7 Conclusion

The Splitting theory makes restrictive predictions about the inventory of possible epenthetic consonants. This chapter has uncovered many cases that cannot be used to support or refute the Splitting theory. All of these cases share a common property: their analysis is ambiguous, and in many cases the non-epenthesis analysis is more plausible or the only possible one. These cases involve ‘epenthesis’ in correspondence between different grammatical systems (diachronic, cross-dialectal, between registers), non-productive lexical generalizations, morphologically prespecified segments, and deletion.

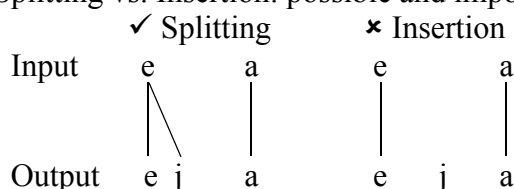
## Chapter 10. Concluding remarks

### 10.1 Summary of the Splitting theory

This dissertation advances a theory where true consonant insertion is not a possible operation. Rather, all consonants added on the surface result from splitting. In particular, the dissertation focuses on the epenthetic consonants that correspond to an underlying vowel. Within the Splitting theory, consonant epenthesis is produced by the same operation that applies in diphthongization (Hayes, 1990; Selkirk, 1990), segmental fission (Keer, 1999; Yu, 2005a) and possibly reduplication (Struijke, 2000).

The Splitting theory is cast within Optimality Theory (Prince & Smolensky, 2004). The main idea is implemented as a restriction on Gen which does not allow addition of new segments in syllable margins – instead these segments correspond to an input segment (see also Yip, 1993b; Baković, 1999; Krämer, 2008 on epenthesis as splitting). This restriction is illustrated in (1) where lines show input-output correspondence.

(1) Splitting vs. Insertion: possible and impossible operations



Within this theory, an ‘epenthetic consonant’ is a segment in the syllable margin that corresponds to a split input segment. The quality of epenthetic segments is regulated by the regular Input-Output faithfulness constraints in competition with markedness constraints. Splitting an input segment is penalized by IO-INTEGRITY (McCarthy & Prince, 1995; 1999). The epenthetic segments are required to be as similar as possible to their input by IO-IDENT constraints.

The fact that epenthetic segments have input correspondents has a profound effect on the predictions of the theory. Within the splitting theory, the markedness constraints can only affect epenthetic consonants if they dominate the IDENT constraints, and this ranking is predicted to have other effects within the same language. For example, insertion of segments which are [+consonantal] is only predicted to occur in the environments where positional markedness blocks the occurrence of [–consonantal] approximants, or in grammars where the inventory constraints rule out [–consonantal] segments altogether.

The account proposed here also relies on several concrete assumptions about features. First, glides and laryngeals are of dual nature: both *consonantal* and *vocalic* versions of these segments occur across languages, and may coexist within the same language (Levi, 2004, 2008). Second, the epenthetic laryngeals are approximants, i.e. [–consonantal, +sonorant] (Chomsky & Halle, 1968; Hume & Odden, 1996; Ladefoged & Maddieson, 1996). The laryngeal consonants are compatible with any tongue position feature specification. Laryngeal approximants that result from splitting a vowel keep the tongue position features of their input vowel. Finally, vowels and vocalic glides all have the place specification Dorsal (Halle, 1995; Halle *et al.*, 2000; Flynn, 2004).

## 10.2 Summary of predictions and results

The Splitting theory identifies the typological relations between epenthetic patterns based on how faithful these patterns are. The most faithful possible epenthesis pattern involves splitting high vowels to yield featurally identical high glides, e.g. /i<sub>1</sub>a<sub>2</sub>/ → [i<sub>1</sub>j<sub>1</sub>a<sub>2</sub>]. This pattern, exemplified in Faroese (Chapters 1-2), violates INTEGRITY but does not violate any IDENT constraints because the margin glides are featurally identical to their input correspondents. This pattern is dubbed *minimal epenthesis* in Chapter 2.

There are two fundamentally different ways in which the minimal epenthesis pattern can be amended: it may be extended (generalized to other contexts), or it may be blocked. The following sections briefly review the predictions of the theory with regard to *extended patterns* and *blocking patterns*. Different kinds of patterns may of course co-occur within the same language.

### 10.2.1 Extended minimal epenthesis

Splitting theory identifies the patterns of extended minimal epenthesis as those which include the minimal pattern: such languages insert homorganic glides next to high vowels, and epenthesize some consonants next to non-high vowels. Chapter 2 argued that vocalic glides are always specified [+high –low], and therefore splitting a non-high vowel has to involve featural unfaithfulness – there are no perfectly identical margin counterparts of the non-high vowels. Therefore all extended patterns arise when a trigger constraint (e.g. ONSET, FINAL-C) ranks above some of the IDENT-feature constraints, so permitting unfaithfulness in splitting.

The Splitting theory predicts that there will be certain implicational relations between the extended patterns. These implicational relations were discussed in detail in Chapter 2. For example, if a language splits the low vowel to yield glides, it will also split the mid vowels to yield glides. Splitting a low back vowel /a/ to yield a vocalic glide like [j] violates the IDENT constraints for features [high], [low], and [back]. On the other hand, the glide [j] is featurally closer to the vowel [e] than it is to [a]. Thus, splitting /e/ to yield [j] incurs only a violation of IDENT-[high]. In general then the mapping /a<sub>1</sub>/ → [j<sub>1</sub>a<sub>1</sub>] is inherently less faithful than /e<sub>1</sub>/ → [j<sub>1</sub>e<sub>1</sub>]. Therefore, if a language includes the more unfaithful mapping /a<sub>1</sub>/ → [j<sub>1</sub>a<sub>1</sub>], it will also include the more faithful mapping /e<sub>1</sub>/ → [j<sub>1</sub>e<sub>1</sub>] (this property holds in output-driven systems, see Tesar (2008, 2014)).

Within the Splitting theory a variety of consonants may be inserted next to non-high vowels. All of these consonants arise as epenthetic because they share features with non-high vowels. The particular epenthetic consonants are selected based on the ranking of IDENT constraints and their interaction with markedness. The predictions about extended epenthesis are explored in Chapter 3. Vocalic glides share the major class features with vowels but they disagree with mid vowels in the feature [high], and with low vowels at least in [high] and [low]. Vocalic glides are inserted next to non-high vowels in Dutch (Zonneveld, 1978; Gussenhoven, 1980; Booij, 1995), Dakota (Shaw, 1980), Woleaian (Sohn, 1971, 1975; Sohn & Tawerilmang, 1976), and possibly in Tamil (Christdas, 1988; Wiltshire, 1998).

On the other hand, laryngeal approximants agree with their input vowels in height and backness features, but disagree in place. Laryngeal approximants are epenthesized next to

non-high vowels in Farsi (the dialect described by Naderi & Van Oostendorp (2011)), and in Dutch stressed syllables (Zonneveld, 1978; Booij, 1995), in Malay (Onn, 1980; Durand, 1987; Ahmad, 2001, 2005), and possibly in Guininaang (Gieser, 1970).

All the extended patterns include the minimal insertion pattern, i.e. homorganic glide epenthesis next to high vowels. The fact that homorganic glides appear in that environment shows that they are not blocked by higher-ranked inventory constraints or by positional markedness. Nevertheless, the extended patterns frequently exhibit blocking of a different kind. While glide insertion next to high vowels is not blocked altogether, it may be blocked if it creates a homorganic glide-vowel sequence like [ji, wu] (Kawasaki, 1982), or if it involves tautosyllabic splitting. The relevant patterns are called *directional blocking* here and they were considered in detail in Chapter 4. Some form of directional blocking almost always cooccurs with extended minimal epenthesis.

### 10.2.2 Segmental blocking and the inventory of epenthetic consonants

The Splitting theory predicts that the epenthetic consonant in a language will always be the most faithful out of the ones allowed by the language's ranking. Conversely a consonant that is unfaithful along some dimension can only be inserted if the more faithful option is blocked. Thus, there is no set universal inventory of epenthetic consonants, but rather the language's markedness constraints determine what is blocked, and the most faithful of the permitted consonants is epenthetic.

Two key components determine the possible epenthetic consonants: (i) faithfulness to the vowels, and the ranking of IDENT constraints and (ii) the markedness hierarchy of the language, which also determines the language's inventory.

For example, while [j] is perfectly faithful to /i/, in principle /i/ may also split to yield [ʔi], but only if [j] is prohibited in a given language across the board or in a given position. On the other hand, it is impossible for a language to insert some consonant if a more faithful consonant is also allowed by the language-particular markedness hierarchy in a given environment. Thus, we expect that the common epenthetic consonants will be those that share most features with the vowels.

The predictions of the Splitting theory were tested in a typological study of the inventory of epenthetic consonants. The range of segments that can be inserted is a subject of an ongoing debate (McCarthy & Prince, 1994; Vaux, 2001; Lombardi, 2002; Flynn, 2004; de Lacy, 2006; Rice, 2008, 2007; Blevins, 2008; Hume, 2011; Morley, 2012, 2013; de Lacy & Kingston, 2013). For that reason, this dissertation aims to single out the clear and unambiguous cases of epenthesis. The present typological survey focuses on detailed analysis of possible cases of epenthesis, and particular attention is paid to the possible alternative analyses. Because of this deep study approach, it appeared impractical to cover all reported examples of epenthetic segments at the appropriate level of detail. Therefore an effort was made to include in the survey as many examples for each possible epenthetic segment as possible, and specifically to include the cases which appeared to be the most robust for each segment. The resulting sample of 49 languages with reported epenthesis is presented in Appendix B. This sample excludes the cases of epenthesis which were clearly only diachronic (see Chapter 9 for some discussion). In addition, the cases of minimality epenthesis and postnasal hardening were not included in the main sample, see Chapters 9 section 10.4 below.

Although the range of reported epenthetic consonants is quite big, many of the relevant cases were found to admit an alternative analysis. The common alternatives to epenthesis are summarized and illustrated in Chapter 9.

The table in (11) summarizes the typological findings of the dissertation. Several languages in the sample have more than one pattern of epenthesis, and therefore the total number of patterns in (11) is greater than the overall number of languages studied. The last column in (11) indicates whether among the studied languages there were any patterns of epenthesis that were found to be robust against alternative analyses. Just as with other consonants, many patterns of epenthesis for glides, laryngeals and dorsals were found to admit an alternative interpretation.

(2) Summary of the survey of possible epenthetic consonants

Consonant class	Number of patterns considered	Robust patterns
glides and related fricatives [j v]	30	yes, e.g. Faroese [j w v], Washo [j]
laryngeals	22	yes, e.g. Washo [ʔ]
voiced dorsal/uvular continuants	2	yes, e.g. Mongolian
rhotic approximants	2	yes, e.g. Boston English
other rhotics (e.g. taps, trills)	3	no
nasals	6	no
laterals	1	no
voiceless stops	6	no
voiceless fricatives	2	no

The results of the typological study are consistent with the predictions of the Splitting theory. Most of the robustly attested epenthetic segments belong to the class of approximants – they share major class features with vowels. This class includes the vocalic glides [j w ɥ]. The back unrounded glide [ɯ] is not found in epenthesis in my sample, which must be an accidental gap since this segment is rare (Maddieson, 1984; Ladefoged & Maddieson, 1996). It is assumed here that epenthetic laryngeals [ɦ h ʔ] are also specified as approximants, i.e. [–consonantal,+sonorant] (Chomsky & Halle, 1968; Hume & Odden, 1996; Ladefoged & Maddieson, 1996). Furthermore laryngeals can share tongue position features like [high], [low], [back] with vowels. Laryngeal approximants are thus good candidates for epenthesis because they preserve the input



vowel's major class features and tongue position features. However, laryngeals differ from vowels in place features and laryngeal features.

The fricatives [j v] also appear as epenthetic, but in the languages of the sample their appearance correlates with a general glide-fricative alternation. Thus it appears that [j v] may be epenthetic only if the glides [j w] are blocked in the given language and context. The rhotic approximants [ɹ] and [ɻ] are also possible epenthetic segments. As argued in Chapter 3, they are inserted next to vowels for which they preserve the tongue height features.

An important prediction of the Splitting theory is that there is no universally set class of possible epenthetic segments. If a language lacks approximants of the right kind, the choice of an epenthetic consonant will depend on other faithfulness dimensions. This prediction is borne out in Washo where [j] is inserted in all vowel sequences (see Chapter 6) and in the striking epenthesis pattern of Mongolian where dorsal [g/ɣ] or uvular [G/ʁ] is inserted depending on the vocalic environment. In a detailed analysis of Mongolian in chapter 7, I argue that these segments are selected because Mongolian lacks fully faithful vocalic glides and because the dorsal/uvular consonant best preserves the input vowels' place and voicing.

Some possible epenthetic segments are featurally very distant from the vowels. For example, [t] differs from all vowels at least in the values for features [consonantal], [sonorant], [continuant], and [voice]. For such segments, the Splitting theory imposes very restricted conditions when they may be epenthetic: the relevant language would have to prohibit all segments that are more faithful to the vowel (e.g. voiced obstruents, continuants, glides). As I argue in Chapters 8-9, all reported cases of voiceless obstruent epenthesis admit an alternative analysis. If the Splitting theory is correct, this alternative analysis has to be the right one.

Finally, the Splitting theory imposes somewhat less stringent restrictions on the insertion of sonorants. For example [ŋ] or [ɭ] may be selected as epenthetic because these segments share the value for [sonorant] and [place] with vowels. However, there are no clear, unambiguous cases of dorsal nasal or dorsal lateral epenthesis in my sample. Thus, it would be premature to claim that this prediction of the Splitting theory is borne out.

To summarize, the predictions of the Splitting theory are borne out in several aspects of the inventory of the attested epenthetic consonants. First, next to non-high vowels fully identical glides are unavailable and the inserted consonants are often those which are specified [-high]. This is the case for laryngeal approximants and for rhotics in English dialects (see Chapter 3). Second, the vast majority of epenthetic segments preserves the major class features of the input vowels, i.e. they are [-consonantal +sonorant] (see Chapters 3 – 6). Non-approximant epenthetic segments arise precisely in the languages where vocalic approximants are blocked – this is the case in Mongolian, discussed in Chapter 7. Finally, voiceless obstruent epenthesis is highly restricted under the Splitting approach, and none of the languages in my sample presents a clear example of voiceless obstruent epenthesis.

### 10.2.3 Epenthetic segments, the inventory, and other processes

Within the Splitting theory, epenthetic mappings are regulated by IO faithfulness constraints. As a result, the ranking conditions on epenthesis have consequences for the input-output mappings in the language as a whole. Conversely, if a language has a particular process that applies to margin vowels, then this process is expected to affect the epenthetic consonants, because they are margin vowels.

Based on this general property, the Splitting theory makes clear predictions about epenthesis and the language-particular inventory. First, the epenthetic consonants should generally be part of the language-specific inventory. The only possible departure from this situation arises because of positional constraints which prefer certain segments or certain mappings in certain positions. For example, in Chapters 5 it was proposed that the constraint V-NUC may lead to a situation where vocalic glides only appear in the environment where they are epenthetic. This situation is attested in Madurese. In Chapter 6, the positional constraints LAR-EDGE were shown to be able to create a situation where laryngeals only occur at prosodic edges, precisely the environment where they are epenthetic.

The Splitting theory also makes restrictive predictions about the interactions between epenthesis and other processes. In particular, the epenthetic consonants are subject only to processes and restrictions that are otherwise active in a given language. On the other hand, we do not expect the epenthetic consonants to show emergent markedness effects – i.e. the effects of universal markedness which are not otherwise observable in the language as a whole (McCarthy & Prince, 1994; Lombardi, 2002; de Lacy, 2006). Chapter 2 argued that this prediction of the Splitting theory is correct. While there are cases where the general alternations of the language also affect epenthetic consonants, there are no clear cases where the epenthetic consonants show emergent markedness effects.

### 10.2.4 Summary

Within the Splitting theory, the patterns of epenthesis can be classified by the way they extend or block the minimal insertion pattern. This dissertation has investigated the predictions of the theory with regard to the possible extended patterns. In these patterns, the Splitting theory predicts certain implicational relationships based on faithfulness asymmetries. In general, all extended patterns involve a competition between different epenthetic options next to non-high vowels. As I argue in Chapter 3, all such options share features with non-high vowels.

The Splitting theory does not provide a universal inventory of possible epenthetic consonants. However, the conditions on insertion of different consonants are different. The most likely epenthetic consonants are those which are very similar to the vowels – glides, laryngeals, and approximants in general are particularly good candidates. From the point of view of Splitting, it is not surprising that the approximant consonants [j w ʋ ? h fi ɹ] are attested in epenthesis. Other consonants may occur as epenthetic if the fully faithful vocalic glides are blocked – this prediction is borne out in Mongolian where the inserted [g/G] arise in the absence of vocalic glides. Finally, some consonants such as voiceless obstruent stops may occur in epenthesis only under very restricted and

practically unachievable circumstances – thus all reported cases of epenthesis of [t] or [k] have been shown to admit an alternative analysis.

Finally, the Splitting theory predicts that the epenthetic consonants should only be subject to the general processes and restrictions of the language, and should not show the emergent markedness effects. Based on this, the theory defines a restricted set of circumstances where some consonants only occur in an environment where they are epenthetic. All such cases have to be due to the activity of positional constraints.

### 10.3 Theory Comparison

This section summarizes the differences between Splitting and other theories of epenthesis. There are two main kinds of other theories. First, section 10.3.1 considers theories where the only restrictions on epenthesis come from its diachronic development – the *diachronic theories* (Vaux, 2001; Blevins, 2008; Morley, 2011, 2012, 2013). Section 10.3.2 is devoted to the theories which admit grammatical restrictions on epenthesis but which crucially allow Insertion as a possible operation – these are the Insertion theories (McCarthy & Prince, 1993b, 1994; Rubach, 2000, 2002; Lombardi, 2002; Kawahara, 2003; Flynn, 2004; Prince & Smolensky, 2004; de Lacy, 2006; Uffmann, 2007a; b; Naderi & van Oostendorp, 2011). The Splitting theory differs from both kinds of theories in that it is more restrictive. Consequently, the restrictions found in the typology of epenthesis support Splitting over other theories.

#### 10.3.1 Diachronic theories

Within the diachronic theories, the explanatory burden lies on language transmission and change. The predictions of diachronic theories with regard to consonant epenthesis are also discussed in detail by de Lacy & Kingston (2013); the predictions for other kinds of processes are discussed by Bermúdez-Otero & Hogg (2003); Bermúdez-Otero (2006); Bermúdez-Otero & Börjars (2006); Kiparsky (2006, 2008); Zuraw (2007). Within the diachronic theories, it is expected that the frequent cases of epenthesis have a *natural history* (Blevins, 2008): they arise due to a common pattern of misperception or misarticulation. However, there are also *unnatural histories* which for epenthesis patterns. One unnatural history involves generalizing a natural insertion pattern to the environments where it is not natural (Morley, 2011, 2012). Another possible unnatural history for epenthesis involves reinterpreting a deletion pattern as insertion – this diachronic path has often been referred to as *rule inversion* or *hypercorrection* (Venneman, 1972; McCarthy, 1991; van Oostendorp, 2000; Vaux, 2001; Blevins, 2008; Morley, 2012).

Blevins (2008) identifies a natural history for a common pattern of glide insertion – this pattern frequently arises through diachronic reinterpretation of formant transitions between vowels. Indeed glides are perceptually similar to vocalic transitions (Lieberman *et al.*, 1956; O'Connor *et al.*, 1957). Based on this natural history, we would expect to frequently find a pattern where glides are inserted next to homorganic high or mid vowels to which they are acoustically similar. However, in most cases of homorganic glide insertion, the natural pattern coexists with insertion of some consonants, such as glides or laryngeals, next to low vowels. It is not clear how the natural history for glide insertion could account for this generalization – there is no clear evidence that formant transitions involving low vowels are similar to laryngeals or to glides (cf. Brunner & Zygis, 2011;

Moisik, 2013). Thus if common epenthesis patterns arose through reinterpretation of formant transitions, it is not clear why epenthesis next to low vowels is so common, and why it almost always coexists with glide insertion next to high and mid vowels.

The unnatural diachronic histories of epenthesis lead us to expect a number of patterns that we do not find. For example, the pattern of homorganic glide insertion may be analogically extended so that [j] is inserted in all vocalic sequences (Morley, 2012) – this is the case in Turkish (Underhill, 1976; Goksel & Kerslake, 2005), Washo (Kroeber, 1907; Jacobsen, 1964, 1996; Midtlyng, 2005), and Ait Seghrouchen Berber (Guerssel, 1986). However, from the point of view of analogical extension, both [j]-insertion and [w]-insertion should be about equally likely generalized. And yet, [w]-insertion is never generalized in the same way as [j]-insertion: no language in my sample inserts [w] between any two vowels (Chapter 6). For the diachronic theories, it is a mystery why one glide is generalized, but the other is not. Finally, if rule inversion is a common diachronic source of epenthesis, we expect that the typology of epenthetic consonants should approximate the typology of consonants that are deleted (Vaux, 2001). A detailed comparison remains to be undertaken, but the results of the present typological study suggest that the epenthetic inventory is very restricted.

### 10.3.2 Synchronic Insertion theories

Insertion theories share two premises: (1) there are non-trivial synchronic grammatical restrictions on epenthesis, and (2) true insertion is allowed. OT Insertion theories are particularly interesting because they highlight crucial properties of the Splitting theory.

All OT Insertion theories can be analyzed as involving two crucial components. First, in all such theories the output of epenthesis is affected by general universal markedness constraints (McCarthy & Prince, 1994; Lombardi, 2002; de Lacy, 2006; Rice, 2007). Second, all Insertion theories have a syntagmatic similarity component; this results in epenthetic segments having the same features as nearby segments. Such similarity may be encoded as DEP-feature constraints (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011), OO-faithfulness (Kitto & de Lacy, 1999), or Consonant-to-Vowel AGREE constraints (de Lacy, 2006).

### 10.3.3 The general markedness component

The predictions of the markedness component are fully visible when general markedness constraints outrank the similarity constraints. In such a situation, OT Insertion theories predict that epenthetic consonants will be the optimal ones along some markedness dimension. For example, all Insertion theories predict that [t] should be epenthetic because of its unmarked values for Place, continuancy, and laryngeal features. This prediction contrasts markedly with the Splitting theory, which places severe restrictions on [t] epenthesis. This dissertation has argued that all reported cases of [t]-epenthesis admit an alternative, non-epenthetic interpretation (Chapters 8 – 9).

Within the Insertion theories, IO-IDENT constraints are irrelevant to epenthetic quality, and therefore general markedness constraints may affect epenthetic consonants even if their effects are invisible in the language as a whole (McCarthy & Prince, 1994). This prediction is also different from the Splitting theory where IO-IDENT constraints are relevant to epenthesis. In Chapter 2, I have shown that the emergent markedness effects

predict that intervocalic epenthesis of [d] should be possible as an emergent effect of intervocalic voicing.

### 10.3.4 The similarity component

The similarity component of Insertion theories shows its effects when similarity constraints outrank general markedness constraints, or are interleaved with them. The similarity component has to be invoked to derive the features of epenthetic segments which are clearly marked, e.g. [Dorsal], [+continuant] or [+voice]. The similarity component yields predictions about epenthesis which are very similar to the predictions of the Splitting theory. However, these predictions are achieved via very different mechanisms, and consequently the Insertion theories yield implications which are very different from the Splitting theory.

The constraints involved in the similarity component all serve the same goal – enforcing the similarity between an output consonant and its neighboring vowel. Consequently, all of these constraints predict that the consonant-to-vowel assimilation pressures should also be applicable to non-epenthetic consonants. While this consequence is apparent for AGREE constraints that de Lacy (2006) uses to regulate epenthetic quality, it is perhaps less trivially obvious for DEP-feature constraints (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011) and for OO-correspondence constraints (Kitto & de Lacy, 1999). Within the DEP-feature theory, the spreading processes which apply to epenthetic segments will also apply if some language has an underlying segment unspecified for a particular feature. For example, if Mongolian epenthetic [g/G] gets its voicing via spreading from a neighboring vowel, we also expect to find a language where the same spreading process would apply to a segment which is underlyingly unspecified for voice.

Finally, for Kitto & de Lacy (1999), epenthetic elements are in a special correspondent relationship with other output segments. However, as argued by Rose & Walker (2004 et seq), such a relationship can hold between non-epenthetic segments as well. Therefore the same surface-correspondence faithfulness constraints that apply to epenthetic segments will also apply to non-epenthetic output consonants that happen to correspond.

To summarize, the similarity mechanisms invoked by the Insertion theories yield implications for consonant-to-vowel assimilation processes. For example, the analysis of Kalaallisut disharmonic glide insertion requires that consonants agree to vowels in major class features without also agreeing in place or tongue position (see Chapter 4). Similarly, the analysis of Mongolian requires that consonants agree to vowels in place and voicing (as discussed in Chapter 7). It remains to be seen whether all relevant consonant-to-vowel assimilation processes are indeed attested.

The burden of finding such assimilation processes is unique to the Insertion theories. Within the Splitting theory the similarity requirements on epenthetic consonants do not yield such implications. The similarity requirements are encoded as IO faithfulness – i.e. the epenthetic consonants are required to be faithful to the input, rather than similar to some output segment. Hence the splitting mapping does not bear on possible consonant-vowel assimilation mappings, as the markedness constraints involved in epenthesis cannot motivate consonant-to-vowel assimilation.

This should not be taken to imply that assimilation constraints do not affect the quality of epenthetic segments within the Splitting theory. Of course, if a language has a general harmony/assimilation process it will have effects on epenthetic quality – this is indeed the case in Mongolian. However, within the Splitting theory there are no *emergent* assimilation effects on inserted consonants, because there are no emergent effects at all.

In both Insertion and Splitting theories, the similarity-enforcing constraints interact with general markedness constraints. However, the Splitting theory is more restrictive because it identifies the similarity constraints with IO-faithfulness constraints in the general case. The interaction between similarity and markedness is illustrated well with the analysis of Madurese epenthesis. Madurese has homorganic glide insertion after high and mid vowels, i.e. /ia/ → [ija]; /ɔa/ → [ɔwa]. However, all sequences of identical vowels are repaired by inserting a glottal stop rather than a glide, i.e. /εε/ → [εʔε], \*[εjε], \*[εwε].

Within the Insertion theories, the glottal stop is epenthesized because of its unmarked features whereas homorganic glide insertion stems from emergent assimilation requirements. A challenge for these theories is to explain why assimilation constraints have no force in sequences of identical vowels, and vice versa – why markedness constraints that select glottal stop do not select it with non-identical vowels. Finally, the markedness constraints also have to block disharmonic glides, e.g. [j] insertion is ungrammatical both in /ua/ and in /ɔɔ/.

The Splitting account is radically different. All epenthetic consonants share some features with the vowels, including the glottal approximant. The vowel that splits is always required to preserve its backness features, and epenthetic [ʔ] satisfies this requirement by being front next to front vowels and back next to back vowels. However, the homorganic glides have to be blocked from appearing in identical vowel sequences – this effect is attributed to the constraint against sequences [ji je wu wo] in Chapter 5.


To summarize, in the Insertion theories the epenthetic glottal stop and the epenthetic glides in Madurese have to be derived by completely different mechanisms. On the other hand, within the Splitting theory all epenthetic consonants stem from the same general pattern of interaction between IDENT and markedness.

To complete the discussion of similarity mechanisms within the Insertion theories, it is worth pointing out some predictions which are specific to particular similarity mechanisms. Kawahara (2007) shows that the surface correspondence theory (Kitto & de Lacy, 1999) makes unfavorable predictions with regard to epenthesis. Surface correspondence can hold between non-adjacent segments, predicting cases where inserted consonants or vowels will get their quality from some unmarked segment within the same word. However, the epenthetic segments always get their quality from an immediate neighbor, and echo-epenthetic vowels always copy the nearest vowel (Kawahara, 2007).

Similarly, DEP-feature constraints may in principle override the effects of markedness predicting marked epenthetic values. The existing analyses of concrete languages usually rely on DEP referring to the place node, or to the vocalic tongue position features (Rubach, 2000; Kawahara, 2003; Uffmann, 2007a; Naderi & van Oostendorp, 2011). However, there are no known restrictions on what features the DEP constraints can refer to. Take, for instance, DEP-feature constraints on the individual place features. If we had

something like DEP-Coronal, DEP-Dorsal and DEP-Labial, the ranking of these constraints would predict that consonants of any place of articulation can be epenthetic. This is illustrated in (3) with a hypothetical pattern of [p] epenthesis. Of course, in order to derive this pattern, the DEP-feature constraints have to dominate any markedness constraints that disprefer labial segments, such as  $\ast\{\text{Dorsal, Labial}\}$  of de Lacy (2006). Homorganic glide epenthesis, i.e. insertion of a placeless segment with spreading must be ruled out by a constraint against spreading,  $\ast\text{MULT-LINK}$  (Rubach, 2000; Davidson & Erker, 2014).

(3) Dep constraints on particular place features derive labial epenthesis

/tia/	DEP-Cor	DEP-Glot	$\ast\text{MULT-LINK}$	DEP-Lab	$\ast\{\text{Dor, Lab}\}$	$\ast\{\text{Dor, Lab, Cor}\}$
 tipa				1	1	1
tita	W1			L	L	1
tiʔa		W1		L	L	L
tija			W1	L	L	L
tiha		W1		L	L	L

### 10.3.5 Summary

The Splitting theory differs from other theories of epenthesis mainly in its restrictiveness. The diachronic theories (Vaux, 2001; Blevins, 2004, 2008; Morley, 2011, 2012) predict that both epenthetic [j] and [w] can be generalized to all V\_V environments, while only [j] epenthesis across-the-board is found. Similarly, the diachronic theories predict that any deletion pattern can in principle be reanalyzed as epenthesis.

The synchronic Insertion theories involve two relatively independent components – general markedness and similarity (McCarthy & Prince, 1993b, 1994; Rubach, 2000, 2002; Lombardi, 2002; Kawahara, 2003; Flynn, 2004; Prince & Smolensky, 2004; de Lacy, 2006; Uffmann, 2007a; b; Naderi & van Oostendorp, 2011). The markedness component of the Insertion theories is responsible for the emergent markedness effects.<sup>1</sup> The similarity mechanisms employed in such theories have implications for the possible consonant-to-vowel assimilation processes. Such implications are absent in the Splitting theory.

## 10.4 Further implications of splitting and directions for the future

The splitting theory makes predictions that go beyond the typology of consonant insertion. In this section, these predictions are briefly summarized, and some directions

<sup>1</sup> The absence of emergent markedness effects within the Splitting theory depends on a particular formulation of the IDENT constraints. For example, if IDENT constraints only required that any input feature has one identical correspondent in the output (e.g. the *existential* IDENT of Struijke (2000)), such constraints could lead to emergent markedness effects even within the Splitting theory. Thus, if an input vowel splits in a  $V_i \rightarrow V_i C_i$  mapping, and the vocalic counterpart is identical to the input, the consonantal counterpart is free of the IDENT requirements, and hence its quality can be regulated solely by markedness. Unlike the universal IDENT constraints used in the dissertation, the existential IDENT constraints also predict that the different features of the input may be preserved in its different correspondents in the output.

for future research are suggested. In this dissertation, I have looked at the cases where a vowel splits into an adjacent margin position. However, splitting may target both underlying vowels and consonants, and both nucleus and margin positions. This is summarized in (4).

(4) Splitting and syllable structure

Output position Input specification	Nucleus	Margin
C	(?)	‘NT effects’ gemination
V	diphthongization echo epenthesis	epenthesis

One phenomenon that the Splitting theory can be extended to involves the so-called echo epenthesis of vowels. In echo epenthesis an inserted vowel takes on a quality from a vowel in a different syllable (Hall, 2003, 2006), and the restrictions on this process are largely parallel to the restrictions on consonant epenthesis. If echo epenthesis involves splitting, the relevant splitting operation has to be non-local, i.e.  $/V_iCCV_j/ \rightarrow [V_iCV_iCV_j]$ .

Apart from echo epenthesis of vowels, there are also reported cases of so-called *default vowel* insertion (Broselow, 1982; Itô, 1989; Lombardi, 2003; de Lacy, 2006; Uffmann, 2007b). Thus, Hall (2011) proposes that vowel epenthesis is not a uniform phenomenon, but in fact is a cover term for two different processes: echo vowel insertion and default vowel insertion. The splitting theory assigns precise formal sense to the difference between these two processes. While echo epenthesis can be derived from splitting, default vowel insertion is analyzed more straightforwardly with true insertion and DEP, since the quality of the output segment is not context-dependent. It is therefore expected that the typology of default vowel insertion will be substantially different from echo vowel insertion.

Another kind of a splitting pattern is splitting a consonant into a nucleus position. No clear examples of this pattern are known to me, but there could be a principled restriction in Gen, whereby the range of possible operations is different, depending on the structural position that these operations are targeting.<sup>2</sup> If splitting an input consonant into a nucleus position is indeed unavailable, this would mean that splitting into a nucleus always has to be non-local, that is a vowel has to split over an intervening consonant. Thus an epenthetic nucleus cannot be achieved via local splitting, and this is why true insertion may be available with nuclei but not with margins.

Vowels can also split locally, within the same syllable:  $CV_i \rightarrow CV_iV_i$ . The surface result of this classical case of splitting is diphthongization (Hayes, 1990; Selkirk, 1990). Local splitting of consonants into a margin is also attested. The process may be driven by the requirement for stressed syllables to be heavy, in which case it has been classified as a kind of fortition (Bye & de Lacy, 2008). Some of the so-called ‘NT effects’ whereby a stop appears between a nasal and an obstruent may also be subject to a splitting analysis

<sup>2</sup> This is not an unprecedented assumption in grammatical theory. For example, in syntax it is commonly assumed that the operation of inserting expletives is limited to the subject position (Chomsky, 1982).



(Clements, 1987; Padgett, 1991, 1994; Steriade, 1993; Warner, 2002; Halpert, 2008). However, many of these cases appear to show incomplete neutralization and bear other signs of being low-level phonetic effects (Fourakis & Port, 1986; Ohala, 1997; Warner & Weber, 2001; Recasens, 2012). It remains to be seen if the ‘NT effects’ can be treated on a par with phonological epenthesis.

To conclude, Splitting Theory provides a new and restrictive way of analyzing consonant epenthesis. The same basic phonological operation is independently necessary, and is potentially applicable in other domains.

## *Appendix A. Formal basis of the Splitting theory*

### **I. Gen**

Within the Splitting theory, Gen does not have a true insertion operation that would target nucleus positions. In other words, mappings of the following shape are impossible  $/\alpha_i\beta_j/ \rightarrow [\alpha_i\gamma_i\beta_j]$  where  $[\gamma]$  is in a syllable margin and does not have an input correspondent. While the constraints and featural assumptions may allow for some variation, this assumption about Gen is essential to the Splitting theory.

### **II. Con**

Formulations of the constraints which are operative within the Splitting theory.

#### **c. Faithfulness constraints**

- (1) IDENT-*F*: let  $\alpha$  be a segment in the input and  $\beta$  be a correspondent of  $\alpha$  in the output. Assign a violation if  $\alpha$  is  $[\gamma F]$ , and  $\beta$  is not  $[\gamma F]$ .
- (2) INTEGRITY: assign a violation for every input segment that has multiple correspondents in the output
- (3) MAX-C: assign a violation for every input consonant that does not have a correspondent in the output
- (4) MAX-V: assign a violation for every input vowel that does not have a correspondent in the output
- (5) MAX-INIT: assign a violation for every word-initial input segment that does not have a correspondent in the output
- (6) Max-C{*F-Place*}: assign a violation mark for every segment S such that S is specified for a place feature belonging to {*F-Place*} and S has no correspondent in the output
- (7) Max-C{*F-Cont*}: assign a violation mark for every segment S such that S is specified for the value of [continuant] belonging to {*F-Cont*} and S has no correspondent in the output
- (8) UNIFORMITY: assign a violation for every output segment that has multiple correspondents in the input
- (9) DEP-V: assign a violation for every output segment in a syllable nucleus that does not have a correspondent in the input
- (10) INITIAL-INTegrity: assign a violation for every word-initial input segment that has multiple correspondents in the output

- (11) ROOT-INTEGRITY: assign a violation mark for every segment in a root which has multiple correspondents in the output
- (12) T(AUTOSYLLABIC) INTEGRITY: assign a violation mark for any input segment which has multiple output correspondents within the same syllable
- (13) MAX- $\mu$ : assign a violation for each input mora which does not have a correspondent in the output
- (14) DEP- $\mu$ : assign a violation for each output mora which does not have a correspondent in the input
- (15) V-NUC: assign a violation mark for every input vowel which does not have a correspondent in a syllable nucleus
- (16) V<sub>core</sub>-NUC: assign a violation for an input vowel / $\alpha$ / which does not have a correspondent in a syllable nucleus
- (17)  $\mu$ -Anchor-R: the rightmost input mora must have a correspondent which is the rightmost output mora

**d. Markedness constraints**

- (18) ONSET: assign a violation for every syllable that does not start with an onset
- (19) ONSET-PCAT(C): assign a violation for every prosodic category *C* whose first syllable does not start with an onset
- (20) STRESS-TO-WEIGHT: assign a violation for every stressed syllable that is not heavy
- (21) FT-BIN: assign a violation for every foot that is not binary at the moraic or syllabic level
- (22) FINAL-C: assign a violation for a prosodic word which does not end in a consonant
- (23) CODACOND: assign a violation for a coda consonant that does not share place with an onset consonant
- (24) OCP-V: assign a violation for a sequence of two adjacent nuclei which are identical
- (25) \*LONG: assign a violation for each long vowel
- (26) \*OVERLONG: assign a violation mark for each trimoraic vowel
- (27) \*DIPH(THONG): assign a violation for every diphthong

- (28) \*HiBKUNRND: assign a violation for every vocalic segment that is [+low –high +back -round]
- (29) \*ji/wu: assign a violation mark for every margin-nucleus sequence of two segments which are identical in all features
- (30) \*ji/je/wu/wo: assign a violation mark for every margin-nucleus sequence of two segments which are identical in all features except feature [high]
- (31) \*MAR/V: assign a violation for every [–consonantal] segment which occurs in a syllable margin
- (32) \*LAR: assign a violation mark for any segment whose major place of articulation is glottal
- (33) \*[constricted glottis] (\*[cg]): assign a violation for every segment that has the feature [constricted glottis]
- (34) \*[spread glottis] (\*[cg]): assign a violation for every segment that has the feature [spread glottis]
- (35) LAR-EDGE(*C*,*E*): assign a violation mark for any vocalic segment  $\alpha$  which has modal voicing and occurs at an edge *E* (R or L) of a prosodic constituent *C*
- (36) \*ONS-u: assign a violation for every instance of [u] which occurs in the onset
- (37) \*SPREAD(*F*): assign a violation for every segment that is a source of a feature *F* spreading its value

#### **e. Morphological constraints**

These constraints (mainly relevant to the analysis of Apurucayali) mention morphological constituents or processes. Splitting does not presuppose a particular theory of morphology-phonology interface, but for illustration I adopt the Prosodic Morphology of McCarthy & Prince (1986, 1993b) and morphologically-indexed constraints (Pater 2000, 2006).

- (38) SFX-TO-PRWD: the base of suffixation is a prosodic word
- (39) FINAL-C<sub>VB</sub>: assign a violation for a prosodic word which is morphologically a verb which does not end in a consonant

#### **f. Descriptive constraints**

These constraints are used here merely for an illustration, and are not intended as a serious theory of the relevant phenomena



v	+	-	+	-	L	-	-	-	-	-	+	-	-	+	+
v	-	+	+	-	L	-	-	-	-	-	+	-	-	+	+
$\theta$	+	-	+	-	C	-	-	-	-	-	-	-	-	-	-
$\delta$	+	-	+	-	C	-	-	-	-	-	+	-	-	-	-
s	+	-	+	+	C	-	-	-	-	-	-	-	-	-	-
z	+	-	+	+	C	-	-	-	-	-	+	-	-	-	-
x	+	-	+	-	D	-	-	-	-	-	-	-	-	-	-
y	+	-	+	-	D	-	-	-	-	-	+	-	-	-	-
t	+	+	+	-	C	+	-	-	-	-	-	-	-	-	-
k	+	+	+	-	C	+	-	-	-	-	+	-	-	-	-
?	-	+	+	-	G	-	-	-	-	+	-				-
h	-	+	+	-	G	-	-	-	+	-	-				-
$\hat{h}$	-	+	+	-	G	-	-	-	+	-	+				-
$j_c$	+	+	+	-	C	-	-	-	-	-	+	+	-	-	-
$w_c$	+	+	+	-	L	-	-	-	-	-	+	+	-	+	+
$\gamma_c$	+	-	-	-	G	-	-	-	-	+	-	-	-	-	-
$h_c$	+	-	+	-	G	-	-	-	+	-	-	-	-	-	-
$\hat{h}_c$	+	-	+	-	G	-	-	-	+	-	+	-	-	-	-

## *Appendix B. Cross-linguistic survey of consonant epenthesis*

The following table gives a brief characterization of each potential case of consonant epenthesis analyzed for the dissertation. For a detailed characterization of the criteria applied to each case see Chapter 9. The table only lists the primary sources of data that were consulted. The relevant secondary sources on each language are listed in the text as appropriate. Some languages were investigated with native speakers – 'elicitation' appears as a source for those.

<b>Language</b>	<b>C's</b>	<b>References</b>	<b>Comments/caveats</b>
Ajyíninka Apurucayali (a.k.a. Axininca Campa)	t	Payne (1981); Payne et al. (1982)	deletion analysis possible (see Chapter 8)
Anejoñ	ʔ, r	Lynch (2000); Lynch & Tepahae (2001)	[r] – linking element in compounds
Ao, Chungli dialect	j w	Gowda (1975)	Little data. Could be an example of heterosyllabic splitting
Atayal (Mabalay)	ʔ	Lambert (1999)	
Berber, Ait Seghrouchen	j	Guerssel (1986)	
Bulgarian	ʔ	Rubach (2000)	no alternations, historic loans only
Buriat	g/ɣ/G/ɤ	Poppe (1960); Sanžeev et al. (1962)	debated, alternations unknown for many relevant affixes
Cantonese	ʔ j w ŋ	Hashimoto (1972); Yip (1993a,b)	For ʔ and ŋ - possibly a non- productive lexical generalization
Carrier	j w h	Prunet (1990)	loans only, dorsal alternant for [w] in some contexts
Chamicuro	w	Parker (1989, 1991, 1994, 1995, 2001, 2010)	Evidence from one personal prefix, could be morphologized

Cuzco Quechua	? h	Rowe (1950); Cushihumán (1976); Carenko (1975); Parker & Weber (1996)	no alternations, but supported by evidence from loans and novel words
Czech	? v	Kučera (1961); Janda & Townsend (2000); Rubach (2000); elicitations	little evidence from alternations; confounded by different dialects/sociolects and code-switching
Dakota	j w	Shaw (1980)	
Dutch	? ɥ j w n	Zonneveld (1978); Gussenhoven (1980); Booij (1995, 1996); van de Velde & van Hout (1998, 2000); van Oostendorp (2001; p.c.); Nazarov (2009)	Variation in the inserted glide after front rounded vowels. Reported 'epenthetic [n]' is morphosyntactically restricted
English (certain non- rhotic dialects, e.g. Boston, RP)	? j w ɹ	see Chapter 3, section 4	
English (Bristol; certain dialects in the US)	? j w l	see Chapter 3, section 4	insufficient data on [l]-insertion
Faroese	j w v	Lockwood (1955); Anderson (1972); Young & Clewer (1985); Thráinsson et al. (2004); Árnason (2011)	after diphthongs – interaction with strengthening alternations known as <i>skerping</i>



Farsi	ʔ j w	Lazard (1957); Mahootian (1997); Naderi & van Oostendorp (2011); Rohany Rahbar (2012); elicitation	Dialectal variation. The dialect described by Naderi & van Oostendorp (2011) does not match the other sources
French	many	many, see Chapter 9, section 9.4.1	
German (some patterns dialectal)	ʔ n R S t	Kohler (1994); Wiese (1996); Ortmann (1998); Alber (2001); Kabak & Schiering (2006); Pompino-Marschall & Zygis (2011)	[s] and [t] are linking elements in compounds. [n] and [R] are morphosyntactically restricted
Guininaang	ʔ j w	Gieser (1970)	little data
Hawaiian	ʔ	Elbert & Pukui (1979); Pukui & Elbert (1986)	Analyzable as a linking morpheme, whose appearance is restricted by morphological and prosodic factors
Ilokano	ʔ j w	Hayes & Abad (1989)	different patterns at suffix and prefix boundaries
Indonesian	ʔ j w	Lapoliwa (1981); Cohn (1989); Cohn & McCarthy (1998)	Closely related to Malay, but the epenthesis patterns may be different, see e.g. Cohn & McCarthy 1998: fn 33.
Kaingang	ŋ	Wiesemann (1968, 1972)	fixed segment in reduplication
Kalaallisut (a.k.a. West Greenlandic Eskimo)	ʔ j j w v	Rischel (1974); Fortescue (1984)	See Chapter 4, section 4.2.6
Karo Batak	ʔ j w	Woollams (1996)	epenthesis is optional
Kod̕ava	j v k	Ebert (1996)	insufficient data
Korean	t n	Kim-Renaud (1974); Lee (1998)	linking elements in compounds

Koya	j v	Tyler (1969); Subrahmanyam (1968)	insufficient data
Madurese	? j w	Stevens (1968, 1985, 1994); Cohn (1993a, b, c); Cohn & Lockwood (1994); Davies (2010)	
Malay	? j w	Onn (1980); Durand (1987); Ahmad (2000, 2001, 2005)	Closely related to Indonesian, but the epenthesis patterns may be different, see e.g. Cohn & McCarthy 1998: fn 33.
Manipuri	j w	Bhat & Ningomba (1997)	little data
Maori	t	Hale (1973); Bauer (1993); de Lacy (2003)	Analyzable as a linking morpheme, whose appearance is restricted by morphological and prosodic factors
Mongolian	g/ɣ/G/ɣ	Sanžeev (1973); Beffa & Hamayon, (1975); Rialland & Djamouri (1984); Krylov (2004); Svantesson et al. (2005); Janhunen (2012)	
Polish (rural)	j w	Rubach (2000)	Evidence from 2 suffixes and historic loanwords
Polish (standard)	j w	Rubach (2000)	Evidence from 2 suffixes and historic loanwords
Selayarese	?	Mithun & Basri (1986); Basri (1999)	

Slovak (colloquial)	j	Rubach (2000)	Evidence from historic loanwords. Availability of alternations unclear
Spanish, Dominican	s	Terrell (1982, 1986); Morgan (1998); Bullock & Toribio (2010)	Only occurs in partially literate speakers who are trying to master the educated speech. See Chapter 9, section 9.2.1
Tamil	ʔ j w v	Subramoniam (1958); Zvelebil (1970); Schiffman (1979); Balasubramanian (1981); Christdas (1988); Wiltshire (1994); Keane (2004); Asher & Keane (2005)	Dialectal variation, the alternations appear to be more like deletion in some dialects and more like epenthesis in others
Tati, Southern dialects	j w h r	Yar-Shater (1969)	insufficient data
Trukese (a.k.a. Chuukese)	k	Goodenough & Sugita (1980)	morphologically restricted
Tunica	n h	Haas (1940)	Reported epenthetic segments can be analyzed as morphemes, see Chapter 9, section 9.4.5
Ukrainian	j	Bilodid (1969); Pugh & Press (1999)	Productivity appears questionable: evidence from historic loanwords and one suffix.
Uradhi	ŋ/k	Hale (1976); Crowley (1983)	Deletion analysis possible. See Chapter 9, section 9.5
Uyghur	j/rhotic	Hahn (1991, 1992)	Highly restricted morphologically

Washo	? j	Kroeber (1907); Jacobsen (1964, 1980, 1996); Midtlyng (2005); Yu (2005a, b; 2008a, b; 2011a, b); Washo Project [washo.uchicago.edu]	
Woleaian	j w	Sohn (1971, 1975); Sohn & Tawerilmang (1976)	

## References

- Aguilar, L. (1999). Hiatus and diphthong: Acoustic cues and speech situation differences. *Speech Communication* 28(1), 57–74.
- Ahmad, Z. (2000). There are no glides in Malay: an Optimality Theoretic account. In: Macken, M. (Ed) *Papers from the 10th annual meeting of the Southeast Asian Linguistic Society*. pp 1–21.
- Ahmad, Z. (2001). Onset satisfaction and violation in Malay: an optimality account. In: Thurgood, G. (Ed) *Proceedings of the Ninth Annual Meeting of the Southeast Asian Linguistics Society*, 2001. pp 135–160. Arizona State University, Program for Southeast Asian Studies.
- Ahmad, Z. (2005). *The phonology-morphology interface in Malay: an optimality theoretic account*. Canberra: Research School of Pacific and Asian Studies, Australian National University.
- Alber, B. (2001). Regional variation and edges: glottal stop epenthesis and dissimilation in standard and southern varieties of German. *Zeitschrift für Sprachwissenschaft* 20, 3 – 41.
- Alderete, J., Beckman, J., Benua, L., Gnanadesikan, A., McCarthy, J. J. & Urbanczyk, S. (1999). Reduplication with fixed segmentism. *Linguistic Inquiry* 30(3), 327–364.
- Anderson, S. R. (1969). *West Scandinavian vowel systems and the ordering of phonological rules*. PhD dissertation, MIT.
- Anderson, S. R. (1972). The Faroese vowel system. In: Brame, M. (Ed) *Contributions to generative phonology*. Austin: University of Austin Press.
- Anttila, A. (1997). Deriving variation from grammar. In: Hinskens, F., van Hout, R., & Wetzels, L. W. (Eds) *Variation and change in phonological theory*. pp 35–68. Amsterdam; Philadelphia: John Benjamins.
- Árnason, K. (2011). *The Phonology of Icelandic and Faroese*. Oxford University Press, USA.
- Asher, R. & Keane, E. (2005). Diphthongs in colloquial Tamil. In: Hardcastle, W. & Beck, J. (Eds) *A figure of speech. A festschrift for John Laver*. pp 147–172. Mahwah NJ, London: Lawrence Erlbaum Associates.
- Baković, E. (1999). Deletion, insertion and symmetrical identity. *Harvard Working Papers in Linguistics* 7.
- Balasubramanian, T. (1981). Duration of vowels in Tamil. *Journal of Phonetics* 9, 151 – 161.
- Basri, H. (1999). *Phonological and syntactic reflections of the morphological structure of Selayarese*. PhD dissertation, SUNY Stony Brook.
- Bauer, W. (1993). *Maori*. London; New York: Routledge.
- Beckman, J. (1998). *Positional Faithfulness*. PhD dissertation, UMass Amherst.
- Beffa, M.-L. & Hamayon, R. (1975). *Éléments de grammaire mongole*. Paris: Dunod.
- Bermúdez-Otero, R. (forthc.). *Stratal Optimality Theory*. Oxford: OUP.
- Bermúdez-Otero, R. (2006). Phonological change in Optimality Theory. In: Brown, K. (Ed) *Encyclopedia of language and linguistics*. 2nd edition., pp 497–505. Oxford: Elsevier.
- Bermúdez-Otero, R. (2014). Stratal Phonology: arguments for cyclic containment, morphological implications. Ms, University of Manchester.

- Bermúdez-Otero, R. & Börjars, K. (2006). Markedness in phonology and in syntax: the problem of grounding. *Lingua* 116, 710–756.
- Bermúdez-Otero, R. & Hogg, R. M. (2003). The actuation problem in Optimality Theory: phonologization, rule inversion, and rule loss. In: Holt, E. D. (Ed) *Optimality Theory and Language Change*. pp 91–119. Dordrecht: Kluwer.
- Bessell, N. (1993). *Towards a phonetic and phonological typology of post-velar articulation*. PhD dissertation, University of British Columbia.
- Bessell, N. & Czaykowska-Higgins, E. (1992). Interior Salish evidence for placeless laryngeals. Amherst, Mass, 1992. pp 35–49. Amherst, Mass: GLSA.
- Bhat, D. N. S. & Ningomba, M. S. (1997). *Manipuri grammar*. München: Lincom Europa.
- Bilodid, I. K. (1969). *Suchasna ukraïns'ka literaturna mova*. Kiev: Naukova Dumka.
- Black, A. (1991). The phonology of the velar glide in Axininca Campa. *Phonology* 8, 183–217.
- Blaho, S., Krämer, M. & Bye, P. (Eds.) (2007). *Freedom of analysis?* Berlin; New York: Mouton de Gruyter.
- Blevins, J. (2004). *Evolutionary phonology: the emergence of sound patterns*. Cambridge; New York: Cambridge University Press.
- Blevins, J. (2008). Consonant epenthesis: natural and unnatural histories. In: Good, J. (Ed) *Linguistic Universals and Language Change*. Oxford: OUP.
- Blumenfeld, L. (2006). *Constraints on phonological interactions*. PhD dissertation, Stanford University.
- Blumenfeld, L. (2011). Coercion and minimality. *The Linguistic Review* 28(2), 207–240.
- Blust, R. (1994). Obstruent epenthesis and the unity of phonological features. *Lingua* 93, 111–139.
- Bochnak, M. R. & Rhomieux, A. (2013). Limited Noun Incorporation in Washo. *International Journal of American Linguistics* 79(2), 253–281.
- Boersma, P. & Hayes, B. (2001). Empirical tests of the Gradual Learning Algorithm. *Linguistic Inquiry* 32, 45–86.
- Boersma, P. & Weenink, D. (2012). *Praat: doing phonetics by computer* [online]. Available from: [www.praat.org](http://www.praat.org).
- Booij, G. (1996). Cliticization as prosodic integration. The case of Dutch. *The Linguistic Review* 13, 219–242.
- Booij, G. E. (1995). *The phonology of Dutch*. Oxford: Oxford University Press.
- Boroff, M. (2007). *A landmark underspecification account of the patterning of glottal stop*. PhD dissertation, Stony Brook University.
- Bourgerie, D. (1980). *A quantitative study of sociolinguistic variation in Cantonese*. PhD dissertation, Ohio State University.
- Bradley, T. (2006). Spanish rhotics and Dominican Hypercorrect s. *Probus* 18, 1–33.
- Broadbent, J. (1991). Linking and intrusive r in English. *UCL working papers in linguistics* 3. pp 281–302.
- Broselow, E. (1982). On predicting the interaction of stress and epenthesis. *Glossa* 16(2), 115–132.
- Broselow, E. & McCarthy, J. J. (1983). A theory of internal reduplication. *The Linguistic Review* 3, 25–88.

- Brunner, J. & Zygis, M. (2011). Why do glottal stops and low vowels like each other? *Proceedings of ICPHS 17*.
- Bullock, B. E. & Toribio, A. J. (2010). Correcting the record on Dominican [s]-hypercorrection. *Romance linguistics 2009: selected papers from the 39th linguistic symposium on romance languages*. pp 15–24. Amsterdam; Philadelphia: John Benjamins.
- Burling, R. (1966). The addition of final stops in the history of Maru (Tibeto-Burman). *Language* 42, 581–586.
- Burzio, L. (2011). Derived environment effects. In: Van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell Companion to Phonology*. Malden, MA: Blackwell.
- Bybee, J. (2001a). Frequency effects on French liaison. In: Bybee, J. & Hopper, P. (Eds) *Frequency and the emergence of linguistic structure*. pp 337–359. Amsterdam: John Benjamins.
- Bybee, J. (2001b). *Phonology and language use*. Cambridge: Cambridge University Press.
- Bye, P. & de Lacy, P. (2000). Edge asymmetries in phonology and morphology. In: Kim, J.-Y. & Hirotani, M. (Eds) *Proceedings of NELS 30*. pp 121–135. Amherst, Mass: GLSA.
- Bye, P. & de Lacy, P. (2008). Metrical influences on fortition and lenition. In: Brandão de Carvalho, J., Scheer, T., & Ségéral, P. (Eds) *Lenition and Fortition*. pp 173–206. Berlin: Mouton de Gruyter.
- Calabrese, A. (1993). On palatalization processes: an inquiry about the nature of a sound change. Ms, University of Connecticut.
- Carenko, E. I. (1975). On laryngealization in Quechua. *Linguistics* 13(146), 5–14.
- Casali, R. (1998). *Resolving Hiatus*. New York: Taylor & Francis.
- Casali, R. (2011). Hiatus resolution. In: Van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell Companion to Phonology*. Malden, MA: Blackwell.
- Chitoran, I. (2002). A perception-production study of Romanian diphthongs and glide-vowel sequences. *Journal of the International Phonetic Association* 32(2), 203–222.
- Chitoran, I. (2003). Gestural timing and the glide percept in Romanian. *Proceedings of the 15th International Congress of Phonetic Sciences*. pp 3013–3016.
- Cho, Y. Y. & Inkelas, S. (1994). Major class alternations. In: Duncan, E., Farkas, D., & Spaelti, P. (Eds) *Proceedings of WCCFL 12*. Stanford: Center for the Study of Language and Information.
- Chomsky, N. (1982). *Some concepts and consequences of the theory of government and binding*. Cambridge, Mass: MIT Press.
- Chomsky, N. & Halle, M. (1968). *The Sound Pattern of English*. New York: Harper & Row.
- Christdas, P. (1988). *The phonology and morphology of Tamil*. PhD dissertation, Cornell University.
- Churchward, M. C. (1953). *Tongan grammar*. London: Oxford University Press.
- Clements, G. N. (1987). Phonological feature representation and the description of intrusive stops. *Parasession on autosegmental and metrical phonology*. Chicago: Chicago Linguistic Society.

- Clements, G. N. (1991). Place of articulation in consonants and vowels: a unified theory. *Working Papers of the Cornell Phonetics Laboratory* 5. Ithaca, NY: Cornell.
- Clements, G. N. & Hume, E. (1995). The internal organization of speech sounds. In: Goldsmith, J. (Ed) *Handbook of Phonological Theory*. Oxford: Blackwell.
- Clements, G. N. & Keyser, S. J. (1983). *CV Phonology: A Generative Theory of the Syllable*. The MIT Press.
- Cohn, A. (1993a). The status of nasalized continuants. In: Krakow, R. A. & Huffman, M. K. (Eds) *Nasals, nasalization, and the velum*. pp 329–367. Orlando: Academic Press.
- Cohn, A. C. (1989). Stress in Indonesian and bracketing paradoxes. *Natural Language and Linguistic Theory* 7(2), 167–216.
- Cohn, A. C. (1993b). Consonant-vowel interactions in Madurese: The feature lowered larynx. *Papers from the 29th Regional Meeting of the Chicago Linguistic Society*. pp 105–119.
- Cohn, A. C. (1993c). Voicing and vowel height in Madurese, a preliminary report. In: Edmondson, J. A. & Gregerson, K. J. (Eds) *Tonality in Austronesian languages*. Honolulu: University of Hawaii.
- Cohn, A. C. & Lockwood, K. (1994). A phonetic description of Madurese and its phonological implications. *Working Papers of the Cornell Phonetics Laboratory* 9. pp 67–92.
- Cohn, A. & McCarthy, J. J. (1998). Alignment and parallelism in Indonesian phonology. *Working Papers of the Cornell Phonetics Laboratory*.
- Coupe, A. R. (2007). *A grammar of Mongsen Ao*. Berlin; New York: Mouton de Gruyter.
- Crowley, T. (1983). Uradhi. In: Dixon, R. M. . & Blake, B. J. (Eds) *Handbook of Australian languages*. pp 307–428. Amsterdam: John Benjamins.
- Crowley, T. (1992). *An introduction to historical linguistics*. Second edition. Auckland: Oxford University Press.
- Cushihumán, A. (1976). *Grammática Quechua: Cuzco-Collao*. Lima, Peru: Ministerio de Educacion and Instituto de Estudios Peruanos.
- Darden, B. J. (1982). Dissimilative glide insertion in West Greenlandic. *Proceedings of CLS 11*, 1982. pp 82–86. University of Chicago Press.
- Davidson, L. & Erker, D. (2014). Hiatus resolution in American English: the case against glide insertion. *Language* 90.
- Davies, W. D. (2010). *A grammar of Madurese*. Berlin, New York: de Gruyter.
- Delattre, P. C. & Freeman, D. C. (1968). A Dialect Study of American r's by X-ray Motion Picture. *Linguistics* 44, 29–68.
- Deligiorgis, I. (1988). *Glides and syllables*. PhD dissertation, University of Iowa.
- Dilley, L., Shattuck-Hufnagel, S. & Ostendorf, M. (1996). Glottalization of Word-Initial Vowels as a Function of Prosodic Structure. *Journal of Phonetics* 24, 423–444.
- Dunn, J. A. (1979). *A reference grammar for the Coast Tsimshian language*. Ottawa: National Museum of Canada.
- Durand, J. (1987). On the phonological status of glides: The evidence from Malay. In: Anderson, J. M. & Durand, J. (Eds) *Explorations in dependency phonology*. pp 79 – 107. Dordrecht: Foris.
- Durand, M. (1936). *Le Genre grammatical en français parlé: à Paris et dans la région parisienne*. Paris: d'Artrey.



- Ebert, K. (1996). *Kodava*. Munich/Newcastle: Lincom Europa.
- Elbert, S. & Pukui, M. K. (1979). *Hawaiian grammar*. Honolulu: University of Hawaii Press.
- Encrevé, P. (1988). *La liaison avec et sans enchaînement: phonologie tridimensionnelle et usages du français*. Paris: Seuil.
- Féry, C. (2004). Liaison and syllable structure in French. Ms, University of Potsdam.
- Fitzgerald, C. M. (1997). *O'odham rhythms*. PhD dissertation, University of Arizona.
- Flack, K. (2007). *The sources of phonological markedness*. PhD dissertation, Umass Amherst.
- Flack, K. (2009). Constraints on onsets and codas of words and phrases. *Phonology* 26(02), 269–302.
- Flynn, D. (2004). Vocalic dorsality in Revised Articulator Theory. Ms, University of Calgary.
- Fortescue, M. D. (1984). *West Greenlandic*. London: Croom Helm.
- Fouché, P. (1959). *Traité de prononciation française*. Paris: Klincksieck.
- Foulkes, P. & Docherty, G. R. (2000). Another chapter in the story of /r/: 'Labiodental' variants in British English. *Journal of sociolinguistics* 4, 30–59.
- Fourakis, M. & Port, R. (1986). Stop epenthesis in English. *Journal of Phonetics* 14, 197–221.
- Garellek, M. (2012a). Glottal stops before word-initial vowels in American English: distribution and acoustic characteristics. *UCLA Working Papers in Phonetics*. pp 1–23. Los Angeles, CA.
- Garellek, M. (2012b). Word-initial glottalization and voice quality strengthening. *UCLA Working Papers in Phonetics*. pp 92–122. Los Angeles, CA.
- Garellek, M. (2013). *Production and perception of glottal stops*. PhD dissertation, UCLA.
- Garellek, M. & Keating, P. (2011). The acoustic consequences of phonation and tone interactions in Jalapa Mazatec. *Journal of the International Phonetic Association* 41(02), 185–205.
- Garrett, E. (1999). Minimal words aren't minimal feet. *UCLA Working Papers in Linguistics*, vol. 1. pp 68–105.
- Gick, B. (1999). A gesture-based account of intrusive consonants in English. *Phonology* 16, 29–54.
- Gick, B. (2002). The American intrusive l. *American Speech* 77, 167–183.
- Gick, B., Campbell, F., Oh, S. & Tamburri-Watt, L. (2006). Toward universals in the gestural organization of syllables: A cross-linguistic study of liquids. *Journal of Phonetics* 34(1), 49–72.
- Gieser, C. R. (1970). The morphophonemic system of Guininaang (Kalinga). *Philippine Journal of Linguistics* 1, 52–68.
- Gnanadesikan, A. (1997). *Phonology with ternary scales*. PhD dissertation, Umass Amherst.
- Goksel, A. & Kerslake, C. (2005). *Turkish: a comprehensive grammar*. London: Routledge.
- Goodenough, W. H. & Sugita, H. (1980). *Trukese-English dictionary*. Philadelphia: American Philosophical Society.
- Gowda, G. K. S. (1975). *Ao grammar*. Mysore: Central Institute of Indian Languages.

- Guerssel, M. (1986). Glides in Berber and Syllabicity. *Linguistic Inquiry* 17(1), 1–12.
- Gussenhoven, C. (1980). Review of Tromellen and Zonneveld (1979). *Gramma* 4, 174–183.
- Haas, M. R. (1940). Tunica. *Handbook of American Indian languages*. pp 1–143. New York: J.J. Augustin.
- De Haas, W. (1988). *A Formal Theory of Vowel Coalescence: a case study of Ancient Greek*. Dordrecht: Foris.
- Hahn, R. F. (1991). *Spoken Uyghur*. Seattle, WA: University of Washington.
- Hahn, R. F. (1992). Modern uyghur y ~ r-insertion. Nativization through analogical extension. *Acta Linguistica Hafniensia* 24, 77–96.
- Hale, K. (1973). Deep-surface canonical disparities in relation to an analysis and change: an Australian example. In: Sebeok, T. (Ed) *Current Trends in Linguistics*. The Hague: Mouton.
- Hale, K. (1976). Phonological developments in a Northern Paman language: Uradhi. In: Sutton, P. (Ed) *Languages of Cape York*. pp 41–49. Canberra: Australian Institute of Aboriginal Studies.
- Hale, M. & Reiss, C. (2000). "Substance abuse" and "dysfunctionalism": current trends in phonology. *Linguistic Inquiry* 30, 157–169.
- Hall, N. (2003). *Gestures and Segments: Vowel Intrusion as Overlap*. PhD dissertation, Umass Amherst.
- Hall, N. (2006). Cross-linguistic patterns of vowel intrusion. *Phonology* 23, 387–429.
- Hall, N. (2011). Vowel epenthesis. In: van Oostendorp, M., Ewen, C. J., & Rice, K. (Eds) *The Blackwell companion to phonology*. pp 1576–1596. Malden, MA and Oxford: Wiley-Blackwell.
- Halle, M. (1995). Feature Geometry and Feature Spreading. *Linguistic Inquiry* 26(1), 1–46.
- Halle, M. & Idsardi, W. (1997). r, hypercorrection, and the elsewhere condition. In: Roca, I. (Ed) *Derivations and constraints in phonology*. pp 331–348. Oxford: Clarendon Press.
- Halle, M., Vaux, B. & Wolfe, A. (2000). On Feature Spreading and the Representation of Place of Articulation. *Linguistic Inquiry* 31(3), 387–444.
- Halpert, C. (2008). Overlap-driven consequences of nasal place assimilation. Ms, MIT.
- Hansford, K. L. (1990). *A grammar of Chumburung. A structure-function hierarchical description of the syntax of a Ghanaian language*. PhD dissertation, SOAS, University of London.
- Harris, J. (1987). Non-structure-preserving rules in Lexical Phonology: Southeastern Bantu harmony. *Lingua* 73, 255–292.
- Harris, J. (1994). *English Sound Structure*. Oxford: Blackwell.
- Harris, J. (2002). Flaps, trills, and syllable structure in Spanish. In: Csirmaz, A., Li, Z., Nevins, A., Vaysman, O., & Wagner, M. (Eds) *Phonological Answers: MIT working papers in linguistics* 42. Cambridge, Mass: MIT Press.
- Harris, J. (2013). Wide-domain r-effects in English. *Journal of Linguistics* 49, 329–365.
- Harris, J. & Kaisse, E. M. (1999). Palatal vowels, glides, and obstruents in Argentinian Spanish. *Phonology* 16, 117–190.
- Harris, J. W. (1983). *Syllable structure and stress in Spanish: a nonlinear analysis*. Cambridge, Mass.: MIT Press.

- Hashimoto, O. Y. (1972). *Phonology of Cantonese. Studies in Yue dialects I*. Cambridge: Cambridge University Press.
- Hayes, B. (1989). Compensatory Lengthening in Moraic Phonology. *Linguistic Inquiry* 20(2), 253–306.
- Hayes, B. (1990). Diphthongization and coindexing. *Phonology* 7, 31–71.
- Hayes, B. (1995). *Metrical stress theory: principles and case studies*. Chicago: University of Chicago Press.
- Hayes, B. & Abad, M. (1989). Reduplication and syllabification in Ilokano. *Lingua* 77(3–4), 331–374.
- Herzallah, R. S. (1990). *Aspects of Palestinian Arabic phonology: a nonlinear approach*. PhD dissertation, Cornell University.
- Howe, D. & Pulleyblank, D. (2004). Harmonic scales as faithfulness. *Canadian Journal of Linguistics* 49(1), 1–49.
- Hualde, J. I. & Gaminde, I. (1998). Vowel interaction in Basque: A nearly exhaustive catalogue. *Studies in the Linguistic Sciences* 28, 41–77.
- Hualde, J. I., Simonet, M. & Torreira, F. (2008). Postlexical contraction of nonhigh vowels in Spanish. *Lingua* 118, 1906–1925.
- Hume, E. (1995). Representing the duality of glides. In: Tsoulas, G. & Nash, L. (Eds) *Actes du congrès: Langues et grammaire. Paris: Universié, Paris VIII*.
- Hume, E. (2011). Markedness. In: Van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell companion to phonology*. Malden, MA: Wiley-Blackwell.
- Hume, E. & Odden, D. (1996). Reconsidering [consonantal]. *Phonology* 13(03), 345–376.
- Hyde, B. (2002). A restrictive theory of metrical stress. *Phonology* 19, 313–359.
- Hyman, L. M. (1985). *A theory of phonological weight*. Dordrecht: Foris.
- Inkelas, S. (1989). *Prosodic constituency in the lexicon*. PhD dissertation, Stanford University.
- Inkelas, S., Orgun, C. O. & Zoll, C. (1997). The implications of lexical exceptions for the nature of grammar. In: Roca, I. (Ed) *Derivations and constraints in phonology*. pp 393–418. Oxford: Oxford University Press.
- Inkelas, S. & Zoll, C. (2007). Is grammar dependence real? A comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology. *Linguistics* 45, 133–171.
- Iosad, P. (2013). Non-contrastive epenthetic segments as surface prosodic structure. Paper presented at MPM 2013.
- Itô, J. (1986). *Syllable theory in prosodic phonology*. PhD dissertation, Umass Amherst.
- Itô, J. (1989). A prosodic theory of epenthesis. *NLLT* 7(2), 217–259.
- Itô, J. & Mester, A. (1999a). Realignment. In: Kager, R., van der Hulst, H., & Zonneveld, W. (Eds) *The prosody-morphology interface*. pp 188–217. Cambridge: CUP.
- Itô, J. & Mester, A. (1999b). The structure of the phonological lexicon. In: Tsujimura, N. (Ed) *Handbook of Japanese Linguistics*. pp 62–100. Malden, MA and Oxford: Blackwell.
- Itô, J. & Mester, A. (2003). Weak layering and word binarity. In: Honma, T., Okazaki, M., Tabata, T., & Tanaka, T. (Eds) *A new century of phonology and phonological theory: a festschrift for Professor Shosuke Haraguchi on the occasion of his sixtieth birthday*. pp 26–65. Tokyo: Kaitakusha.

- Jacobsen, W. H. (1964). *A grammar of the Washo language*. PhD dissertation, UC Berkeley.
- Jacobsen, W. H. (1980). Washo bipartite verb stems. In: Klar, K., Langdon, M., & Silver, S. (Eds) *American Indian and Indo-European studies. Papers in honor of Madison S. Beeler*. The Hague: Mouton.
- Jacobsen, W. H. (1996). *Beginning Washo*. Carson, NV: Nevada State Museum. (Nevada State Museum Occasional Papers).
- Jakobson, R., Fant, C. G. M. & Halle, M. (1951). *Preliminaries to Speech Analysis: The Distinctive Features and Their Correlates*. The MIT Press.
- Janda, L. & Townsend, C. (2000). *Czech*. Munich/Newcastle: Lincom Europa.
- Janhunen, J. A. (2012). *Mongolian*. Amsterdam; Philadelphia: John Benjamins.
- Jespersen, O. (1913). *Lehrbuch der Phonetik*. Leipzig, Berlin: Teubner.
- Jongenburger, W. & van Heuven, V. J. (1991). The distribution of (word initial) glottal stop in Dutch. In: Drijkoningen, F. & van Kemenade, M. C. (Eds) *Linguistics in the Netherlands 1991*. pp 101–110. Amsterdam: John Benjamins.
- Kabak, B. & Schiering, R. (2006). The phonology and morphology of function word contractions in German. *Journal of Comparative Germanic Linguistics* 9, 53–99.
- Kager, R. (1994). Ternary rhythm in alignment theory. Ms, Utrecht University.
- Kahn, D. (1976). *Syllable-based generalizations in English phonology*. PhD dissertation, MIT.
- Kaisse, E. M. (1985). *Connected speech: the interaction of syntax and phonology*. Orlando: Academic Press.
- Kaisse, E. M. (1992). Can [Consonantal] Spread? *Language* 68(2), 313–332.
- Karlsson, A. & Svantesson, J.-O. (2011). Preaspiration in Mongolian dialects: acoustic properties of contrastive stops. *Proceedings of the 10th Seoul International Altaistic Conference*. pp 125–140. Seoul: Sunchon National University.
- Kawahara, S. (2003). On a certain kind of hiatus resolution in Japanese. *Onin Kenkyuu* 6, 11 – 20.
- Kawahara, S. (2007). Copying and spreading in phonological theory: Evidence from echo epenthesis. In: Bateman, L. & Werle, A. (Eds) *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory III*. Amherst, Mass: GLSA.
- Kawasaki, H. (1982). *An acoustical basis for universal constraints on sound sequences*. PhD dissertation, UC Berkeley.
- Keane, E. (2004). Tamil. *Journal of the International Phonetic Association* 34(01), 111–116.
- Keer, E. (1996). Glide insertion asymmetries. Handout from a talk presented at the 15th West Coast Conference on Formal Linguistics.
- Keer, E. (1999). *Geminates, the OCP and the nature of CON*. PhD dissertation, Rutgers University.
- Kenstowicz, M. (1994). Syllabification in Chukchee: a constraint-based analysis. *Proceedings of the Formal Linguistics Society of Mid-America*. pp 160 – 181. Iowa City, Iowa: Department of Linguistics, University of Iowa.
- Kenstowicz, M. & Kisseberth, C. (1979). *Generative phonology*. San Diego, CA: Academic Press.

- Kim-Renaud, Y.-K. (1974). *Korean consonantal phonology*. Honolulu: University of Hawaii Press.
- Kiparsky, P. (forthc.). *Paradigm Effects and Opacity*. Stanford: CSLI Publications.
- Kiparsky, P. (1982). Lexical Phonology and Morphology. In: In-Seok, Y. (Ed) *Linguistics in the Morning Calm*. Seoul.
- Kiparsky, P. (1985). Some consequences of Lexical Phonology. *Phonology Yearbook 2* 85–138.
- Kiparsky, P. (2006). The Amphichronic Program vs. Evolutionary Phonology. *Theoretical Linguistics* 32, 217–236.
- Kiparsky, P. (2008). Universals constrain change; change results in typological generalizations. In: Good, J. (Ed) *Linguistic Universals and Language Change*. pp 23 – 52. Oxford: OUP.
- Kitto, C. & de Lacy, P. (1999). Correspondence and epenthetic quality. Ms, University of Toronto and UMass Amherst. Available from: ROA-337.
- Kohler, K. J. (1994). Glottal stops and glottalization in German. *Phonetica* 51, 38–51.
- Kroeber, A. L. (1907). The Washo language of East Central California and Nevada. *University of California Publications in American Archaeology and Ethnology* 4, 251 – 317.
- Krylov, S. A. (2004). *Teoreticheskaia grammatika sovremennogo mongol'skogo iazyka i smezhnye problemy obshchei lingvistiki*. Moskva: Vostochnaia Literatura.
- Krämer, M. (2008). English schwa insertion before liquids and phonological opacity. *Proceedings of CLS 41*. Chicago Linguistic Society.
- Krämer, M. (2012). *Underlying representations*. Cambridge; New York: Cambridge University Press.
- Kučera, H. (1961). *The phonology of Czech*. The Hague: Mouton.
- De Lacy, P. (2003). Maximal words and the Maori passive. In: McCarthy, J. J. (Ed) *Optimality Theory in phonology: a reader*. pp 495–512. Oxford: Blackwell.
- De Lacy, P. (2006). *Markedness: Reduction and Preservation in Phonology*. Cambridge: CUP.
- De Lacy, P. (2007). Freedom, interpretability, and the loop. In: Blaho, S., Bye, P., & Krämer, M. (Eds) *Freedom of Analysis?* pp 175–202. Berlin, New York: Mouton de Gruyter.
- De Lacy, P. & Kingston, J. (2013). Synchronic explanation. *NLLT* 31(2), 287–355.
- Ladefoged, P. & Maddieson, I. (1996). *The sounds of the world's languages*. Malden, MA: Wiley-Blackwell.
- Lambert, W. M. (1999). *Epenthesis, metathesis, and vowel-glide alternation: prosodic reflexes in Mabalay Atayal*. MA Thesis, National Tsing Hua University.
- Lapoliwa, H. (1981). *A generative approach to the phonology of Bahasa Indonesia*. Canberra: Australian National University.
- Lass, R. (1976). On the phonological characterization of [ʔ] and [h]. *English phonology and phonological theory*. pp 145–167. Cambridge: CUP.
- Lazard, G. (1957). *Grammaire du Persan contemporain*. Paris: Klincksieck.
- Leben, W. (1973). *Suprasegmental phonology*. PhD dissertation, MIT.
- Lee, D.-Y. (1998). *Korean phonology. A principle-based approach*. Munich: Lincom Europa.

- Levi, S. V. (2004). *The Representation of Underlying Glides: A Cross-linguistic Study*. University of Washington.
- Levi, S. V. (2008). Phonemic vs. derived glides. *Lingua* 118(12), 1956–1978.
- Levin, J. (1985). *A metrical theory of syllabicity*. PhD dissertation, MIT.
- Lewis, M. P., Simons, G. F. & Fenning, C. D. (Eds.) (2013). *Ethnologue: languages of the world, seventeenth edition* [online]. Dallas, TX: SIL. Available from: <http://www.ethnologue.com>.
- Lieberman, A. M., Delattre, P. C., Gertsman, L. J. & Cooper, F. S. (1956). Tempo of frequency change as a cue for distinguishing classes of speech sounds. *Journal of Experimental Psychology* 52(2), 127–137.
- Lockwood, W. B. (1955). *An introduction to modern Faroese*. Copenhagen: Munksgaard.
- Lombardi, L. (1999). Positional faithfulness and voicing assimilation in optimality theory. *NLLT* 17, 267–302.
- Lombardi, L. (2001). Why place and voice are different: constraint interactions and feature faithfulness in Optimality Theory., Cambridge, 2001. pp 13–45. Cambridge: CUP.
- Lombardi, L. (2002). Coronal epenthesis and markedness. *Phonology* 19(02), 219–251.
- Lombardi, L. (2003). Markedness and the typology of epenthetic vowels. Ms, University of Maryland. Available from: ROA-578.
- Łubowicz, A. (2002). Derived environment effects in Optimality Theory. *Lingua* 112, 243–280.
- Łubowicz, A. (2003). *Contrast preservation in phonological mappings*. PhD dissertation, UMass Amherst.
- Lynch, J. (2000). *A grammar of Anejoñ*. Canberra: Australian National University.
- Lynch, J. & Tepahae, P. (2001). *Anejoñ dictionary*. Canberra: Australian National University.
- Maddieson, I. (1984). *Patterns of sounds*. Cambridge: Cambridge University Press.
- Maddieson, I. & Emmorey, K. (1985). Relationship between semivowels and vowels: cross-linguistic investigations of acoustic difference and coarticulation. *Phonetica* 42, 163–174.
- Mahootian, S. (1997). *Persian*. London: Routledge. (Descriptive grammar series).
- Martínez-Celdrán, E. (2004). Problems in the classification of approximants. *JIPA* 34, 201–210.
- Mccarthy, J. J. (1994). The phonetics and phonology of Semitic pharyngeals. *Papers in Laboratory Phonology III: Phonological Structure and Phonetic Form*. pp 191–233. Cambridge: CUP.
- McCarthy, J. J. (1986). OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17, 207–263.
- McCarthy, J. J. (1988). Feature geometry and dependency: a review. *Phonetica* 43, 84–108.
- McCarthy, J. J. (1991). Synchronic rule inversion. *Proceedings of BLS 17*. University of California.
- McCarthy, J. J. (1993). A case of surface constraint violation. *Canadian Journal of Linguistics* 38, 169–195.
- McCarthy, J. J. (1995). Extensions of faithfulness: Rotuman revisited. Ms, UMass Amherst.

- McCarthy, J. J. (2002). *A thematic guide to optimality theory*. Cambridge, UK ; New York, NY, USA: Cambridge University Press. (Research surveys in linguistics).
- McCarthy, J. J. (2003). Comparative markedness. *Theoretical linguistics* 29, 1–51.
- McCarthy, J. J. (2008a). *Doing optimality theory: applying theory to data*. Malden, MA ; Oxford: Blackwell Pub.
- McCarthy, J. J. (2008b). The gradual path to cluster simplification. *Phonology* 25(2), 271–319.
- McCarthy, J. J. (2008c). The serial interaction of stress and syncope. *NLLT* 26(3), 499–546.
- McCarthy, J. J. & Prince, A. (1986). Prosodic morphology 1986. Ms, UMass Amherst and Rutgers University.
- McCarthy, J. J. & Prince, A. (1993a). Generalized Alignment. Ms, UMass Amherst and Rutgers University.
- McCarthy, J. J. & Prince, A. (1993b). Prosodic morphology: constraint interaction and satisfaction. Ms, UMass Amherst and Rutgers University.
- McCarthy, J. J. & Prince, A. (1994). The Emergence of the Unmarked: Optimality in Prosodic Morphology. Ms, UMass Amherst and Rutgers University.
- McCarthy, J. J. & Prince, A. (1995). Faithfulness and Reduplicative Identity. Ms, UMass Amherst and Rutgers University.
- McCarthy, J. J. & Prince, A. (1999). Faithfulness and identity in Prosodic Morphology. In: Kager, R., van der Hulst, H., & Zonneveld, W. (Eds) *Prosody-morphology interface*. Cambridge: CUP.
- McCawley, J. D. (1968). *The phonological component of a grammar of Japanese*. The Hague: Mouton.
- McDonough, J. & Johnson, K. (1997). Tamil liquids: An investigation into the basis of the contrast among five liquids in a dialect of Tamil. *Journal of the International Phonetic Association* 27(1-2), 1–26.
- Midtlyng, P. (2005). Washo morphophonology: hiatus resolution at the edges or let them be vowels. *Santa Barbara Papers in Linguistics*. pp 50–63.
- Miller, B. (2012). Sonority and the larynx. In: Parker, S. (Ed) *The sonority controversy*. pp 257 – 288. Berlin: de Gruyter.
- Mills, R. (1975). *Proto South Sulawesi and Proto Austronesian phonology*. PhD dissertation, University of Michigan.
- Mohanan, K. (1986). *The Theory of Lexical Phonology*. Dordrecht: Reidel.
- Moisik, S. R. (2013). *The epilarynx in speech*. PhD dissertation, University of Victoria.
- Mompeán, J. A. & Gómez, A. (2011). Hiatus resolution strategies in non-rhotic English: the case of /r/-liaison. *Proceedings of ICPHS 17*. pp 1414–1417. Hong Kong.
- Moore-Cantwell, C. (2013). Contexts for epenthesis in Harmonic Serialism. In: McCarthy, J. & Pater, J. (Eds) *Harmonic Grammar and Harmonic Serialism*. London: Equinox.
- Moreton, E. (2004). Non-computable functions in Optimality Theory. In: McCarthy, J. J. (Ed) *Optimality Theory in Phonology: a reader*. pp 141–163. Malden, Mass: Blackwell.
- Morgan, T. (1998). The linguistic parameters of /s/-Insertion in Dominican Spanish: a case study in qualitative hypercorrection. In: Gutiérrez-Rexach, J. & del Valle, J.

- (Eds) *Perspectives on Spanish linguistics*. pp 79–96. Columbus, OH: Ohio State University.
- Morin, Y.-C. & Kaye, J. (1982). The syntactic bases for French liaison. *Journal of Linguistics* 18, 291–330.
- Morley, R. (2011). From phonetics to phonology: learning epenthesis. *Proceedings of CLS* 47.
- Morley, R. (2012). The emergence of epenthesis: an incremental model of grammar change. *Language Dynamics and Change* 2(1), 59–97.
- Morley, R. (2013). Deletion or epenthesis? On the falsifiability of phonological universals. Ms, Ohio State University.
- Mudzingwa, C. (2010). *Shona morphophonemics: repair strategies in Karanga and Zezuru*. PhD dissertation, UBC.
- Murasugi, K. (1991). Economy in the syllabification of West Greenlandic Eskimo. *Proceedings of the 3rd Student Conference in Linguistics*, 1991. pp 179–194. MIT Press.
- Murphy, J. & Yu, A. C. L. (2007). Moraic anchoring of F0 in Washo., Saarbrücken, 2007. Saarbrücken.
- Myers, S. (2002). Gaps in factorial typology: The case of voicing in consonant clusters. Ms, UT Austin.
- Naderi, N. & van Oostendorp, M. (2011). Reducing the number of Farsi epenthetic consonants. In: Korn, A., Haig, G., Karimi, S., & Samvelian, P. (Eds) *Topics in Iranian Linguistics*. pp 153–166. Weisbaden: Ludwig Reichert Verlag.
- Narayanan, S., Byrd, D. & Kaun, A. (1999). Geometry, kinematics, and acoustics of Tamil liquid consonants. *The Journal of the Acoustical Society of America* 106(4 Pt 1), 1993–2007.
- Narayanan, S., Kaun, A., Byrd, D., Ladefoged, P. & Alwa, A. (1996). Liquids in Tamil., 1996.
- Nazarov, A. (2009). N-deletion in Dutch: an analysis in OT. Ms, Leiden University.
- Nespor, M. & Vogel, I. (1986). *Prosodic phonology*. Dordrecht: Foris.
- Nevins, A. (2005). Overwriting does not optimize in nonconcatenative morphology. *Linguistic Inquiry* 36, 275–287.
- Nevins, A. & Chitoran, I. (2008). Phonological representations and the variable patterning of glides. *Lingua* 118, 1979–1997.
- Ngakulmungan Kangka Leman (1997). *Lardil Dictionary*. Gununa, Queensland, Australia: Mornington Shire Council.
- Ní Chiosáin, M. & Padgett, J. (1993). Inherent VPlace. Ms, UC Santa Cruz.
- Núñez-Cedeño, R. (1988). Structure-preserving properties of an epenthetic rule in Spanish. In: Birdsong, D. & Montreuil, J.-P. (Eds) *Advances in Romance Linguistics*. pp 319–335. Dordrecht: Foris.
- Núñez-Cedeño, R. (1989). La /r/, único fonema vibrante del español. *Anuario de Lingüística Hispánica* 5, 153–171.
- Núñez-Cedeño, R. (1994). The alterability of Spanish geminates and its effects on the Uniform Applicability Condition. *Probus* 6, 23–41.
- O'Connor, J. D., Gertsman, L. J., Liberman, A. M., Delattre, P. C. & Cooper, F. S. (1957). Acoustic cues for the perception of initial /w,j,r,l/ in English. *Word* 13, 24–43.



- Ohala, J. J. (1974). Experimental historical phonology. In: Anderson, J. M. & Jones, C. (Eds) *Historical linguistics, II: Theory and description in phonology*. pp 353–389. Amsterdam: North-Holland.
- Ohala, J. J. (1997). Emergent stops. *Proc. 4th Seoul International Conference on Linguistics*. pp 84–91.
- Onn, F. M. (1980). *Aspects of Malay phonology and morphology: a generative approach*. Bangi: Universiti Kebangsaan Malaysia.
- Van Oostendorp, M. (1994). Affixation and integrity of syllable structure in Dutch. In: Bok-Bennema, R. & Cremers, C. (Eds) *Linguistics in the Netherlands 1994*. pp 151–162. Amsterdam: John Benjamins.
- Van Oostendorp, M. (2000). Rule inversion without rules. Ms, Meertens Institute.
- Van Oostendorp, M. (2001). Nasal consonants in variants of Dutch and some related systems. [neerlandistiek.nl: artikelnummer 01.08](http://neerlandistiek.nl/artikelnummer/01.08).
- Van Oostendorp, M. (2000). Rule inversion without rules. Ms, Meertens Institute.
- Van Oostendorp, M. (2007). Restricting repairs. Ms, Meertens Institute.
- Orgun, C. O. (2001). English r-insertion in optimality theory. *NLLT* 19(4), 737–749.
- Ortmann, A. (1998). Consonant epenthesis: its distribution and phonological specification. In: Kehrein, W. & Wiese, R. (Eds) *Phonology and morphology of the Germanic languages*. Berlin, New York: de Gruyter.
- Padgett, J. (1991). *Stricture in feature geometry*. PhD dissertation, UMass Amherst.
- Padgett, J. (1994). Stricture and nasal place assimilation. *Natural Language & Linguistic Theory* 12(3), 465–513.
- Padgett, J. (2008). Glides, vowels, and features. *Lingua* 118, 1937–1955.
- Parker, S. (1989). The sonority grid in Chamicuro phonology. *Linguistic Analysis* 19, 3–58.
- Parker, S. (1991). *Estudios sobre la fonología del Chamicuro*. Lima, Peru: SIL.
- Parker, S. (1994). Laryngeal codas in Chamicuro. *IJAL* 60, 261–271.
- Parker, S. (1995). Chamicuro laterals. A case for radical underspecification. *Lingua* 97, 195–210.
- Parker, S. (1997). An OT Account of laryngealization in Cuzco Quechua. *Working Papers of the Summer Institute of Linguistics*.
- Parker, S. (2001). Nonoptimal onsets in Chamicuro: an inventory maximised in coda position. *Phonology* 18, 361–386.
- Parker, S. (2010). Chamicuro data: exhaustive list. SIL Language and Culture Documentation and Description 12.
- Parker, S. & Weber, D. (1996). Glottalized and aspirated stops in Cuzco Quechua. *IJAL* 62(1), 70–85.
- Paster, M. (2006). *Phonological conditions on affixation*. PhD dissertation, UC Berkeley.
- Pater, J. (2000). Non-uniformity in English secondary stress: the role of ranked and lexically specific constraints. *Phonology* 17(02), 237–274.
- Pater, J. (2003). Balantak metathesis and theories of possible repair in Optimality Theory. Ms, UMass Amherst.
- Pater, J. (2006). The locus of exceptionality: Morpheme-specific phonology as constraint indexation. In: Bateman, L., O’Keefe, M., Reilly, E., & Werle, A. (Eds) *Papers in Optimality Theory III*. pp 259–296. Amherst, Mass: GLSA.

- Payne, D. L. (1981). *The Phonology and Morphology of Axininca Campa*. Arlington: SIL & UTA.
- Payne, D. L., Payne, J. K. & Sanchez Santos, J. (1982). *Morfología, fonología y fonética del Ashéninka del Apurucayali (Campa Arawak preandino)*. Lima, Peru: SIL.
- Picard, M. (2003). On the emergence and resolution of hiatus. *Folia Linguistica Historica* 24(1-2).
- Pierrehumbert, J. B. (1995). Prosodic effects on glottal allophones. In: Fujimura, O. & Hirano, M. (Eds) *Vocal fold physiology: voice quality control*. pp 39–60. San Diego, CA: Singular Publishing Group.
- Piggot, G., L. (1980). *Aspects of Odawa morphophonemics*. New York and London: Garland.
- Piggot, G., L. (1993). Satisfying the minimal word. *McGill working papers in linguistics*. Montreal: McGill University.
- Piggot, G., L. (2010). Cyclic spell-out and the typology of word minimality. Ms, McGill University.
- Pompino-Marschall, B. & Zygis, M. (2011). Glottal marking of vowel-initial words in German. *Proceedings of ICPhS 17*. pp 1626–1629. Hong Kong.
- Poppe, N. N. (1951). *Khalkha-mongolische Grammatik*. Weisbaden: Harrassowitz.
- Poppe, N. N. (1960). *Buriat grammar*. Bloomington: Indiana University.
- Prentice, D. J. (1971). *The Murut languages of sabah*. Canberra: Australian National University.
- Prince, A. (2002). Arguing optimality. In: Coetzee, A., Carpenter, A., & De Lacy, P. (Eds) *UMOP 26. Papers in Optimality Theory II*. Amherst, Mass: GLSA.
- Prince, A. & Smolensky, P. (2004). *Optimality Theory. Constraint Interaction in Generative Grammar*. Malden, Mass: Blackwell.
- Proctor, M. (2009). *Gestural characterization of a phonological class: the liquids*. PhD dissertation, Yale University.
- Pugh, S. & Press, I. (1999). *Ukrainian: a comprehensive grammar*. London; New York: Routledge.
- Pukui, M. K. & Elbert, S. (1986). *Hawaiian dictionary*. Honolulu: University of Hawaii Press.
- Pulleyblank, D. (1998). Yoruba vowel patterns: deriving asymmetries by the tension between opposing constraints. Ms, UBC.
- Pullum, G. & Ladusaw, W. (1986). *Phonetic symbol guide*. Chicago: University of Chicago Press.
- Raffelsiefen, R. (2012). Die Silbifizierung hoher Vokoide: das Deutsche im Sprachvergleich. In: Gunkel, L. & Gisela, Z. (Eds) *Deutsch im Sprachvergleich*. pp 99–134. Berlin, New York: Mouton de Gruyter.
- Recasens, D. (2012). The phonetic implementation of underlying and epenthetic stops in word final clusters in Valencian Catalan. *Journal of the International Phonetic Association* 42(01), 65–90.
- Redi, L. & Shattuck-Hufnagel, S. (2001). Variation in the realization of glottalization in normal speakers. *Journal of Phonetics* 29(4), 407–429.
- Rialland, A. & Djamouri, R. (1984). Harmonie vocalique, consonantique et structures de dépendance dans le mot en mongol khalkha. *Bulletin de la Société de Linguistique de Paris* 79, 333–383.

- Rice, K. (1994). Peripheral in consonants. *Canadian Journal of Linguistics* 39, 191–216.
- Rice, K. (1996). Default variability: The coronal-velar relationship. *NLLT* 14, 493–543.
- Rice, K. (2000). Featural markedness in phonology: variation. In: Cheng, L. & Sybesma, R. (Eds) *The Second Glot International State-of-the-Article Book: The Latest in Linguistics*. pp 389–429. Berlin: Mouton de Gruyter.
- Rice, K. (2007). Markedness in phonology. In: de Lacy, P. (Ed) *Cambridge Handbook of Phonology*. pp 79–98. Cambridge: CUP.
- Rice, K. (2008). Review of de Lacy (2006). *Phonology* 25(2), 361–371.
- Rischel, J. (1974). *Topics in West Greenlandic Phonology: Regularities Underlying the Phonetic Appearance of Word Forms in a Polysynthetic Language*. Copenhagen: Akademisk Forlag.
- Rohany Rahbar, E. (2012). *Aspects of Persian phonology and morphology*. PhD dissertation, University of Toronto.
- Rose, S. (1996). Variable laryngeals and vowel lowering. *Phonology* 13(01), 73–117.
- Rose, S. & Walker, R. (2004). A typology of consonant agreement as correspondence. *Language* 80, 475–531.
- Rosenthal, S. (1997a). The Distribution of Prevocalic Vowels. *Natural Language & Linguistic Theory* 15(1), 139–180.
- Rosenthal, S. (1997b). *Vowel/Glide Alternation in a Theory of Constraint Interaction*. Taylor & Francis.
- Rotenberg, J. (1978). *The syntax of phonology*. PhD dissertation, MIT.
- Rowe, J. H. (1950). Sound patterns in three Inca dialects. *IJAL* 16, 137–48.
- Rubach, J. (2000). Glide and Glottal Stop Insertion in Slavic Languages: A DOT Analysis. *Linguistic Inquiry* 31(2), 271–317.
- Rubach, J. (2002). Against subsegmental glides. *Linguistic Inquiry* 33(4), 672–687.
- Sanžeev, G. D. (1973). *The modern Mongolian language*. Moskva: Nauka.
- Sanžeev, G. D., Bertagaev, T. A. & Tsidendambaev, T. B. (Eds.) (1962). *Grammatika buriatskogo iazyka*. Moskva: Izdatel'stvo Vostochnoi Literatury.
- Schiffman, H. F. (1979). *A grammar of Spoken Tamil*. Cambridge University Press.
- Schiffman, H. F. (2000). The Tamil liquids, revisited. Ms, UPenn.
- Selkirk, E. (1972). *The phrase phonology of English and French*. PhD dissertation, MIT.
- Selkirk, E. (1974). French liaison and the X'-notation. *Linguistic Inquiry* 5, 573–590.
- Selkirk, E. (1984). *Phonology and syntax: the relation between sound and structure*. Cambridge, Mass: MIT Press.
- Selkirk, E. (1990). A two-root theory of length. In: Dunlap, E. & Padgett, J. (Eds) *UMOP 14. Papers in phonology*. Amherst, Mass: GLSA.
- Selkirk, E. (1995). The prosodic structure of function words. In: Beckman, J., Walsh Dickey, L., & Urbanczyk, S. (Eds) *University of Massachusetts occasional papers in linguistics 18: papers in Optimality Theory*. pp 439–470. Amherst, Mass: GLSA.
- Senturia, M. (1998). *A prosodic theory of hiatus resolution*. Ms, University of California, San Diego.
- Shaw, P. A. (1980). *Theoretical Issues in Dakota Phonology and Morphology*. Garland Pub., N.Y.
- Smith, J. (2002). *Phonological Augmentation in Prominent Positions*. PhD dissertation, Umass Amherst.

- Snider, K. L. (1984). Vowel harmony and the consonant l in Chumburung. *Studies in African linguistics* 15(1), 47–57.
- Snider, K. L. (1985). Vowel coalescence across word boundaries in Chumburung. *Journal of West African Languages* 15(1), 3–13.
- Snider, K. L. (1986). Apocope, tone and the glottal stop in Chumburung. *Journal of African Languages and Linguistics* 8, 133–144.
- Snider, K. L. (1989). Vowel coalescence in Chumburung: an autosegmental approach. *Lingua* 73, 217–232.
- Snider, K. L. (1990). *Studies in Guang phonology*. PhD dissertation, State University of Leiden.
- Sohn, H. (1971). *a-raising in Woleaian*. Honolulu: Dept. of Linguistics, University of Hawaii.
- Sohn, H. (1975). *Woleaian reference grammar*. University Press of Hawaii.
- Sohn, H. & Tawerilmang, A. F. (1976). *Woleaian-English dictionary*. University Press of Hawaii.
- Spring, C. (1990a). How many feet per language? In: Halpern, A. L. (Ed) *Proceedings of WCCFL 9*. Stanford: CSLI Publications.
- Spring, C. (1990b). *Implications of Axininca Campa for prosodic morphology and reduplication*. Tuscon, AZ: PhD dissertation, University of Arizona.
- Spring, C. (1990c). Unordered morphology: the problem of Axininca reduplication. *Proceedings of BLS 16*. pp 137–157. Berkeley, CA: University of California.
- Spring, C. (1992). The velar glide in Axininca. *Phonology* 9, 329–352.
- Steriade, D. (1984). Glides and vowels in Romanian. *Proceedings of BLS 10*. pp 47–64.
- Steriade, D. (1993). Closure, release, and nasal contours. In: Krakow, R. A. & Huffman, M. K. (Eds) *Nasals, Nasalization, and the Velum*. New York: Academic Press. (Phonetics and Phonology).
- Steriade, D. (2008). The Phonology of Perceptibility Effects: the P-map and its consequences for constraint organization. In: Hanson, K. & Inkelas, S. (Eds) *The Nature of the Word: Essays in Honor of Paul Kiparsky*. pp 151–180. Cambridge, Mass: MIT Press.
- Stevens, A. M. (1968). *Madurese phonology and morphology*. New Haven, CT: American Oriental Society.
- Stevens, A. M. (1980). Formative boundaries in phonological rules. In: Aronoff, M. & Kean, M.-L. (Eds) *Juncture*. Saratoga, CA: Anma Libri.
- Stevens, A. M. (1985). Reduplication in Madurese. *Proceedings of ESCOL 1985*. pp 232–243. Columbus, OH: Ohio State University.
- Stevens, A. M. (1994). Madurese reduplication revisited. In: Adams, K. L. & Hudak, T. J. (Eds) *Papers from the Second Annual Meeting of the Southeast Asian Linguistics Society 1992*. pp 357–381. Tempe, AZ: Arizona State University.
- Stroomer, H. J. (1987). *A comparative study of three Southern Oromo dialects in Kenya*. Hamburg: Helmut Buske Verlag.
- Struijke, C. (2000). Existential faithfulness. A study of reduplicative TETU, feature movement, and dissimilation. PhD dissertation, University of Maryland.
- Subrahmanyam, P. S. (1968). *A Descriptive Grammar of Gondi*. India: Annamalai University.

- Subramoniam, V. I. (1958). *A descriptive analysis of a dialect of Tamil*. PhD dissertation, Indiana University.
- Svantesson, J.-O. & Karlsson, A. (2012). Preaspiration in Modern and Old Mongolian. *Mémoires de la Société Finno-Ougrienne* 264, 453–464.
- Svantesson, J.-O., Tsendina, A., Karlsson, A. & Franzén, V. (2005). *The phonology of Mongolian*. Oxford; New York: Oxford University Press.
- Sweet, H. (1908). *The sounds of English*. Oxford: Clarendon Press.
- Terrell, T. D. (1982). Relexificación en el español dominicano: implicaciones para la educación. In: Alba, O. (Ed) *El español del Caribe*. pp 301–318. Santiago de los Caballeros, Dominican Republic: Universidad Católica Madre y Maestra.
- Terrell, T. D. (1986). La desaparición de /s/ posnuclear a nivel léxico en el habla dominicana. In: Núñez-Cedeño, R., Páez Urdaneta, I., & Guitart, J. M. (Eds) *Estudios sobre la fonología del español del Caribe*. pp 117–134. Caracas: Casa de Bello.
- Tesar, B. (2008). Output-driven maps. Ms, Rutgers University.
- Tesar, B. (2013). *Output-driven phonology. Theory and learning*. Cambridge: CUP.
- Thráinsson, H., Petersen, H. P., Jacobsen, J. i L. & Hansen, Z. S. (2004). *Faroese: An Overview and Reference Grammar*. Foroya Frodskaparfelag.
- Tollfree, L. (1999). South East London English: discrete versus continuous modelling of consonantal reduction. In: Foulkes, P. & Docherty, G. R. (Eds) *Urban voices*. pp 163–184. London: Arnold.
- Tranel, B. (1981). *Concreteness in generative phonology: evidence from French*. Berkeley: University of California Press.
- Tranel, B. (1996). French liaison and elision revisited: a unified account within Optimality Theory. In: Parodi, C., Quicoli, C., Saltarelli, M., & Zubizarreta, M. L. (Eds) *Aspects of Romance Linguistics*. Washington, DC: Georgetown University Press.
- Trigo, L. (1988). *On the phonological derivation and behavior of nasal glides*. PhD dissertation, MIT.
- Trigo, L. (1991). On pharynx-larynx interactions. *Phonology* 8, 113–136.
- Trudgill, P. (1986). *Dialects in Contact*. Oxford: Blackwell.
- Tyler, S. A. (1969). *Koya: an outline grammar: Gommu dialect*. Berkeley and Los Angeles: University of California Press.
- Uffmann, C. (2007a). Intrusive [r] and optimal epenthetic consonants. *Language Sciences* 29(2–3), 451–476.
- Uffmann, C. (2007b). *Vowel epenthesis in loanword adaptation*. Tübingen: Niemeyer.
- Uffmann, C. (2010). The non-trivialness of segmental representations. Paper presented at Old World Conference in Phonology VII.
- Uffmann, C. (2014). Possible epenthetic segments: the role of faithfulness. Handout from a talk presented at Manchester Phonology Meeting.
- Underhill, R. (1976). *Turkish Grammar*. The MIT Press.
- Urbanczyk, S. (1993). Infixing and moraic circumscription. In: Sherer, T. (Ed) *UMOP 16. Phonological Representations*. pp 319 – 357. Amherst, Mass: GLSA.
- Vaux, B. (2001). *Consonant Epenthesis and Hypercorrection*. Ms, Harvard University.

- Van de Velde, H. & van Hout, R. (1998). Dangerous aggregations. A case study of Dutch (n) deletion. In: Paradis, C., Vincent, D., Deshaies, D., & Laforest, M. (Eds) *Papers in Sociolinguistics*. pp 137–147. Quebec: Editions Nota Bene.
- Van de Velde, H. & van Hout, R. (2000). N-deletion in reading style. In: de Hoop, H. & van der Wouden, D. (Eds) *Linguistics in the Netherlands 2000*. pp 209–219. Amsterdam: John Benjamins.
- Venneman, T. (1972). Rule inversion. *Lingua* 29, 209–242.
- Waksler, R. (1990). *A formal account of glide/vowel alternation in prosodic theory*. PhD dissertation, Harvard University.
- Walsh Dickey, L. (1997). *The phonology of liquids*. PhD dissertation, Umass Amherst.
- Warner, N. (2002). The phonology of epenthetic stops: implications for the phonetics/phonology interface in optimality theory. *Linguistics* 40(1), 1–27.
- Warner, N. & Weber, A. (2001). Perception of epenthetic stops. *Journal of Phonetics* 29(1), 53–87.
- Weissmann, E. (1970). Phonematische Analyse des Stadtdialektes von Bristol. *Phonetica* 21, 151–181; 211–240.
- Wells, J. C. (1982). *Accents of English*. Cambridge: CUP.
- Wiese, R. (1996). *The phonology of German*. Oxford: Clarendon press.
- Wiesemann, U. (1968). Phonological syllables and words in Kaingang. *Völkerkundliche Abhandlungen des Niedersächsischen Landesmuseums*. pp 307–313.
- Wiesemann, U. (1972). *Die Phonologische und grammatische Struktur der Kaingang Sprache*. The Hague: Mouton.
- Wiltshire, C. (1998). Extending ALIGN constraints to new domains. *Linguistics* 36(3), 423–468.
- Winter, W. (1970). Reduplication in Washo: A Restatement. *International Journal of American Linguistics* 36(3), 190.
- Wolf, M. (2008). *Optimal interleaving: serial phonology-morphology interaction in a constraint-based model*. PhD dissertation, Umass Amherst.
- Wolf, M. (2011). Exceptionality. In: van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell Companion to Phonology*. Malden, MA: Wiley-Blackwell.
- Woollams, G. (1996). *A grammar of Karo Batak, Sumatra*. Canberra: Department of Linguistics, Research School of Pacific and Asian Studies, Australian National University.
- Yar-Shater, E. (1969). *A grammar of Southern Tati dialects*. The Hague; Paris: Mouton.
- Yip, M. (1983). Some problems of syllable structure in Axininca Campa. In: Sells, P. & Jones, C. (Eds) *Proceedings of NELS 13*. pp 243–251. Amherst, Mass: GLSA.
- Yip, M. (1993a). Cantonese loanword phonology and Optimality Theory. *Journal of East Asian Linguistics* 2, 261–291.
- Yip, M. (1993b). Phonological constraints, optimality, and phonetic realization in Cantonese. Ms, UC Irvine.
- Young, G. V. C. & Clewer, C. R. (1985). *Faroese-English dictionary*. Tórshavn, Føroyar: Mansk-Svenska Pub. Co.
- Young, R. & Morgan, W. (1980). *The Navajo language: a grammar and colloquial dictionary*. Albuquerque: University of New Mexico Press.

- Yu, A. C. L. (2005a). Prosodically-governed segmental fission in Washo. *Proceedings of BLS 31*. University of California.
- Yu, A. C. L. (2005b). Quantity, stress and reduplication in Washo. *Phonology* 22(03), 437–475.
- Yu, A. C. L. (2008a). The phonetics of quantity alternation in Washo. *Journal of Phonetics* 36(3), 508–520.
- Yu, A. C. L. (2008b). Two patterns of reduplication in Washo. *Proceedings of BLS 34*. University of California.
- Yu, A. C. L. (2011a). *Laryngeal phonology in Washo*. Ms, University of Chicago.
- Yu, A. C. L. (2011b). *Laryngeal schizophrasia in Washo resonants*. Ms, University of Chicago.
- Zimmermann, E. & Trommer, J. (2007). A correspondence-theoretic account of fixed segmentism reduplication. In: Trommer, J. & Opitz, A. (Eds) *1 2 many. One-to-many relations in grammar*. pp 303–333. Leipzig: Universitat Leipzig.
- Zoll, C. (1996). *Parsing below the segment in a constraint based framework*. PhD dissertation, UC Berkeley.
- Zonneveld, W. (1978). *A formal theory of exceptions in Generative Phonology*. Dordrecht: Foris.
- Zuraw, K. (2007). The Role of Phonetic Knowledge in Phonological Patterning: Corpus and Survey Evidence from Tagalog Infixation. *Language* 83(2), 277–316.
- Zvelebil, K. (1970). *Comparative Dravidian phonology*. Mouton.