INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

UNIVERSITY OF CALIFORNIA

Los Angeles

Resolving Hiatus

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Linguistics

by

Roderic F. Casali

1996

UMI Number: 9704586

The dissertation of Roderic F. Casali is approved.

Bruce P. Hayes

Donka Minkova

Russell G. Schuh

Donca Steriade, Committee Chair

University of California, Los Angeles

1996

This dissertation is dedicated to my wife Ellen, my children Chris, Andy, and Amy, and my mother, Norma Casali.

ACKNOWLEDGMENTS

I am deeply grateful to my supervisor, Donca Steriade, for her constant help and encouragement during my time at UCLA. She has taught me a great deal not only about phonology, but about how to do linguistics. I think I can safely say that there is no one who has contributed more to my development as a linguist than her.

I am also indebted to the other members of my committee: Bruce Hayes, Donka Minkova, and Russ Schuh. Not only have their specific suggestions been extremely valuable, but their general advice and encouragement have contributed greatly to making this dissertation writing experience a very positive one. Special thanks are due to Bruce Hayes not only for his comments on several versions of the dissertation, but for his generous assistance on several other papers and projects during my time at UCLA, as well as for inspiring instruction I received in several courses and proseminars he taught.

It has been a privilege to take classes from or serve as a teaching assistant for several other professors, from whose teaching I have learned a lot: Vicki Fromkin, Nina Hyams, Sun-Ah Jun, Pat Keating, Hilda Koopman, Anoop Mahajan, Caroline Smith, Dominique Sportiche, Robert Stockwell. I have benefited a lot from formal and informal interaction with present and former phonetics/phonology students at UCLA, including Katherine Crosswhite, Edward Flemming, Sean Fulop, Matt Gordon, Chai-Shune Hsu, Jungho Jun, Abby Kaun, Robert Kirchner, Peggy

MacEachern, Kie Ross, Bonny Sands, Aaron Shryock, Dan Silverman, Richard Wright, and Jie Zhang.

My work on this dissertation has benefited from comments or discussion with many people. While I'm sure I cannot remember everyone, I would like to mention some of those who come to mind. For helpful comments or discussion on analytical or theoretical issues, or for helping with facts or references concerning particular languages, I am grateful to Mike Cahill, Manuel Español-Echavarria, Tom Hinnebusch, Mary Holman, Hilda Koopman, Connie Kutsch-Lojenga, Ian Maddieson, Tony Naden, Deo Ngonyani, Peggy MacEachern, Russ Schuh, George Vilakazi, and Richard Wright. Several people kindly made data available to me from their own field notes or papers: Julie Bentinck, Mike Cahill, Rebecca Herman, Renate Kleiner, Myles Leitch, Ruth Roberts-Kohno, and Keith Snider.

My stay here has been made more enjoyable and rewarding by the friendship of a lot of people. Though I cannot hope to mention them all, I would specifially like to thank Aaron Shryock for his friendship, encouragement and prayers, and my "classmates" Manuel Español-Echavarria, Robert Kirchner, Felicia Lee, Benjamin Munson, and Brian Potter, for being a fun and friendly group to be around. I especially thank my friend and classmate Peggy MacEachern for many interesting discussions about linguistics and other matters, as well as for much help on various aspects of this dissertation.

My family has been very supportive and helpful to me during my studies. I would like thank my sons Chris and Andy for a lot of fun times and for being so patient with me while I was writing my "chapter-book," and my daughter Amy (still too young to know about chapter-books) for making our home a livelier and more enjoyable place. Most of all, I want to thank my wife Ellen. As much as anything, this dissertation owes its successful completion to her constant help and encouragement over the past four years, Without her help, I could not have done it.

I would like to thank the Summer Institute and Linguistics and the Ghana Institute of Linguistics, Literacy, and Bible Translation for encouraging me in my decision to do further studies, and also many past and present GILLBT colleagues for personal encouragement, especially Steve and Wendy Batstone, Mike Cahill, Myles Leitch, Keith Snider, and Ralph and Marey Todd. I am also grateful to the many churches and individuals who supported my wife and I financially while we worked in Ghana and continued to support us during my studies.

Above all, I thank God Almighty, the creator of language, for enabling me to do what I could not do on my own strength (Psalm 73:26).

VITA

August 29, 1957	Born, Ipswich, Massachusetts
1980	B.S., Physics University of Massachusetts Amherst, Massachusetts
1980-1981	Physics Teacher Amherst High School Amherst, New York
1985-1988 1989-1991 Bible	Linguistics Field Research Ghana Institute of Linguistics, Literacy and Translation, Ghana
1988	M.A., Linguistics University of Texas at Arlington Arlington, Texas
1993-1994 1996	Teaching Assistant Department of Linguistics University of California, Los Angeles

PUBLICATIONS AND PRESENTATIONS

Casali, Roderic F. 1988. Vowel clusters and syllable structure in Nawuri. Papers in Ghanaian Linguistics 7:40-61, ed. by Kofi Saah & Emmanuel Osam. Legon: Institute of African Studies, University of Ghana.

___. 1990. Contextual labialization in Nawuri. Studies in African Linguistics 21:319-346.

___. 1991. Vowel elision and glide formation in Niger-Congo: An approach based on syllabification. Paper presented at the 22nd Annual Conference on African Linguistics, Nairobi.

___. 1993. Labial opacity and roundness harmony in Nawuri. Paper presented at the 24th Annual Conference on African Linguistics, Ohio State University.

___. 1994. Nominal tone in Nawuri. Journal of West African Languages, vol. XXIV, 2.45-64.

___. 1994. Vowel Elision and Glide Formation in Niger-Congo: A Harmony Theoretic Approach. Paper presented at the January 1994 LSA meeting, Boston, January 9, 1994.

___. 1995. Patterns of Glide Formation in Niger-Congo: An Optimality Account. Paper presented at the January 1995 LSA meeting, New Orleans, January 7, 1995.

___. 1995. Nawuri Phonology. (Language Monographs no. 3.) Legon: Institute of African Studies, University of Ghana.

___. 1995. NC's in Moghamo: Prenasalized Onsets, or Heterosyllabic Clusters? Studies in African Linguistics 24:152-166.

___. 1995. Labial opacity and roundness harmony in Nawuri. Natural Language & Linguistic Theory 13:649-663.

___. 1995. An overview of the Nawuri verbal system. Journal of West African Languages, vol. XXV, 1:63-86.

___. On the reduction of vowel systems in Volta-Congo. African Languages and Cultures 8, 2:109-121.

___. 1996. Vowel Coalescence in Niger-Congo: Implications for height-feature theory. Paper presented at the 27th Annual Conference on African Linguistics, University of Florida, Gainesville, March 29, 1996.

___. 1996. A typology of vowel coalescence. Paper presented at the 2nd Southwest Optimality Theory Workshop, University of California Irvine, May 11, 1996.

___. 1996. Vowel elision in hiatus contexts. UCLA Working Papers in Phonology 1:18-56.

ABSTRACT OF THE DISSERTATION

Resolving Hiatus

by

Roderic F. Casali

Doctor of Philosophy in Linguistics

University of California, Los Angeles, 1996

Professor Donca Steriade, Chair

An examination of 91 languages which resolve hiatus through Vowel Elision and/or Coalescence (merger) reveals two correlations that pose interesting challenges for phonological theory. First, in certain contexts the vowel targeted by Elision is universally predictable. At (non-function) word boundaries for example, languages consistently elide the leftmost (word-final) vowel. Second, the type of Coalescence possible in a language depends on the language's vowel inventory. While seven-vowel systems coalesce /a+i/ to [ɛ], for example, nine-vowel systems realize this same sequences as [e]. These generalizations are analyzed within the framework of Optimality Theory.

My analysis of Elision assumes that languages make greater effort to preserve features occurring in certain phonetically or semantically prominent positions (e.g. in roots). Corresponding to these are a series of position-sensitive Faithfulness constraints requiring preservation of features in these positions. The possible rankings of these constraints yield an Elision typology in good agreement with attested patterns.

The Coalescence correlations strongly suggest that the height features of vowel depend on the inventory in which the vowel occurs, a claim supported by other facts as well. I propose that (auditorily defined) height features are assigned to vowel systems via best satisfaction of a set of constraints on height specification, for example a constraint requiring minimal use of certain features. The specifications assigned to a given vowel system will, in conjunction with a uniform ranking of Faithfulness constraints that characterizes Height Coalescence across all the systems, correctly generate the possible patterns in that type of system.

In its prototypical form, Elision is position-sensitive: the elided segment is the one that occupies a particular position. (Symmetric) Coalescence, on the other hand, is feature-sensitive: the resulting vowel is retains the most preferred features from the original vowels. Also attested however are a 'Feature-Sensitive" Elision process in which the vowel preserved is the one which possesses particular feature(s), and a type of "Asymmetric" Coalescence, in which positional and featural preferences play a role. All four processes are correctly generated by the analysis, arising under different permutations of the same constraints posited to account for Elision and Coalescence in their prototypical incarnations.

Chapter 1: Introduction

1.1 Hiatus resolution strategies

There are a variety of ways in which languages deal with sequences of vowels that arise through morphological or syntactic concatenation. One alternative of course is to leave the sequence unchanged and syllabify the two vowels into separate syllables, a possibility we may refer to as Heterosyllabification. Many languages do not readily tolerate adjacent heterosyllabic vowels, however. In languages which do not, a vowel sequence may be subject to any one of several possible hiatus resolution strategies. These include syllabifying the two vowels into the nucleus of a single syllable (Diphthong Formation), Epenthesis of an intervening consonant, Vowel Elision, Glide Formation (here used exclusively to refer to a process in which the first of two adjacent vowels surfaces as a semivowel), and Coalescence (here defined, following Bergman (1968), as a situation in which an underlying $/V_1+V_2/$ sequence is realized as a third vowel sharing features of both V_1 and V_2). These are schematized in (1). (The parenthesized colon indicates that Vowel Elision, Glide Formation, and Coalescence may occur with or without compensatory lengthening, depending on the particular language.)

(1)	Heterosyllabification:	$CV_1+V_2 > .CV_1.V_2.$
	Diphthong Formation:	$CV_1+V_2 > .CV_1V_2.$
	Epenthesis:	$CV_1+V_2 > .CV_1.CV_2.$
	Vowel Elision:	$CV_1+V_2 > .CV_2(:).$ or $.CV_1(:).$

Glide Formation:	$CV_1+V_2 > .CGV_2(:).$
Coalescence:	$CV_1+V_2 > .CV_3(:).$

Some examples of these processes in various languages are given in (2).

(2) Heterosyllabification (English):

a. ple ɪnsaɪd 'play inside' → .ple.ɪn.saɪd.

b. go əwe 'go away' → .go.ə.we.

Diphthong Formation (Ngiti: Logjenga 1994b):

c. izo ɔkʊ 'reed-sugar cane' → .i.z°ɔ.kʊ.

d. ngbangba ɔdzɔ 'dwarf' → .ngba.ngbᵃɔ.dzɔ.

Epenthesis (Axininca: Payne 1981.):

e. no-N-pisi-i 'I will sweep' → .nom.pi.si.ti.

f. no-N-piyo-i 'I will heap.' → .nom.pi.yo.ti.

Vowel Elision (Etsako: Elimelech 1976)

g. dɛ akpa 'buy a cup' → .da.kpa.

h. ukpo ɛnodɛ 'yesterday's cloth' → .u.kpɛ.no.dɛ.

Glide Formation (LuGanda: Clements 1986)

i. li+ato 'boat' → .lyaa.to.

j. mu+iko 'trowel' → .mwii.ko.

Coalescence (Anufɔ: Adjekum, Holman & Holman 1993)

k. fa-i 'take it' → fɛ:

l. fa-u 'take you' → fɔ:

These processes can, and frequently do, co-occur in a language. There are quite a few Niger-Congo languages in fact in which some sequences are resolved by Vowel Elision, others by Glide Formation, and still others by Coalescence. This is the case for example in Chumburung (Snider 1985, 1989c), Nawuri (Casali 1988, 1995d), and Xhosa (Aoki 1974, McLaren, J. 1955).

The present study deals with cross-linguistic variation in the behavior of two of these processes, Vowel Elision and Coalescence. These processes have been the subject of many language-specific studies, for example Aoki (1974), Bunkowske (1972), Casali (1988), Clements (1986), Donwa-Ifode (1985), Hoffman (1972), Masagbor (1989), Pulleyblank (1988), Snider (1985, 1989c). Cross-linguistic studies of these processes, on the other hand, have been rare. It turns out, however, that when the range of variation exhibited by Elision and Coalescence across languages is examined, there are some surprising and interesting restrictions on their behavior, such that a number of seemingly very plausible patterns which these processes might (from the viewpoint of virtually all current theories) be expected to exhibit are apparently unattested. To cite just a single example here, we may note that languages which regularly elide the second (rightmost) of two vowels which come together across a word boundary do not seem to exist. My goal is to provide a principled account of these cross-linguistic restrictions within the framework of Optimality Theory (McCarthy & Prince 1993, Prince & Smolensky 1993).

While other possibilities for dealing with hiatus, i.e. Heterosyllabification, Diphthong Formation, Epenthesis, and Glide Formation will be discussed at various points, their treatment will not be very detailed, and a number of important questions pertaining to these realization strategies (e.g. the question of what determines the phonetic identity of an epenthetic consonant) will be left unaddressed. The cross-linguistic behavior of Glide Formation is treated in some detail in Casali (1995a).

1.2 Empirical basis of the study

The generalizations discussed in this study are based on a survey of 91 languages which display at least some instances of Elision and/or Coalescence. The information on these languages was collected from published and unpublished sources over a period of about five years (1990-1995). Because my interest in these processes grew out of my own exposure to West African languages, the survey originally consisted almost entirely of Niger-Congo languages. Later, it was expanded to include languages from other families as well. The genetic representation of the languages presently in my database is summarized in (3).

(3)

language family	languages
Afro-Asiatic	Afar, Iraqw, Pero
Australian	Malakmalak
Austronesian	Kisar, West Tarangan, Uma Juman
Indo-European	Chicano Spanish, Modern Greek
Niger-Congo	(70 total)
Nilo-Saharan	Lango, Logo, Lulobo, Nandi, Shilluk
Sino-Tibetan	Kagate
Siouan	Santee Dakota, Teton Dakota
Torricelli	Au
Trans-New Guinea	Daga, Tabla
Other	Basque

While my database is still heavily skewed in favor of Niger-Congo languages, the non-Niger-Congo representation is not insignificant. The generalizations concerning Vowel Elision and Coalescence which obtain for the non-Niger-Congo languages do not appear to differ from those which hold true of the Niger-Congo languages.

As might be expected in a sample of this size, the quality and completeness of the sources consulted varies considerably. I was fortunate to find a number of sources which deal very thoroughly with hiatus resolution in particular languages, detailing both the relevant morphosyntactic contexts and the phonetic outcome that results from all possible input sequences. Descriptions that provide this level of completeness are comparatively rare, however. Many of my sources show only a few examples of hiatus resolution, with little or no discussion of how general a particular hiatus resolution strategy is in the language or what input sequences are affected.[1]

The sources I consulted were of several broad types, including articles whose focus is directly on hiatus resolution, papers dealing with other phonology topics which happened to touch on hiatus resolution, overviews of a language's phonology, and complete grammars. In (4) I indicate the approximate percentage of the sources consulted that fall into each of these types.

(4)

type of source	percentage
hiatus study	20
other phonology paper	22
phonology overview	18
grammar	26
other	14

The only previous cross-linguistic study of hiatus resolution that I am aware of is an unpublished M.A. thesis by Richard Bergman (1968). Bergman's survey treats a total of 34 African languages (21 of which are covered in my own survey as well). Although the issues treated in the present study overlap only partially with those considered by Bergman, there are a number of points at which I am indebted to his clear and insightful discussion of the patterns which his survey revealed. In particular, Bergman may well have been the first to note that Elision of the leftmost of

[1] This should not be taken to imply that these sources are necessarily lower in quality. In many instances, a detailed description of hiatus resolution would not have been in keeping with the overall aim of a source.

two adjacent vowels (V_1) is much more common than Elision of the rightmost vowel (though, as we shall see below, the overall preference for V_1 Elision does not extend equally to all morphosyntactic contexts).

1.3 Preview of major results

The major generalizations to be addressed in this study fall into two classes. First, with respect to Vowel Elision, we shall see that there are interesting restrictions governing the choice of which of two juxtaposed vowels is elided. Second, it turns out that of the many logically possible Coalescence patterns which might be expected to occur, there is one type, involving the merger of a relatively low V_1 with a relatively high V_2 to form a lowered version of V_2 which is especially common; interestingly, the specific implementation of this general schema (e.g. whether /a+i/ is realized as [e] or [ɛ]) that occurs in a particular language can apparently be predicted to a large extent from the number of vowel heights in the language's underlying inventory.

My account of the first class of generalization, regarding the choice of vowel elided, will rely crucially on the notion (discussed at length in section 2.3.3) that languages take greater pains to preserve features and/or segments which occur in certain morphologically or prosodically defined positions, e.g. in roots as opposed to affixes. I formalize this notion in terms of a fixed universal ranking schema

PARSE(F)-P >> PARSE(F), where PARSE(F)-P is representative of a family of PARSE constraints favoring preservation of a feature F in certain favored (in view of their phonetic prominence and/or functional importance in terms of information content) positions (represented by P). Given this fixed ranking, it follows that in cases where one of the two vowels in juxtaposition occurs in a favored P-position and the other does not, Elision must always target the one that does not occur in the favored position, since this violates only PARSE(F), while Elision of the vowel that occurs in the more favored position would violate, in addition, the more highly ranked PARSE(F)-P.

To take a concrete example, I have already suggested that occurrence in a root morpheme constitutes one of the P positions. I propose that there is a constraint, which I designate PARSE(F)-lex, that favors preservation of features in lexical morphemes (i.e.. roots) but not in grammatical morphemes (affixes). In keeping with the general schema PARSE(F)-P >> PARSE(F), PARSE(F)-lex will universally be ranked above PARSE(F). Consider now a hiatus situation at the boundary between a CV prefix and a following root, as in (5).

(5) $CV_1 + V_2 \ldots$

In the absence of some other PARSE(F)-P constraint which could conceivably give special preference to the preservation of features of the prefix, the ranking

PARSE(F)-lex >> PARSE(F) predicts that Elision in this context must universally target V_1. We shall see that this prediction appears in fact to be correct.

If on the other hand we are dealing with a hiatus context in which both V_1 and V_2 occur in positions favored by some PARSE(F)-P constraints, which we may here label PARSE(F)-P_a and PARSE(F)-P_b, then we predict that languages may target either vowel, depending on the relative ranking of PARSE(F)-P_a and PARSE(F)-P_b (which I assume to be variable on a language-particular basis). I argue below that root plus suffix contexts provide an instance of exactly this type PARSE(F) variability.

In accounting for the generalizations related to Coalescence, I propose an explanation that consists of two components. The first of these is a general theory (formulated in terms of possible rankings of certain constraints) of the conditions that give rise to Coalescence of any type. This component of the explanation is relatively uncontroversial, at least in broad outline; although one can conceive of alternatives to the specific implementation I have opted for, it seems fairly clear that some analogous mechanisms are needed within any Optimality-Theoretic account.

The second aspect of my account is more novel. In explaining the observed correlations between the type of Coalescence found in a language and the shape of its vowel inventory, I propose a theory of height features which differs from traditional approaches based on the features [high], [low], and Advanced Tongue Root ([ATR]). My theory has two fundamental aspects. First vowel height features are defined exclusively in terms of their auditory and acoustic properties. There is no direct reference to articulatory properties of these features, which as a consequence are expected (in agreement, I believe, with the empirical facts) to exhibit considerable inter-language and even inter-speaker variation. Second, the height feature composition of a given vowel quality is largely determined, via explicit principles, on the basis of the overall inventory in which it occurs. Thus, a given vowel quality (as indicated for example by its IPA symbol) may have a different height feature analysis when it occurs in one vowel system than when it occurs in another.

Because my approach to height features departs significantly from standard views with respect to a number of issues that require careful discussion (as do the empirical generalizations which they seek to explain), I will not attempt to preview my model in any serious fashion at this point. A few brief remarks illustrating the general spirit of my approach must therefore suffice.

One of the most common forms of Coalescence is a type of "Height Coalescence" in which an underlying sequence /a+i/ is realized as [e]. (Similarly, /a+u/ may be realized as [o].) Significantly, however, while this type of pattern is commonly reported in five-vowel /ieaou/ systems and is attested in a number of nine-vowel /iɪeɛaɔoʊu/ systems, it is apparently unattested in the very common seven-vowel system /ieɛaɔou/. Instead, the result of coalescing /a+i/ in such languages is apparently always [ɛ]. (Similarly, /a/ and /u/ coalesce to form [ɔ].) The fact that these two different realization patterns are in complementary distribution based on vowel inventory shape suggests that we are dealing with a single process which should be given a uniform characterization at some level across the different vowel systems. In straightforward descriptive terms, it is evident that Height Coalescence, in either its /a+i/ > [e] or /a+i/ > [ɛ] manifestations, involves the preservation of an underlying height feature of V_1 together with the non-height (frontness or roundness) features of V_2. Formally, we might express this in Optimality-Theoretic terms by means of a constraint ranking which favors preservation of some relatively low/non-high height feature of V_1 over the [+high] specification of V_2. If this is on the right track, then it is evident that the complementary distribution of the two alternative manifestations of Height Coalescence poses a serious challenge for theories of height features. For while the realization /a+i/ > [e] must be viewed as involving preservation of the [-high] specification of V_1 (a contention which is further supported by the typical realization of /e+i/ and /o+i/ as [e] in languages with this type of Coalescence), the realization /a+i/ > [ɛ] in the seven-vowel system in which it is found appears to involve preservation of [-ATR] (a claim which is confirmed by other typical realizations in languages with this pattern, e.g. /a+e/ > [ɛ]). It is by no means obvious why [-ATR] should be predictably preserved only in the seven-vowel system. This surprising correlation is also supported by other phonological evidence, e.g. from feature spreading, which shows that [-ATR] is predictably active in seven-vowel systems (of the type /ieɛaɔou/), but is predictably inactive in languages with more or fewer vowel heights. In the final chapter of the dissertation, I seek to motivate a set of principles (formalized as constraints in the spirit of Optimality Theory), which correctly predict the value of [ATR] (or rather, its auditory equivalent) that is specified in a given type of vowel inventory.

Chapter 2: Vowel Elision

Vowel Elision may target either the leftmost vowel in a sequence (henceforth V_1) or the rightmost (henceforth V_2). In fact, it is not uncommon for a single language to manifest V_1 Elision in some contexts and V_2 Elision in others. This is the case for example in Etsako (Elimelech 1976), as illustrated in the examples below. (Notice that example (7d) involves V_1 Elision of the final vowel of /ɔna/ 'the' as well, and that example (7c) involves Glide Formation in addition to V_2 Elision.)

(6)	V_1 Elision:			
	a. dɛ akpa buy cup	→	dakpa	'buy a cup'
	b. ukpo ɛnodɛ cloth yesterday	→	ukpɛnodɛ	'yesterday's cloth'
	c. owa ɔda house different	→	owɔda	'a different house'
	d. umhele ɔtsomhi salt some	→	umhelɔtsomhi	'some salt'
	e. ɔna idu the lion	→	ɔnidu	'the lion'
(7)	V_2 Elision:			
	a. ɔna aru ɔli the louse that	→	ɔnaruli	'that louse'
	b. akpa ɔnikeθe cup small	→	akpanikeθe	'a small cup'
	c. eɤi ɔnɔmiɛ tortoise the one he saw	→	eɤinɔmyɛ	'a tortoise that he saw'
	d. ɔna eɤi ɔna the tortoise the	→	ɔneɤina	'this tortoise'

The primary goal of this chapter is to explain the factors that affect which vowel is elided. I claim that this choice is not random but is subject to interesting restrictions, to be discussed in section 2.2. In some morphosyntactic contexts in fact, the choice appears to be universally determined. In other environments, either type of Elision is possible; I argue that in these environments the type which is manifested in a given language is determined by the ranking of certain constraints that obtains in that language.

2.1 Approaches to Vowel Elision

2.1.1 Rule-based approaches

Most previous treatments of Vowel Elision (cf. Aoki 1974, Casali 1988, Clements 1986, Donwa-Ifode 1985, Massagbor 1989, Pulleyblank 1988, Snider 1985, 1989c) have been carried out within the framework of linear or non-linear generative phonology. Within these approaches, the choice of which of two adjacent vowels is elided is determined, trivially, by the form of the rule that carries out the deletion. Thus the literature contains examples of rules deleting V_1, as in (8), as well as rules deleting V_2, as in (9):

(8) V_1 Elision:

$$V \rightarrow \emptyset \; / \; \_\_\_ \; V$$

(9) V_2 Elision:

$$V \rightarrow \emptyset \; / \; V \; \_\_\_$$

Implicit in this approach is the claim that which vowel is deleted is not predetermined by contextual factors, but is simply a matter of which of two equally available options is selected by the language. In fact, the possibility that the choice of vowel targeted might be to some extent predictable seems never to have been seriously explored. Nevertheless, we shall see below that the choice of which vowel is elided is in fact predictable to a large extent. At the boundary between a prefix and a root, for example, Elision targets V_1 almost universally. This generalization is clearly unaccounted for by approaches in which the vowel targeted by Elision must be directly encoded in the rule responsible for the process.

2.1.2 Optimality Theory

From the viewpoint of Optimality Theory, the issue potentially takes on a very different appearance. On the one hand, it is a relatively straightforward matter to devise a ranking of well-motivated constraints that gives rise to Vowel Elision, as opposed to other possible hiatus resolution strategies such as Epenthesis. (This will be discussed in detail below.) Predicting which of two adjacent vowels elides, on the other hand, poses a more interesting challenge. This is because, in contrast to rule-based approaches, Optimality Theory provides no direct mechanism for simply stipulating which vowel is elided. Rather, the choice must be determined based on the extent to which the output forms resulting from the two types of Elision satisfy various constraints. What renders the matter difficult here is the fact that the phonological makeup of the two outputs is so nearly identical, such that it is not obvious what well-motivated constraints might distinguish between them. For one thing, the surface syllabifications resulting from both processes are identical:

(10)	a. V_1 Elision:	$CV_1\ V_2CV$	$\rightarrow$	$.CV_2.CV.$
	b. V_2 Elision:	$CV_1\ V_2CV$	$\rightarrow$	$.CV_1.CV.$

This means that constraints like ONSET that refer to syllable structure are equally satisfied by either candidate. Also, it is not immediately clear that faithfulness constraints like PARSE can effectively distinguish between the outputs, since both candidates involve the loss of exactly one segment. While one could imagine adopting a pair of constraints "PARSE-leftmost-V" and "PARSE-rightmost-V" whose relative ranking would decide the issue, such a maneuver is patently ad hoc. Relying on constraints which directly mimic the directional effects of conventional phonological rules in this fashion would undermine the content of the theory by eroding the potentially very significant empirical differences between the predictions of Optimality Theory and those of rule-based phonology.

In his account of Elision directionality, Rosenthall (1994) appeals to a more subtle difference between the representations in (10a) and (10b), i.e. the location of the unparsed segment with respect to the syllable boundaries in the output. In the case of the former representation, which involves V_1 Elision, the unparsed segment occurs in the middle of a syllable, as shown in (11):

(11) $_{\sigma}[C{<}V_1{>}V_2]_{\sigma}\ _{\sigma}[CV]_{\sigma}$

In the case of (10b), which involves V_2 Elision, on the other hand, the unparsed segment occurs between two syllables:

(12) $_\sigma[CV_1]_\sigma<V_2>_\sigma[CV]_\sigma$

Rosenthall claims that the preference for V_1 Elision is due to the fact that the syllable boundaries in a representation like (11) are segmentally contiguous, satisfying a constraint Syllable Contiguity:

(13) Syllable Contiguity:
$*rt]_\sigma<rt>_\sigma[rt$ (rt = root node)

The representation deriving from V_2 Elision on the other hand violates this constraint. Other things being equal, V_1 Elision should therefore always be preferred to V_2 Elision. Cases in which V_2 Elision does occur must then be due to the effects of other constraints (which are not specifically discussed). As Rosenthall notes (citing Kaye, Lowenstamm & Vergnaud (1985) and Casali (1992)), V_1 Elision is in fact overwhelmingly more common than V_2 Elision.

This analysis relying on Syllable Contiguity raises as many questions as it answers. We should like to know, for example, why UG makes available a constraint that disprefers interruption of a heterosyllabic sequence of (parsed) segments by an unparsed segment, but no constraint like the one in (14) that disprefers interruption (such as results from V_1 Elision) of a tautosyllabic sequence.

(14) Syllable Continuity:
$*_\sigma[rt<rt>rt]_\sigma$

This analysis relies crucially on the absence of such a constraint, which could give rise to V_2 Elision in languages in which it is ranked above Syllable Contiguity. And yet the formal expression of such a constraint is entirely parallel to Syllable Contiguity. Since the asymmetric existence of Syllable Contiguity but not the constraint (14) cannot be readily explained on formal grounds, and since no substantive justification for Syllable Contiguity is given, the explanatory value of the analysis is questionable.

The analysis based on Syllable Contiguity also fails to account for the observed fact that the overall preference for V_1 Elision does not apply equally in all morphosyntactic contexts. Whereas V_1 Elision occurs to the almost total exclusion of V_2 Elision in some contexts (e.g. at prefix-root boundaries), there are other contexts (e.g. at root-suffix boundaries) in which both types of Elision are well-attested. We shall see below in fact that once due regard is given to the effects of contextual factors, there remains little if any clear justification for assuming the sort of context-independent preference for V_1 Elision that is implicit in (13).

2.2 V_1 and V_2 Elision: cross-linguistic generalizations

Of the 91 languages in my survey, 88 have Vowel Elision in at least some context(s). (Three languages, Anufɔ (Adjekum, Holman & Holman 1993), Kasem (Bonvini 1988, Callow 1965a,b, Haas 1988a), and Nuni (Kurrle 1988) show only Coalescence, at least in the sources I examined.) The generalizations presented in this section are based on these 88 languages. These languages are listed in (15), grouped according to the type(s) of Elision (V_1 and/or V_2) which they display. (Non-Niger-Congo languages are underlined.)

(15) a. Languages where source shows V_1 Elision only:

Au (Scorza 1985), Babole (Leitch 1994, Myles Leitch personal communication), Bemba (Sims 1959, Sambeek 1955, Givon 1970a, Kashoki 1968), Bobangi (Whitehead 1899), Bolia (Mamet 1960), Central Kambari (Hoffman 1972), Chagga (Nurse & Philippson 1977, Saloné 1980), Chicano Spanish (Schane 1987), Chumburung (Hansford 1988, Snider 1985, 1989c), Chiyao (Ngunga 1995), Dyula (Long & Diomandé n.d.), Eggon (Maddieson 1972), Engenni (Elugbe 1989, Thomas 1978), Ghotuo (Elugbe 1972), Gichode (Keith Snider, field notes), Gonja (Painter 1970), Igede (Bergman 1968, 1971), Ila (Smith 1907), Iraqw (Rosenthall & Mous 1995), Izi (Meier, Meier & Bendor-Samuel 1975), Kamba (Whitely & Muli 1962, Roberts-Kohno 1995a,b), KiYaka (Eynde 1968, Kidima 1991), Kikuyu (Armstrong 1940, Leakey 1959), Kinande (Clements 1991, Goad 1993, Hyman 1989, Mutaka & Hyman 1990, Schlindwein 1987), Kisar (Christensen & Christensen 1992), Kongo (Meinhoff 1932), Krachi (Keith Snider, field notes), Lango (Noonan 1992), Lokəə (Iwara 1982), Logo (Goyvaerts 1983), Lugisu (Brown 1969), Malakmalak (Birk 1976), Moba (Russell 1985), Nawuri (Casali 1988, 1995b), Nupe (Smith 1967, 1969), Ogbia (Williamson 1972), Owon Afa (Awobuluyi 1972, Stahlke 1976), Pero (Frajzyngier 1980), Santee Dakota (Shaw 1980), Shilluk (Gilley 1992), Si-Luyana (Givon 1970b), SiSwati (Cahill 1994, Herman 1995), Southern Sotho (Doke & Mofokeng 1957, Guma 1971), Swahili (Keach 1987), Tabla (Collier & Gregerson 1985), Teton Dakota (Carter 1974), Tsonga (Baumbach 1987), Uma Juman (Blust 1977), Urhobo (Elugbe 1972), West Tarangan (Nivens 1992), Xhosa (Aoki 1974, McLaren 1955), Yakata (Motingéa 1993), Zulu (Doke 1926, 1931, 1954)

b. Languages where source shows V_2 Elision only:

Basque (Hualde & Elordieta 1992), Kagate (Walker 1989)

c. Languages with both V_1 Elision and V_2 Elision:

Afar (Bliese 1981), Aghem (Hyman 1979), Avatime (Schuh 1995), Chichewa (Mtenje 1980, 1992), Daga (Murane 1974), Dangme (Dakubu 1987), Diola-Fogny (Sapir 1965), Ebira (Adive 1984), Edo (Agheyisi 1987, Folarin-Schleicher 1992, Omozuwa 1992, Wescott 1962), Efik (Cook 1969(?), Ward 1933, Welmers 1973), Emai (Folarin-Schleicher 1992, Schaefer 1987), Etsako (Elimelech 1976), Ewe (Westermann 1930), Igbo (Emenanjo 1972), Ijo (Williamson 1965), Isekiri (Dunstan 1969, Omamor 1979), Isoko (Donwa-Ifode 1985, Elugbe 1989), Ivie (Masagbor 1989), Lamba (Doke 1922, 1931, 1938), LuGanda (Ashton et. al. 1954, Clements 1986, Katamba 1985, Tucker 1962), Lulobo (Andersen 1987), Modern Greek (Kaisse 1977), Mundani (Parker, Elizabeth. n.d.), Nandi (Creider & Creider 1989), Niaboua (Bentinck 1978, 1979), Obolo (Faraclas 1982, 1985), Ogola Yala (Bunkowske 1972), Ogori (Chumbow 1982a,b), Okpe (Hoffman 1973, Omamor 1988, Pulleyblank 1986), Sango (Samarin 1967), Shona (Doke 1931, Fortune 1955), Vata (Kaye 1982), Yoruba (Pulleyblank 1988)

In many cases, it was not easy to ascertain from a source how general an Elision process is in a particular language. I have therefore made no attempt in (15) to distinguish languages with fully general V_1 or V_2 Elision from those in which a process occurs only under restricted circumstances. Also, it is relatively rare to find a source which explicitly states that only one type of Elision occurs in a language. Thus, it is conceivable that more data would show that some of the languages in (15a) actually have V_2 Elision as well as V_1 Elision (or that one or both of the two languages in (15b) actually has V_1 Elision in addition to V_2 Elision). I believe that this is unlikely to occur in more than a very few cases, however. In most of the sources I looked at, the stated aims of the author(s) are such that it seems unlikely that they would have failed to mention the other the type of Elision had they been aware of its existence in the language.[2]

We may now consider the cross-linguistic generalizations to which Vowel Elision conforms. The first and most striking of these is that V_1 Elision is far more common and productive than Elision of V_2. This asymmetry is manifested in several ways. First, in terms of sheer frequency of occurrence, languages with V_1 Elision outnumber languages with V_2 Elision by more than two to one. Second, with the exception of only two languages, Kagate and Basque, every language in the survey with V_2 Elision also has V_1 Elision in at least some contexts. Finally, while there are many languages with fully productive V_1 Elision at word and/or morpheme boundaries, V_2 Elision is almost always restricted in some way e.g. it applies only to

---

[2] There is an issue of interpretation which must be noted here, involving two common situations in the survey that superficially appear to involve V_2 Elision but which I have not treated as such. One of these, which occurs for example in Bemba (Sims 1959) and a number of other Bantu languages, involves the failure of the initial vowel of a noun to surface in certain syntactic contexts. Although some of these contexts follow a preceding word-final vowel and might thus appear to be cases of hiatus resolution through V_2 Elision, a closer examination of the facts indicates that the absence of the non-initial vowels is determined by syntactic factors that have nothing to do with hiatus resolution.

The second case of pseudo V_2 Elision involves a large number of languages which have a Coalescence process that realizes /a+i/ and /a+u/ as [e] and [o] respectively. It is extremely common for such languages to realize the sequences /e+i/ and /o+u/ as the first vowel in each sequence, i.e. /e+i/ is realized as [e] and /o+u/ as [o]. In languages which clearly have Coalescence (e.g. with /a+i/ > [e]) in some contexts, I have regarded all such cases as instances of Coalescence rather than V_2 Elision, i.e. these languages have a general Coalescence process that converts a non-high V_1 plus a high V_2 to a vowel that combines the [-high] value of V_1 with all other features of V_2. That this is correct is shown by the fact that the resolution of precisely these sequences via superficial V_2 Elision is extremely rare in languages without Coalescence, but very common in languages with Coalescence.

particular vowel combinations or to particular morphemes. This tendency for V_2 Elision to be restricted was also noticed by Bergman (1968:46) in his survey of hiatus resolution in 33 Niger-Congo languages:

> "When elision occurs in a given language, there is always loss of [word- or morpheme-] final vowels, but seldom loss of [word- or morpheme-] initial vowels...Furthermore, the loss of initial vowels is usually very limited in its statistical incidence."

If we delve into additional facts not represented in (15), however, it turns out that the overall preference for V_1 Elision does not apply equally in all morphosyntactic contexts. There are four distinct environments for which I have sufficient data to identify significant generalizations concerning the vowel targeted by Elision: the boundary between two lexical words, the boundary between a lexical (content) word and a following function word, the boundary between a prefix and a root, and the boundary between a root and a suffix. The generalizations that obtain at each of these types of juncture are listed below.

1. At the boundary between two lexical words, Elision is always of V_1. This generalization is very robust; the only exceptions involve the idiosyncratic behavior of particular vowels or particular combinations of words (e.g. the vowel /i/ is elided after a preceding word-final vowel in Yoruba, even though Elision otherwise generally

targets V_1).[3] I have not found a single example of a language which generally elides V_2 at lexical word boundaries.

2. At the boundary between a lexical word and a following function word, V_1 Elision also appears to be more common. There is however a significant number of languages which elide V_2 in this environment with at least some function words. For example Etsako elides the initial vowel of /ɔli/ 'that' following a word-final vowel, as in example (7a) given previously, and repeated below as (16).

(16) ɔna aru ɔli → ɔnaruli 'that louse'
the louse that

3. Only V_1 Elision generally occurs at the boundary between a (minimally) CV prefix and a root. I have come across no languages which regularly elide V_2 in this environment. (Data bearing on how Elision treats monosegmental V prefixes in this context is too limited to draw reliable conclusions.)

4. At the boundary between a root and a suffix, either V_1 or V_2 Elision is possible. There seems to be a tendency, however, for V_1 Elision to occur when the suffix consists entirely of a single vowel, and for V_2 Elision to occur when the suffix is minimally of the form VC.

[3] In addition, Wescott (1962) reports that Edo has V_2 Elision at boundaries involving particular sequences of categories, e.g. noun + verb, verb + adverb, and noun + numeral. These facts are not reported however by my other sources on Edo, and I make no attempt to account for them in this paper.

Particularly telling with respect to the asymmetries between lexical and function words and between prefixes and suffixes are languages which display opposite patterns in opposite environments, i.e. languages which display V_1 Elision at the juncture of two lexical words but V_2 Elision at the boundary between a lexical and a following function word, or which display V_1 Elision at a prefix-root boundary but V_2 Elision at a root-suffix boundary. The former type of asymmetry is displayed by a number of languages, including Etsako, Isoko, Ivie, and Emai. Languages displaying the latter type of asymmetry include Chichewa and Avatime.

The existence of these regular patterns shows strongly that the choice of which vowel is elided is not merely an idiosyncratic property of individual languages, but is to some extent predictable from the context in which hiatus arises. In the following section, I outline an analysis, within the framework of Optimality Theory, that relies on constraints making crucial reference to these two factors. This analysis will allow for the range of variation which is found to occur while ruling out unattested patterns such as a language which regularly elides V_2 at lexical word boundaries.

2.3 Determining the target of Elision: An analysis

My analysis may conveniently be divided into two subcomponents: the mechanisms that determine the general conditions under which Vowel Elision occurs, and the mechanisms which determine, in languages which do have Vowel Elision, which vowel is elided. These are presented in sections 2.3.2 and 2.3.3 respectively. Before proceeding to these matters, however, I first discuss the theory of Faithfulness constraints I will be employing.

2.3.1 Background assumptions: Faithfulness Theory

In Prince & Smolenski's original conception of Faithfulness (hereafter referred to as the "Containment" view) no element was ever literally removed from or inserted into the input. Rather, "deletion" of a feature or segment was accomplished indirectly. An element that was structurally associated in the input could appear in an output candidate delinked from its original anchoring node; such a floating element would receive no phonetic interpretation and would be left unpronounced (and thus, in effect, deleted). This state of affairs would however be penalized as a violation of the constraint PARSE. Similarly, "insertion" of segmental or featural material was also effected indirectly through the generation of candidates that contain, in addition to all of the material in the input form, one or more empty elements devoid of phonological content; these empty elements would receive featural interpretation in the phonetic component and thus appear as epenthetic features or segments. Here again, the deviation from the input was not cost free, but resulted in violation of a constraint, in this case the constraint FILL, which militated against empty elements.

The Containment approach to Faithfulness has largely been supplanted by a more recent theory, Correspondence Theory, developed in McCarthy & Prince (1995). Unlike the Containment approach, the Correspondence model allows actual deletion or insertion of features or segments, although all such deletion or insertion violates one or more constraints. Deletion of an entire segment violates a constraint MAX-IO which requires that every segment in the input correspond to some segment in the output. Insertion of a segment violates DEP-IO, which requires that every segment in the output correspond to some segment in the input. Deletion or insertion of an individual feature within a segment, on the other hand, violates neither MAX-IO nor DEP-IO, but rather a constraint IDENT-IO(F) which states that corresponding input and output segments should bear identical specifications for a feature F. Finally, Coalescence violates, in addition to IDENT-IO(F), a constraint UNIFORMITY, which disprefers a situation in which two segments that are distinct in the input are merged as a single segment in the output.

Although the original Containment approach to Faithfulness and the Correspondence theory which is intended to replace it clearly differ in important respects, they share the significant characteristic that loss (or insertion) of an individual feature violates a different constraint than loss of an entire segment. In the Containment model, featural loss violates a constraint PARSE-feature, while loss of an entire segment satisfies PARSE-feature but violates a constraint PARSE-segment.

In the version of Correspondence theory proposed in McCarthy & Prince, loss (or addition) of an individual feature(s) is penalized as an IDENT-IO(F) violation, while deletion of an entire segment violates only MAX-IO.

While there is nothing obviously unreasonable in regarding featural and segmental loss as violating different constraints, especially if one adopts a relatively standard view of phonological structure in which the segment plays a crucial role, this is not the only conceivable approach. An alternative possibility would be to treat the loss of an entire segment simply as the cumulative effect of deleting each of the segment's individual features. In other words, we would have a constraint (or family of constraints) that penalizes every loss of an input feature; we might therefore assume (following Kirchner 1993) that a separate constraint(s) that directly penalizes Elision of an entire segment is unnecessary. Similarly, in place of a constraint that penalizes insertion of segments, we will have a constraint that militates against insertion of individual features; insertion of an entire segment will incur multiple violations of this constraint. (It would also be necessary to assume some further constraint that favors maintaining the original temporal alignment of features, in order to prevent wholesale cost-free redistribution of features among segments.)

The notion that Faithfulness violations might be measured primarily with reference to features strikes me as an appealing prospect that deserves exploration. The claim that both segmental Elision and loss of individual features violate the same constraint favoring preservation of features makes potentially interesting predictions. For example, since this same constraint is violated by both Vowel Elision and Coalescence, we potentially expect that there might be some type of correlation between these two processes in different languages. In Correspondence Theory (as presently conceived), on the other hand, the constraints violated by segmental Elision and those violated by Coalescence are entirely different: Elision violates MAX-IO, while Coalescence violates IDENT-IO and UNIFORMITY; there is therefore no obvious reason to expect any type of interdependence between the two processes.

Ultimately, the question of whether Faithfulness violations are best reckoned in terms of featural loss/insertion or segmental loss/insertion (or both) can only be settled with reference to a wide range of empirical facts and is an issue which is well beyond the scope of this dissertation. I hope to show, however, that the feature-mediated approach is fully capable of handling the hiatus resolution facts we will be concerned with here, despite the considerable richness and complexity of the phenomena. We will see below, moreover, that the feature-mediated approach avoids one technical difficulty encountered by the segment-mediated version of Correspondence Theory proposed in McCarthy & Prince.

The choice between feature-mediated and segment-mediated implementations of Faithfulness is orthogonal to the question of whether actual loss or insertion of features or segments is to be permitted (though penalized), as in Correspondence

Theory, or ruled out by UG (as in Containment Theory). With respect to this latter issue, I follow Correspondence Theory in assuming that Epenthesis involves actual insertion of phonological material (i.e., material is present in a candidate output form which was not present in the input), and that Elision involves actual removal of phonological material (i.e., material present in an input is absent in a candidate output form). The result then, will be an approach to Faithfulness which allows actual insertion and deletion of material and in which violations incurred by these processes are reckoned in terms of addition or removal of features rather than changes to segments. The specific set of Faithfulness constraints I propose to adopt is given in (17). Note that even though I retain the original designation PARSE, this constraint is here interpreted as militating against actual deletion of features rather than against unassociated elements, as in Containment Theory (in which actual deletion is impossible).

(17)	PARSE(F)	Preserve an input feature F in the output.
	*Ins(F)	Don't insert feature(s).
	Segment Integrity (Seg-Int)	If one feature of a segment is preserved, all its features are preserved.

The constraint Seg-Int largely corresponds to McCarthy & Prince's UNIFORMITY. As Seg-Int is now stated, many violations of McCarthy & Prince's IDENT-IO(F) (i.e. those involving featural loss) will also be penalized as Seg-Int violations. Whether this extremely broad construal of Seg-Int can be maintained in the face of empirical evidence from a wide variety of phenomena remains to be seen; I have not so far discovered any obvious difficulties which arise from this formulation in connection with the languages dealt with in this study however.

The theory proposed here makes no claims about the presence or absence of hierarchical structure internal to the segment, and is potentially compatible with a variety of theories of phonological structure, including one (which I will henceforth assume for our purposes) in which segments possess no internal structure whatsoever, but simply consist of unordered sets of features.

It is worth noting that the feature-mediated theory of Faithfulness adopted here avoids a technical problem that arises within Correspondence Theory as proposed in McCarthy & Prince. McCarthy & Prince (pp. 313-320) discuss a situation involving juxtaposition of a morpheme-final /k/ before a morpheme-initial /ʔ/ in Chumash. Among the candidates supplied by Gen as possible realizations of the underlying /k_1+$ʔ_2$/ sequence (where the subscripts are used to associate segments in underlying with the segments to which they correspond in surface forms) are a candidate [$ʔ_2$] which involves deletion of the /k/, and a candidate [$k'_{1,2}$] which involves Coalescence of the two segments to form a velar ejective. The second of these candidates is the attested realization in Chumash; the Elision candidate, while not attested in Chumash, is certainly a plausible outcome that might be expected to occur in some languages. In addition to these forms, however, Gen will also supply a candidate [ʔ$_{1,2}$] which, while phonetically identical to the candidate that has undergone Elision of /k/, actually involves Coalescence of /k/ and /ʔ/ along with loss of the place and laryngeal specifications of /k/. The two superficially identical candidates [ʔ$_2$] and [ʔ$_{1,2}$] violate entirely different constraints: the former violates MAX-IO, while the latter violates UNIFORMITY, IDENT-IO(Place), and IDENT-IO(Laryngeal), both of the IDENT-IO(F) violations being due to the mapping of an input /k/ to an output [ʔ] (indicated by the fact that both segments bear a subscript 1). The fact that there are thus two different ways in which a language may obtain this same superficial result is a potentially undesirable result; at the very least, it places an added burden on the grammar of any language which realizes /k+ʔ/ as something other than [ʔ], in that the overall facts of the language must be compatible not only with a ranking that rules out segmental Elision (i.e. /k$_1$+ʔ$_2$/ > [ʔ$_2$]) but with one that rules out the pseudo-Coalescent candidate (i.e. /k$_1$+ʔ$_2$/ > [ʔ$_{1,2}$]). Much more vexing, however, is the fact that the correct output in Chumash, [k'$_{1,2}$], incurs exactly the same Faithfulness violations as the pseudo-Coalescent candidate, i.e. UNIFORMITY, IDENT-IO(Place), and IDENT-IO(Laryngeal). (The IDENT-IO(Place) violation incurred by [k'$_{1,2}$] is due to the mapping of /ʔ/ onto [k'], while the IDENT-IO(Laryngeal) violation is due to the mapping or /k/ onto [k'].) Since these two candidates tie on Faithfulness violations, we would expect the outcome to be decided by other constraints which favor less marked segments over more marked segments. Since [ʔ] is presumably a less marked segment than [k'], it will always be preferred by these constraints and will therefore always be more optimal overall. The theory thus predicts, incorrectly, that [k'] will never be a possible realization of an input /k+ʔ/ in any language.

While McCarthy & Prince discuss a number of possible solutions to this difficulty within their framework, none is implemented in detail and it remains to be seen to what extent they may prove viable. Within the Feature-Mediated theory of Faithfulness, on the other hand, this simply never arises to begin with. Since <u>any</u> situation in which one or more input features is absent in the output necessarily violates PARSE(F), there can never be a candidate which superficially involves Elision but does not violate the constraints that genuine Elision violates.

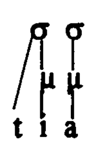
2.3.2 General constraints relevant to vocalic hiatus

Within the framework of Optimality Theory, the particular resolution strategy adopted in a given language will depend on the relative ranking of a series of constraints which favor or disfavor particular strategies. In the paragraphs which follow, I briefly describe the constraints which, under the present analysis, are primarily relevant to this issue. My analysis largely follows proposals made previously in Casali (1994) and Rosenthall (1994).

For purposes of discussion, I assume the set of vowel features [front], [round], [high], [low], and [ATR]. I further assume that with the exception of [high], which is binary, these features are all privative. These assumptions are not however crucial to the analysis, which is compatible with a variety of alternative feature frameworks.

The first constraint, ONSET (Prince & Smolensky 1993), expresses the cross-linguistic preference for syllables with onsets. As with all constraints, ONSET is assumed to be universal. Its effects may however be obscured in a given language by the higher ranking of other constraints. In languages in which ONSET is ranked sufficiently low, onsetless syllables may be tolerated in at least some environments. In some languages this will entail that heterosyllabic sequences of adjacent non-identical vowels are permitted, even though the second vowel belongs to an onsetless syllable, as in the hypothetical example below:

(18)



In languages in which ONSET is ranked sufficiently high, on the other hand, such sequences will not be permitted; where they arise through morphological or syntactic concatenation they will be subject to elimination by particular means which depend on the ranking of other relevant constraints.

A second constraint, *DIP ("avoid diphthongs"), expresses the relative markedness of tautosyllabic sequences of non-identical vowels. Where the low ranking of *DIP relative to other constraints dictates that such sequences are permitted in a particular language, vocalic hiatus may be rectified by analyzing the vowels as tautosyllabic. This reanalysis will only be possible in languages in which *DIP is outranked by ONSET, since the syllabification .CVV. obeys ONSET but not *DIP, while the syllabification .CV.V. obeys *DIP but not ONSET.

The constraint *INS(F), discussed in the preceding section, assigns a cost to the insertion of features (Itô, Mester & Padgett 1995, Kirchner 1993), and by implication, to the insertion of entire segments. It replaces the constraint FILL of Prince & Smolensky (1993). The significance of *INS(F) for our purposes is that its ranking will determine whether or not a language will repair onsetless syllables arising in CVV sequences through Epenthesis of an intervening consonant. (This consonant would be syllabified with the second vowel, providing an onset for the syllable to which this vowel belongs.) This will be possible only in languages in which *INS(F) is ranked sufficiently low (and in particular, below ONSET).[4]

The constraint PARSE(F), discussed in the preceding section, militates against loss of features. As with other constraints, multiple violations of PARSE(F) may be incurred: each unassociated feature in an output candidate counts as an additional violation of PARSE(F). "Deletion" of an entire segment, for example, would entail one PARSE(F) violation for every feature in the segment. Following Kirchner (1993), I assume that a separate constraint against loss of segments is therefore unnecessary.

Finally, in order to allow for the fact that many languages do not allow Glide Formation, as well as for the fact that many languages do not tolerate [Cw] or [Cy] onsets arising from other sources, I assume a constraint *CG which penalizes these onsets.[5]

---

[4] Strictly speaking, *INS(F) should be regarded not as a single constraint but rather as a series of constraints, one for each feature. That is, we will have individual constraints like *INS(voiced), *INS(round), etc. Depending on how these individual *INS(F) constraints are ranked with respect to each other and with respect to other constraints that might favor feature insertion, it should be possible for a language to permit insertion of certain features but not others. And this of course is what we find: languages which epenthesize features or segments impose limitations on which features or combinations of features are inserted. For the matters with which we will be concerned, however, it will generally be safe to treat *INS(F) as though it were a single constraint.

[5] Under the usual assumption that there is a genuine representational difference between bisegmental [Cw] / [Cy] sequences and secondarily articulated labialized / palatalized consonants ([C^w] / [C^y]), we must also assume constraint(s) which disprefer the latter type of entity. It is not clear to me however whether the putative phonological difference between these representational possibilities is really justified, in view of the fact that the two types are almost never reported to contrast within a

As a first approximation, we may identify each of the possible hiatus resolution strategies described earlier with a particular constraint violation it entails:

(19)

Result:	Constraint Violated:
Heterosyllabification	ONSET
Epenthesis	*INS(F)
Diphthong Formation	*DIP
Vowel Elision	PARSE(F)
Glide Formation	*CG

Here I have omitted separate mention of Coalescence. Like Elision, this process violates the constraint PARSE(F). It is generally true, moreover, that languages with Coalescence manifest Elision as well, with at least some input sequences. In a sense, therefore, we might regard Coalescence as a form of Elision.

Note that under this state of affairs, in which each strategy violates exactly one constraint, the strategy selected should depend only on which constraint is ranked lowest. This analysis is clearly oversimplified however, since it predicts that Vowel Elision and Glide Formation will never co-occur in the same language. In fact, it is very common for a language to manifest Glide Formation with some sequences of vowels, typically where V_1 is high (or at least non-low), and Elision with others,

---

single language. The issue is in any case of relatively little consequence as far as our aims here are concerned.

typically where V_1 is low (or at least non-high). In order to account for this, I propose the following additional constraints on glides:

(20)	a. *low-G	A glide must not be [low].
	b. frt/rnd-G	A glide must be [front] or [round].

These constraints are rarely violated in languages, and for our purposes we may assume that they are undominated in the languages we will be concerned with. To simplify the exposition somewhat, I will conflate these two constraints into a single constraint, which I label GLIDEHOOD (GH), that requires glides to be non-low and either [front] or [round].

Assuming that this constraint is undominated, the only way in which it would be possible to have a vowel like /a/ undergo Glide Formation would be to fail to parse its feature [low] and, in addition, insert either a [round] or a [front] specification, in violation of *INS(F). It will therefore be possible to have languages in which Glide Formation occurs with a high V_1 like /u/, but Vowel Elision takes place when V_1 is /a/. This will be the case when the constraints ONSET, *INS(F), and *DIP are ranked above PARSE(F), which in turn is ranked above *CG. This is illustrated in (21) and (22). (Here *... is used to symbolize multiple violations of a PARSE(F) or *INS(F) constraint i.e., one violation for every feature affected. The symbol <u>A</u> is used to represent a glide formed from /a/.)

(21) Glide Formation preferred to Vowel Elision when V_1 is /u/:

	/Cu V_2CV/	GH	ONSET	*INS(F)	*DIP	PARSE(F)	*CG
⇒	Cw V_2CV						*
	C<u> V_2CV					*...	

(22) Vowel Elision preferred to Glide Formation when V_1 is /a/:

	/Ca V_2CV/	GH	ONSET	*INS(F)	*DIP	PARSE(F)	*CG
	CA V_2CV	*					*
	Cy V_2CV			*...		*...	
	Cw V_2CV			*...		*...	
⇒	C<a> V_2CV					*...	

An adequate account of the behavior of mid vowels is less straightforward and requires additional mechanisms which, for reasons of space, I will not go into here. A discussion of these mechanisms is given in Casali (1995a).

2.3.3 V_1 vs. V_2 Elision: position-sensitive PARSE constraints

In this section I develop an explicit formal analysis of the directional asymmetries related to Vowel Elision. My proposal relies fundamentally on the notion, which goes back to Trubetzkoy (1939), that certain prominent positions lend themselves more readily to maintaining contrasts among particular kinds of features and/or segments (see also Steriade (1993)). In keeping with this idea, we might expect that vowel features or segments will be more resistant to deletion in certain environments. I propose that the universal set of constraints includes a family of position-sensitive constraints of the form PARSE(F)-P which favor preservation of features in certain prominent morphosyntactically or prosodically defined positions (P). Among these positions are those listed in (23).

(23) a. word-initially
b. in a lexical (content) word/morpheme
c. in a stressed syllable
d. in a geminate segment

For our purposes, the contexts which are most relevant are those in (23a,b). Corresponding to these positions are the PARSE(F) constraints in (24):

(24)	PARSE(F)-$[_w$	Parse F in a word-initial segment.
	PARSE(F)-lex	Parse F in a lexical word or morpheme.

The effect of the particular constraint PARSE(F)-lex will depend on how the distinction between lexical and non-lexical (i.e. 'function') words is precisely defined. This is not a trivial matter. On the one hand, there are categories of words, such as nouns, verbs, and adjectives, which seem indisputably lexical, as well as other types, e.g. determiners, which few would hesitate to treat as non-lexical. On the other hand there are other words, e.g. prepositions and pronouns, whose status is not so clear. As a first approximation, I will assume that nouns, verbs, adjectives, and adverbs are lexical words, while all other words are non-lexical. With regard to word-internal contexts, I will treat all roots as lexical and all affixes as non-lexical. These assumptions should however be regarded as tentative and subject to modification. I assume that position-sensitive PARSE constraints are universally ranked above ordinary (non-position-specified) PARSE(F):

(25) universal ranking:

$\{$ PARSE(F)-$[_w$, PARSE(F)-lex $\} >>$ PARSE(F)

Although these position-sensitive PARSE(F) constraints play a crucial role in accounting for the directionality of Vowel Elision, it must be emphasized that their effects are not limited to the phenomena related to hiatus resolution. Instead, they are independently warranted by a variety of synchronic and diachronic phenomena which suggest that languages go to greater length to preserve features and/or segments in word-initial position and in lexical elements.

In the case of word-initial position, I note that while there are many languages in which word-final or word-medial vowels are lost historically or synchronically,[6] the loss of word-initial vowels seems to be quite rare. (Here I am speaking of vowel loss in general and not just in hiatus contexts.) Loss of individual features may also be less common in word-initial position. Obstruent devoicing, for example, is common word-finally, but seemingly unattested word-initially. On grounds of phonetic naturalness alone, this fact is rather surprising, given that articulatory considerations favor voicelessness in word-initial obstruents just as they do in word-final obstruents (Westbury & Keating 1986). Nevertheless, it is quite rare to find languages which neutralize a voicing contrast word-initially; if a language has a voicing contrast at all,

[6] Synchronic loss of medial or final vowels occurs for example in Akan (Schachter & Fromkin 1968), French (Schane 1973), Lardil (Itô 1986), Nawuri (Casali 1995d), Tonkawa (Kenstowicz & Kisseberth 1979), and Yawelmani (Kisseberth 1970). Historical loss of medial or final vowels occurred in English (Minkova 1982), French (Schane 1973), Ojibwa (Kenstowicz & Kisseberth 1979), and several Guang languages (Snider 1986).

it will tend to preserve this contrast in word-initial position. The existence of PARSE(F)-[$_w$ (but no corresponding constraint favoring preservation of features word-finally) provides a possible reason for this fact.

In the case of vowel features, a representative example of the kind of asymmetry that may arise between word-initial and non-initial positions is found in Nawuri. This language (and several related North Guang languages discussed in Snider (1989a,b)) has a process in which front vowels centralize interconsonantally, in both closed and open syllables. This is illustrated in the examples in (26).[7] (Note that here I use the symbol [ï] to represent a central allophone of /ɪ/. Certain irrelevant phonetic details are ignored.)

(26)	a. /o-liŋ/	→	[olɨŋ]	'root'
	b. /alibi/	→	[alɨbi]	'badness'
	c. /ɔ-kɪŋ/	→	[ɔkïŋ]	'fish'
	d. /gɪ-ba:/	→	[gïba:]	'hand'
	e. /lembiɾi/	→	[ləmbɨɾi]	'black'
	f. /dekeɾeke/	→	[dəkᵊɾəke]	'chameleon'
	g. /tʃɛ-mɪnɛ:/	→	[tʃɐmïnɛ:]	'friend'

I propose (Casali (1995b)) that this process involves the loss of [-back] (equivalent to [front] in the present feature framework). Crucially, while the process may apply to

[7] The examples are from Casali (1995d).

word-final vowels when followed by a word-initial consonant, as in (27), it never applies to word-initial vowels which follow a word-final consonant, as in (28).

(27)	a. /a-bite gi-du/	→	[abɨtəgudu]	'ten girls'
	b. /tʃa:sɪ gɪ-ya:/	→	[tʃa:sigɪya:]	'fowl's leg'
	c. /tɛ mfɪ:/	→	[tɐmfɪ:]	'sit here'
(28)	a. /ɪ-saŋ i-liŋ mʊ/	→	[ɪsaŋilɨŋmʊ] (*[ɪsaŋɨlɨŋmʊ])	'the roots remain'
	b. /ɪ-saŋ ɪ-kɪŋ mʊ/	→	[ɪsaŋɪkiŋmʊ] (*[ɪsaŋikiŋmʊ])	'the fish remain'

The strong tendency to preserve features in word-initial position is conceivably a consequence of the fact that there is often a greater degree of both length and amplitude associated with the beginnings of words. This additional measure of length and/or amplitude presumably serves to render featural cues more salient in word-initial position. If we assume that languages make more effort to preserve features in contexts where they are more salient, as argued by Jun (1995a) and Steriade (1995), we might expect the greater acoustic prominence of word-initial position to lead to preferential preservation of features in this context.

Preservation of word-initial features may also be favored by speech processing considerations. MacEachern (1995) suggests that word-recognition may be facilitated by a larger number of contrasts in word-initial position, both because more information will tend to be gained earlier in the word, and because there is evidence that speaker's mental lexicons may be organized or "indexed" by word-initial phonemes; a greater number of distinctions in word-initial position means that the total number of words indexed under each initial phoneme will be less, with the result that fewer possibilities for a word must be entertained once the initial phoneme is identified.

In the case of PARSE(F)-lex, it is well-known that languages frequently support a greater variety of contrasts in roots than in affixes (Steriade 1993). It is also generally true that affix segments are more likely to undergo assimilation to root segments than vice-versa. (Here we may cite for example the fact that vowel harmony is commonly root-controlled (Clements 1976).) Similarly, we might expect to find that lexical (content) words tend to support a wider range of contrasts than function words and that segments in lexical words will be less likely to undergo assimilation processes. Diachronically, there are cases where historical reduction processes have taken place only (or earlier) in affixes or in function words. Donwa-Ifode (1989) for example argues that vowel contrasts were lost earlier in prefixes than roots in a number of Edoid languages. Also, some dialects of English neutralize voicing of /d/ by devoicing before a nasal consonant in the (relatively non-lexical) auxiliaries couldn't, wouldn't and shouldn't though not in fully lexical words like hidden. While fully explicit analyses remain to be worked out, all of these facts lend support to the notion, implicit in the universal ranking PARSE(F)-lex >> PARSE(F), that languages make more effort to preserve features of lexical than non-lexical elements. This makes sense from a functional point of view: since lexical morphemes typically encode more semantic content, their accurate recognition is more critical for speech processing. It is therefore natural to expect that languages should take greater pains to favor their distinctiveness by preserving their featural content.

The concept of position-sensitive PARSE(F) constraints has played a crucial role in a number of other Optimality-Theoretic analyses. In his analysis of place assimilation in Korean and other languages, Jun (1995a,b) relies on constraints which favor preservation of place features more heavily in particular segmental contexts (e.g. before coronals). To account for the distribution of voicing in Taiwanese, Hsu (1995) posits a constraint that is equivalent to our PARSE(F)-$[_w$. Rosenthall & Mous's (1995) analysis of Iraqw employs a constraint that favors parsing of consonants belonging to roots, while Beckman's (1995) analysis of Shona height harmony relies on a constraint that favors preservation of height features in the initial syllables of roots.

While each of the PARSE(F)-P constraints is universally ranked above ordinary PARSE(F), the ranking of PARSE(F)-$[_w$ and PARSE(F)-lex with respect to each other is not fixed, but varies from language to language. It is this variability that gives rise to the different patterns of Elision that are found to occur cross-linguistically at word boundaries, as I now seek to show.

Consider first the situation that obtains when hiatus arises at the boundary between two lexical words. Setting aside for now the possible relevance of segment length or stress, the only constraints that are relevant in this context are PARSE(F)-$[_w$ and ordinary PARSE(F). PARSE(F)-lex is irrelevant because it is violated equally by Elision of either vowel, since by hypothesis both words are lexical. This being the case, we predict that Elision in this context must always target V_1, since this type of Elision violates only ordinary PARSE(F), while Elision of V_2 violates, in addition, the more highly ranked PARSE(F)-$[_w$:

(29) V_1 Elision at lexical word boundaries:

	/...CV_1 V_2C.../	PARSE(F)-$[_w$	PARSE(F)
⇒	...C<V_1> V_2C...		*...
	...CV_1 <V_2>C...	*...	*...

This prediction holds true almost without exception. The only recalcitrant cases in the survey involve the Elision of particular "weak" vowels in V_2 position in a number of languages, and the occurrence of V_2 Elision with particular combinations of lexical items in Yoruba and perhaps one or two other languages. (The first of these exceptional situations will be treated in connection with an analysis of Afar given in section 2.5 below.) Significantly, while there are many languages with fully regular V_1 Elision at the boundary between two lexical words, I have yet to find a single example of a language which consistently elides V_2 in this context.

The situation is different when hiatus arises at the boundary between a lexical word and a following function word. Here the constraint PARSE(F)-lex is relevant; it is violated by Elision of V_1 (i.e. the final vowel of the lexical word), but not by Elision of V_2 (the initial vowel of the function word). With PARSE(F)-$[_w$, on the other hand, the situation is exactly opposite: this constraint is violated by Elision of V_2, but not by Elision of V_1. Thus we correctly predict that both V_1 Elision and V_2 Elision are possible in this context: the former will occur when PARSE(F)-$[_w$ is ranked above PARSE(F)-lex, as illustrated in (30), while the latter will take place under the opposite ranking, as show in (31).

(30) PARSE(F)-$[_w$ >> PARSE(F)-lex gives V_1 Elision at lexical word plus function word boundary:

	/...CV_1 V_2C.../	PARSE(F)-$[_w$	PARSE(F)-lex
⇒	...C<V_1>V_2C...		*...
	...CV_1<V_2>C...	*...	

(31) PARSE(F)-lex >> PARSE(F)-$[_w$ gives V_2 Elision at lexical word plus function word boundary:

	/...CV_1 V_2C.../	PARSE(F)-lex	PARSE(F)-$[_w$
	...C<V_1>V_2C...	*...	
⇒	...CV_1<V_2>C...		*...

Notice that the ranking PARSE(F)-lex >> PARSE(F)-$[_w$ gives V_2 Elision only in cases where a function word <u>follows</u> a lexical word. If the function word precedes, then V_1 Elision is predicted instead, since this violates neither PARSE(F)-lex nor PARSE(F)-$[_w$, whereas V_2 Elision violates both of these constraints:

(32) PARSE(F)-lex >> PARSE(F)-$[_w$ gives V_1 Elision at function word plus lexical word boundary:

	/...CV_1 V_2C.../	PARSE(F)-lex	PARSE(F)-$[_w$
⇒	...C<V_1>V_2C...		
	...CV_1<V_2>C...	*...	*...

In this connection it is interesting to consider the behavior of the Etsako word /ɔna/ 'the' in example (7d), repeated here as (33):

(33) ɔna eɣi ɔna → ɔneɣina 'this tortoise'
the tortoise the

Here /ɔna/ occurs both before and after a noun of the form VCV.[8] As predicted by the ranking PARSE(F)-lex >> PARSE(F)-$[_w$, the prenominal instance of /ɔna/ triggers V_1 Elision, while the postnominal instance triggers V_2 Elision. This example strongly supports the notion that what is at work here is not a simple preference for eliding the vowel that occurs in a particular linear position. Rather, the language displays a greater willingness to sacrifice a segment of /ɔna/ than a segment of an adjacent noun. This preference is very plausibly related to the non-lexical status of /ɔna/, providing strong support for the constraint PARSE(F)-lex.

[8] Although Elimelech (1976) glosses the prenominal instance of /ɔna/ as "DA" ("definite article") and the postnominal instance as "this," he states (p. 40) that "the DA /ɔna/ and the demonstrative adjective /ɔna/ are identical morphemes or homonyms." All that is actually crucial for our purposes is that, whether or not we are dealing with a single morpheme, both instances of /ɔna/ are non-lexical.

Consider next the boundary between a prefix and a following root. For simplicity I consider only word-initial prefixes. In this context, the relevant constraints are PARSE(F)-lex, which favors the preservation of the root-initial vowel, and ordinary PARSE(F), which is violated by Elision of either vowel. These circumstances predict, correctly, that Elision in this context will always target V_1:

(34) V_1 Elision at prefix-root boundary:

	$/\#\#CV_1+V_2C\ldots/$	PARSE(F)-lex	PARSE(F)
⇒	$C<V_1>V_2C\ldots$		*...
	$CV_1<V_2>C\ldots$	*...	*...

Here I have represented the prefix as having the shape CV, which is easily the most common prefix form to occur before a vowel-initial root in the languages covered by my survey. In the case of word-initial prefixes of the shape V, on the other hand, we predict that either V_1 Elision or V_2 Elision is possible, depending on the relative ranking of PARSE(F)-lex and PARSE(F)-$[_w$. Where PARSE(F)-lex is ranked above PARSE(F)-$[_w$, V_1 Elision is favored, as shown in (35), while ranking of PARSE(F)-$[_w$ above PARSE(F)-lex gives V_2 Elision in preference to V_1 Elision, as shown in (36):

(35)

	$/\#\#V_1+V_2C\ldots/$	PARSE(F)-lex	PARSE(F)-$[_w$
⇒	$<V_1>V_2C\ldots$		*...
	$V_1<V_2>C\ldots$	*...	

(36)

	$/\#\#V_1+V_2C\ldots/$	PARSE(F)-$[_w$	PARSE(F)-lex
	$<V_1>V_2C\ldots$	*...	
⇒	$V_1<V_2>C\ldots$		*...

I have only a single example of a language which employs Elision in this context: West Tarangan (Nivens 1992) elides the vowel of both CV and V prefixes before a vowel-initial root, as in the examples in (37):[9]

(37)	a. i-ɛkar '(s)he receives'	→	ɛkar
	b. mu-ɛkar 'you receive'	→	mɛkar

This behavior follows from the assumption that West Tarangan has the ranking in (35).

Finally, consider the boundary between a root and a following suffix. As things stand, the situation in this case is simply the mirror image of the prefix-root case, i.e. we expect universal elision of the initial suffix vowel (V_2) in preference to Elision of the preceding root vowel (V_1), since the former violates only PARSE(F) while the latter violates PARSE(F)-lex also. This prediction is incorrect: although nine languages in my survey show only V_2 Elision at a root-suffix boundary, there are

[9] The other cases of hiatus resolution at /##V+[$_{root}$VC.../ boundaries in my survey are as follows. First, there are eight languages, Shona (Fortune 1955), SiSwati (Herman 1995), Lamba (Doke 1922), Bemba (Givon 1970a), Aghem (Hyman 1979), Yakata (Motingéa 1993), LuGanda (Clements 1986) and Chagga (Nurse & Philippson 1977), in which an initial V prefix (usually a high vowel /i/ or /u/, but sometimes a mid front or round vowel) will, in at least some instances, undergo Glide Formation before a V-initial root. Second, three languages, Bemba (Givon 1970a, Sambeek 1955), Chagga (Nurse & Philippson 1977), and Santee Dakota (Shaw 1980), resolve (at least some) /##V+[$_{root}$VC.../ sequences by Coalescence. Third, three languages, Yakata (Motingéa 1993), Lango (Noonan 1992), and Santee Dakota (Shaw 1980), retain hiatus with at least some /##V+[$_{root}$VC.../ sequences. Finally, Epenthesis of an intervening consonant apparently occurs in some instances in Chagga (Saloné 1980) and Santee Dakota (Shaw 1980).

fourteen which show only V_1 Elision at a root-suffix boundary and seven which have both types of Elision in this context:

(38) a. Languages with only V_2 Elision at root-suffix boundary:

Basque, Chichewa, Dangme, Edo, Kagate, Lulobo, Nandi, Ogori, Okpe.

b. Languages with only V_1 Elision at root-suffix boundary:

Igede, Iraqw, KiYaka, Lamba, LuGanda, Moba, Nawuri, Nupe, Ogbia, Santee Dakota, Shilluk, Shona, Tabla, Tsonga.

c. Languages with V_1 Elision and V_2 Elision at root-suffix boundary:

Afar, Aghem, Avatime, Daga, Diola-Fogny, Niaboua, Vata.

If we look at the facts in more detail, however, it turns out that in a considerable number of the cases where a root vowel is elided before a suffix vowel, the suffix consists of a single vowel only, and that there is a clear asymmetric preference for V_1 Elision with this type of suffix. Thus, 17 languages display V_1 Elision at the boundary between a root and a V suffix (eliding the root vowel), while only ten display V_2 Elision (i.e. Elision of the suffix vowel) in this context:

(39) a. Languages which elide a root vowel before a /-V/ suffix:

Aghem, Avatime, Daga, Igede, Iraqw, Lamba, LuGanda, Moba, Nawuri, Niaboua, Nupe, Nuni, Ogbia, Santee Dakota, Shilluk, Tabla, Vata.

b. Languages which elide a /-V/ suffix after a root vowel:

Aghem, Avatime, Niaboua, Vata, Basque, Dangme, Lulobo, Ogori, Okpe, Nandi(?).

(Notice here that four languages, Aghem, Avatime, Niaboua, and Vata, have both V_1 Elision and V_2 Elision in this type of context, displaying V_1 Elision with some sequences and V_2 Elision with others.)

With minimally VC suffixes, on the other hand, things are much more balanced. V_1 Elision and V_2 Elision each occur in nine languages.

(40) a. Languages which elide a root vowel before a VC… suffix:

Afar, Avatime, Daga, Diola-Fogny, Lamba, Niaboua, Shona, SiSwati, Tsonga.

b. Languages which elide the vowel of a VC… suffix after a root vowel:

Afar, Avatime, Daga, Diola-Fogny, Niaboua, Basque, Chichewa, Kagate, Nandi.

(Here again, several languages manifest both types of Elision with VC suffixes: Afar, Avatime, Daga, Diola-Fogny, and Niaboua.)

Furthermore, in at least one of the four languages (Avatime, Daga, Lamba, Niaboua) which has V_1 Elision before both V and longer suffixes, Avatime (Schuh 1995), V_1 Elision is more common than V_2 Elision with V suffixes, while V_2 Elision is more common with longer suffixes. Presumably, the reason for this is a functional one: if the vowel in a V suffix is elided, there is no remaining segmental trace of the suffix. In some languages, non-segmental cues are possible, in the form of compensatory lengthening of the final root vowel and/or the retention of the elided suffix's tone on the root vowel (i.e. the phenomenon of 'tone stability'). Even in such cases we can imagine that the loss of all segmental features of a morpheme places an undesirable burden on the hearer faced with the challenge of recovering the morphemic content of an utterance. This is in fact precisely the explanation proposed by Schuh:

> 'For the definite suffixes...the preferred option is to elide V_1; for the postposition and the indefinite and demonstrative suffixes, the preferred option is to elide V_2. There are good reasons for this. The definite suffixes all consist of a vowel alone. Were that vowel elided, morpheme identity would thus be lost, aside from possible tonal cues...On the other hand, in both the case of the postposition and the indefinite and demonstrative suffixes, the initial vowels of these affixes (=V_2) are not necessary to retain morpheme identity--in the case of the indefinites and demonstratives, the vowels are even predictable based on the class of the noun to which they are affixed." -- Schuh (1995:19).

Formally, it seems reasonable to represent the undesirability of this type of situation as involving the violation of a constraint that favors preservation of features in monosegmental morphemes:

(41) PARSE(F)-+V+ Parse F in a monosegmental morpheme.[10]

In languages in which PARSE(F)-+V+ is ranked above PARSE(F)-lex, we now predict that V_1 Elision will occur before suffixes of the form V:

[10] While I assume that this constraint actually applies to morphemes consisting of a single consonant as well as those consisting of a single vowel, only the latter type of monosegmental morpheme will concern us in this study. In the interest of transparency, I have therefore used the label V within the constraint name rather than some more general symbol indicative of both consonants and vowels.

	$/...CV_1+V_2/$	ONSET	PARSE(F)-+V+	PARSE(F)-lex	PARSE(F)
(42) ⇒	$.C<V_1>V_2.$			*...	*...
	$.CV_1.V_2.$	*			
	$.CV_1<V_2>.$		*...		*...

With longer suffixes, on the other hand, V_2 Elision is predicted, since this violates only PARSE(F), whereas Elision of V_1 (the root vowel) violates the more highly-ranked PARSE(F)-lex:

(43)	$/...CV_1+V_2C/$	ONSET	PARSE(F)-+V+	PARSE(F)-lex	PARSE(F)
	$.C<V_1>V_2C.$			*...	*...
	$.CV_1.V_2C.$	*			
⇒	$.CV_1<V_2>C.$				*...

In languages which have PARSE(F)-lex ranked above PARSE(F)-+V+, the prediction is that V_2 Elision will occur with both V and minimally VC suffixes:

(44)	$/...CV_1+V_2/$	ONSET	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)
	$.C<V_1>V_2.$		*...		*...
	$.CV_1.V_2.$	*			
⇒	$.CV_1<V_2>.$			*...	*...

(45)	$/...CV_1+V_2C/$	ONSET	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)
	$.C<V_1>V_2C.$		*...		*...
	$.CV_1.V_2C.$	*			
⇒	$.CV_1<V_2>C.$				*...

As an alternative to the constraint PARSE(F)-+V+, a more direct rendering of the notion that languages go to extra lengths to preserve at least some featural content of a morpheme might employ a constraint like the one in (46):

(46) TRACE Preserve at least one (non-prosodic) feature of a morpheme.

Although this approach is intuitively more appealing and may ultimately prove to be correct, its implementation faces some challenges which require, at a minimum, some additional constraints which cannot be adequately discussed here without taking us too far afield from our main topic. I will therefore tentatively continue to employ the constraint PARSE(F)-+V+ rather than TRACE, while recognizing that this is unlikely to be the last word on this issue.

There are a number of languages in the survey which cannot be analyzed with the constraint types given so far. These fall into two types. First, there are five languages (Afar, Diola-Fogny, Shona, SiSwati, and Tsonga) whose only Elision at root-suffix boundaries targets V_1 before a VC... suffix. Second, there are seven languages, Afar, Aghem, Avatime, Daga, Diola-Fogny, Niaboua, and Vata which have V_1 Elision with some suffixes of a particular shape (whether V or VC...), but V_2 Elision with other suffixes of precisely the same shape. To account for the former type of situation, I tentatively propose an additional constraint that favors preservation of features in morpheme-initial position:

(47) PARSE(F)-$[_m$ Parse F in a morpheme-initial segment.

Ranked above PARSE(F)-lex, this constraint will give rise to V_1 Elision before a VC... (or V) suffix:

(48)	$/\ldots CV_{root}]+VC\ldots/$	PARSE(F)-$[_m$	PARSE(F)-lex	PARSE(F)-+V+
⇒	$C< V_1>V_2C\ldots$		*...	
	$C\ V_1<V_2>C\ldots$	*...		

The analysis of languages that have both types of Elision before suffixes of the same shape is less clear to me at present. Conceivably, detailed investigation of the languages which exhibit this behavior would reveal plausible reasons why the initial (or only) vowels of some suffixes are preserved (giving rise to V_1 Elision of the preceding root vowel) while the initial (or only) vowels of other suffixes are elided (giving V_2 Elision). For example, the greater resistance of some suffixes to Elision might be due to the fact that they carry high semantic content. It does not seem to me, however, that the data available to me at present will permit profitable speculation along these lines. I simply note that in the worst case, it might be necessary to appeal to morpheme-specific PARSE(F) constraints to account for the fact that some suffixes in a language pattern differently than others. Some such device is almost certainly needed within Optimality Theory in any case to account for the fact that individual morphemes sometimes idiosyncratically fail to undergo otherwise regular processes in particular languages.

2.4 Elision at the juncture of two affixes

In addition to the four Elision contexts considered in section 2.3.3, there is at least one other environment for which my analysis makes testable predictions: where hiatus arises through the juxtaposition of two prefixes or two suffixes. Data bearing on this context is less substantial than for the four contexts treated above, both in that there are fewer languages in the survey which display Elision in this context, and in that many of the sources which do show Elision have little to say about it.[11] For the most part, however, the results which do emerge are consistent with my overall analysis.

An exhaustive listing of the languages in the survey which show evidence of Elision at affix-affix boundaries is given in the tables in (49) and (50) below. These tables display both the type(s) of underlying affix-affix sequences that trigger Elision in each language and the type(s) of Elision they are subject to.

(49) Elision at prefix-prefix boundaries:

language	prefix sequence(s)	result(s)
Chagga	CV+V CV+VC... V+V	V_1 Elision V_1 Elision V_2 Elision
Chichewa	CV+V	V_1 Elision
Diola-Fogny	CV+V	V_1 Elision
Kamba	CV+V	V_1 Elision
KiYaka	CV+V CV+VC	V_1 Elision V_1 Elision
LuGanda	CV+V	V_1 Elision
Nandi	CV+V	V_1 Elision
Ogori	CV+VC...	V_1 Elision
Pero	CV+V	V_1 Elision
Teton Dakota	CV+V	V_1 Elision
Tsonga	CV+VC...	V_1 Elision

[11] In many cases, the existence of Elision with affix-affix sequences is not explicitly stated but must be inferred from a few examples, for which morpheme glosses are not always provided.

(50) Elision at suffix-suffix boundaries:

language	suffix sequence(s)	result(s)
Afar	V+V	V_1 Elision, V_2 Elision
Chichewa	...CV+VC... V+VC... (?)	V_1 Elision V_1 Elision
Daga	...CV+VC... CV+VC	V_1 Elision V_2 Elision
Diola-Fogny	...CV+V	V_1 Elision
Lamba	V+V V+VC...	V_1 Elision V_1 Elision
Lango	V+V	V_1 Elision
Nandi	V+VC	V_2 Elision
Pero	CV+V	V_1 Elision
Shilluk	V+V	V_1 Elision
Tabla	CV+V CV+VC... V+V V+VC...	V_1 Elision V_1 Elision V_1 Elision V_1 Elision

The most striking fact evident in these tables is that Elision in the affix-affix contexts almost always targets V_1. Notice however that a considerable majority of the cases in these tables involve sequences in which the first affix is minimally of the form CV. This type of sequence accounts for nearly all the instances of Elision at prefix-prefix boundaries, and about half of the instances of Elision at suffix-suffix boundaries. With such sequences, our current analysis gives rise only to V_1 Elision, for the simple reason that this violates only ordinary PARSE(F), while V_2 Elision violates (at a minimum) the additional constraint PARSE(F)-$[_m$. There is only one language which clearly violates this prediction: Daga (Murane 1974) has V_2 Elision in some suffix plus suffix contexts and V_1 Elision in others.[12] This language will be treated in detail in section 2.5.2 below.

The remaining cases of V_1 Elision in these tables include five cases involving V+V suffixal sequences (in Afar, Lamba, Lango, Shilluk, and Tabla), and two cases (Lamba and Tabla) involving a V suffix preceding a VCV suffix. (The Lamba case is questionable, since it is not clear from Doke's (1938:172,3) discussion whether the failure of the first morpheme in the sequence, a "theme vowel," to surface is due to phonological rather than morphological factors.) Neither of these results are fully expected under the present analysis. In the case of the V+V sequences, the analysis is not yet sufficiently fine-tuned to decide between the two Elision possibilities, either of which violates the same three constraints: PARSE(F)-+V+, PARSE(F)-$[_m$, and ordinary PARSE(F). In the case of the V+VCV sequences, the present analysis actually gives the wrong result, predicting V_2 Elision (which violates only PARSE(F)-$[_m$ and PARSE(F)) rather than V_1 Elision (which violates these same two constraints plus PARSE(F)-+V+).

---

[12] Lamba (Doke 1938) has apparent cases of V_2 Elision with sequences in which a CV "pre-prefix" precedes a /iCV/ noun class prefix. Tom Hinnebusch informs me (personal communication) however that the VCV "noun class prefixes" are actually bimorphemic, at least historically: the initial /i/ of the "prefix" is actually a separate morpheme. In some languages, e.g. Bemba, this initial vowel is frequently absent in certain morphosyntactic contexts. Hence there is some question whether the failure of this /i/ to surface in Lamba following a CV "pre-prefix" is due to hiatus resolution or morphosyntactic factors.

I am unsure at present what significance to attribute to these cases. Taken at face value, the V+VCV facts in particular suggest that there might be some context-independent preference for V_1 Elision that remains to be incorporated into the analysis. On the one hand, this would not necessarily be an unwelcome result. (In particular, the presence of a residual context-independent preference for preserving V_2 would by no means nullify the clear contextual effects which the present analysis has been designed to cope with.) In view of the limited nature of the data, however, an attempt to pursue this possibility seems premature at this point. Consequently, I will not try to resolve this issue here.

In addition to the Daga case referred to above, the survey shows three other instances of V_2 Elision at affix-affix boundaries: Chagga exhibits V_2 Elision with a sequence of two word-initial V prefixes, Nandi displays V_2 Elision with a VC suffix following a V suffix, and Afar shows V_2 Elision with some V+V suffixal sequences. (The Afar case will be discussed in detail below.)

2.5 Vowel Elision in particular languages

Although my discussion of Vowel Elision has so far focused on the question of which of two adjacent vowels is targeted, a full phonological treatment of Vowel Elision in a particular language will typically have to address a variety of additional concerns. In many languages, for example, vowel sequences arising in some environments are resolved by Elision while those at other boundaries either remain in hiatus or are subject to a different resolution strategy such as Epenthesis of an intervening consonant. The relevance of tonal or accentual properties also varies from language to language, as does the presence or absence of compensatory lengthening with Elision. It is also fairly common to find that the choice of which vowel is elided is at least partly sensitive to the identities of the particular vowels comprising the sequence. Vowel length may be relevant as well: there are a number of languages in which long vowels are more resistant to Elision than short vowels. Finally, it is not uncommon for particular morphemes (or classes of morphemes) to exceptionally trigger a different hiatus resolution pattern than the one which normally obtains.

In this section, I provide a more detailed analysis of hiatus resolution in four languages: Chichewa, Daga, Okpe, and Emai. I have selected these languages both because they exemplify different directional possibilities predicted by my analysis in various contexts, and because they are reasonably illustrative of the challenging language-specific variation that arises in conjunction with factors, such as those just referred to, that go beyond the issue of directionality. It should be noted however that the full range of variation in factors related to hiatus resolution exhibited by languages in my survey is much greater than can possibly be treated in a study of this size. Hence, the selection of the languages discussed in this section has necessarily involved at least a degree of arbitrariness.[13]

In giving examples throughout this section, I ignore certain irrelevant phonetic details. I also occasionally employ different phonetic symbols than those used in the original sources. Tone, which is phonemic in several of the languages treated, is also omitted except where directly relevant. Although I show compensatory lengthening where it occurs, I make no attempt to explicitly account for it in my analyses; thus, in displaying tableaux, I do not show competing candidates differing only in whether or not they manifest lengthening. (For an account of compensatory lengthening within the framework of Optimality Theory, see Rosenthall (1994).)

2.5.1 Chichewa

Vowel Elision in Chichewa (a Bantu language spoken in Malawi) is described in Mtenje (1980, 1992). For our purposes, the Chichewa facts are of interest primarily because of different directional behaviors exhibited in prefix plus root and root plus suffix contexts, and also at suffix plus suffix boundaries as opposed to root plus suffix boundaries. We shall see that these differences are handled straightforwardly by the present analysis.

[13] The choice of languages has also been heavily constrained by the clarity and completeness of the descriptive sources. Unfortunately, it was necessary to exclude a number of languages which seemed to show very interesting patterns simply because crucial pieces of information were lacking in the source(s).

In addition, the language exhibits two other interesting complexities. First, it has Glide Formation when V_1 is /u/ but not when V_1 is /i/. Although this fact poses no particular difficulty for the overall framework, it represents a state of affairs that is actually rather common cross-linguistically, and thus worthy of some brief discussion. Second, the language also exhibits glide Epenthesis in at least a few instances.

Chichewa has both V_1 and V_2 Elision. V_2 Elision occurs only with demonstrative suffixes of the form VCV. (Clear instances of V suffixes do not occur in Mtenje's data.) Examples are shown below.[14]

(51)	a. mwana-uyo child-that	→	mwanayo 'that child'
	b. bambo-awa man-this	→	bambowa 'this man'
	c. nyimbo-izi songs-these	→	nyimbozi 'these songs'
	d. khasu-ili hoe-this	→	khasuli 'this hoe'

The occurrence of V_2 Elision with these examples is correctly predicted if we assume that Chichewa has the ranking PARSE(F)-lex >> PARSE(F)-$[_m$, provided we assume, in addition, the ranking of the other hiatus resolution constraints above PARSE(F)-lex. This is illustrated in the tableau in (52).

[14] There is some question as to whether the demonstratives in (51) are really suffixes. Although Mtenje's 1992 paper treats them as such, his 1980 thesis analyzed them as separate words, a treatment which is apparently supported by the fact that they can also precede the noun they modify in some instances, as in /uyu ndi mwana/ 'this is a child' (cf. (51a) above). If it turned out that they are in fact separate words, then it is only necessary to rank PARSE(F)-lex >> PARSE(F)-$[_w$. The effect of this ranking would be exactly analogous to the word-internal ranking PARSE(F)-lex >> PARSE(F)-$[_m$ demonstrated in (52).

(52) V_2 Elision at stem-suffix boundary:

	/khasu+ili/	ONSET	*DIP	*INS(F)	*CG	PARSE(F)-lex	PARSE(F)-$[_m$	PARSE(F)
	khas<u>ili					*...		*...
⇒	khasu<i>li						*...	*...
	.kha.su.i.li.	*						
	.kha.sui.li.		*					
	khasuwili			*				
	khaswili				*			

Here V_1 Elision incurs a fatal violation of PARSE(F)-lex; V_2 Elision, whose most serious violation is of the more lowly ranked PARSE(F)-$[_m$, is therefore to be preferred.

V_1 Elision is found in three different environments. First, the vowel of a CV prefix is elided before a following prefix, as shown in the examples in (53) (from Mtenje 1992:67). (Mtenje does not give any examples of hiatus at a prefix-root boundary).

(53)

a. si-u-pita → supita
NEG-you-go 'you will not go'

b. ti-a-bwela → tabwela
we-PERF-com 'we have come'

c. chi-a-bwino → chabwino
CL.7-POSS-good 'a good one'

d. zi-a-gona → zagona
CL.8-PERF-sleep 'they have slept'

In these examples, the second prefix consists of a single segment. Deletion of V_2 would therefore violate PARSE(F)-+V+, and also PARSE(F)-$[_m$. Eliding the vowel of the first (CV) prefix in contrast violates only PARSE(F). Thus, the analysis necessarily predicts V_1 Elision in this context, as illustrated in (54). (Note that although this result does not crucially depend on the ranking PARSE(F)-lex >> PARSE(F)-$[_m$ that has already been established for the demonstrative suffix cases, it is fully consistent with it. Also, although I have placed PARSE(F)-+V+ below PARSE(F)-lex in the tableau in (54), there is no evidence that these constraints are crucially ranked with respect to each other.)

(54) V_1 Elision at prefix-prefix boundary:

	/si+u+pita /	other hiatus constraints	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)-$[_m$	PARSE(F)
⇒	s<i>upita					*...
	si<u>pita			*...	*...	*...
	.si.u.pi.ta.	*				
	.siu.pi.ta.	*				
	siyupita	*				
	syupita	*				

The second context where V_1 Elision occurs in Chichewa is at a stem plus VCV suffix boundary, as in the examples in (55), from Mtenje (1980:50).

(55)	a. umba-idwa	→	umbidwa	'be moulded'
	b. omba-edwa	→	ombedwa	'be slapped'
	c. pita-itsa	→	pititsa	'cause to surpass'
	d. peta-etsa	→	petetsa	'cause to sieve'

In these examples, the forms /-idwa/ and /-edwa/ are allomorphs of the same passive suffix (the choice of allomorph being determined by harmony with the vowel preceding the final /a/ of the stem). Similarly, the forms /-itsa/ and /-etsa/ are allomorphs of a causative suffix (the choice of allomorph once again being determined by vowel harmony). At first glance, these examples seem to pose a problem for our analysis, in that the attested V_1 Elision presumably violates PARSE(F)-lex, which we have had to rank above PARSE(F)-$[_m$ in order to correctly account for the V_2 Elision that occurs with the demonstrative suffix examples in (51). V_2 Elision, on the other hand, obeys PARSE(F)-lex, violating only PARSE(F)-$[_m$, and should therefore be more optimal. To put it differently, the context exemplified in (55) appears to be identical in all relevant respects to that in (51), and we should therefore expect the same outcome.

I argue however that the two contexts are not in fact identical. Specifically, I claim that V_1 Elision in (55) does not violate PARSE(F)-lex, for the simple reason that the elided vowel is not actually part of the root. In Chichewa all verb stems end in /a/. Since this /a/ is predictable, it need not be considered part of the lexical entry of the verb root. We might either regard it as epenthetic, inserted when necessary to satisfy syllable or word structure conditions, or as an "empty" suffix entirely devoid of lexical content. Under the former view, the failure of this epenthetic vowel to surface before the passive suffixes in (55) is entirely expected, since inserting this vowel here would only degrade the existing CV sequencing by introducing hiatus. If the second option is chosen, it would be necessary to modify our conception of the constraint PARSE(F)-lex to allow for degrees of "lexicalness," i.e. in place of a single constraint we would have a family of constraints PARSE(F)-lex_1, PARSE(F)-lex_2, PARSE(F)-lex_3, etc., where the lower integers indicate greater lexicalness. These constraints would be subject to a universal ranking in which PARSE(F)-lex constraints referring to more lexical morphemes are universally ranked above those referring to morphemes which are less lexical.

Assuming that such an approach is viable, it would certainly appear reasonable to place the /a/ stem vowel at the absolute bottom of the lexicalness scale, since the semantic content of this stem vowel is essentially zero. We might therefore argue that Elision of this morpheme does not violate <u>any</u> PARSE(F)-lex constraint. Loss of part of a causative or passive suffix on the other hand would at least violate a PARSE(F)-lex$_n$ constraint for some level n in the lexicalness hierarchy, albeit presumably a rather low one. As long as this particular constraint PARSE(F)-lex$_n$ were ranked above PARSE(F)-+V+ (which, under this approach, is violated by Elision of the stem vowel /a/ but not by Elision of the initial vowel of a passive or causative suffix), we would safely predict V_1 Elision rather than V_2 Elision in the passive and causative contexts:

(56)

/umb-a-idwa/	other hiatus constraints	PARSE(F)-lex$_n$	PARSE(F)-+V+	PARSE(F)-[$_m$	PARSE(F)
⇒ umb<a>idwa			*...	*...	*...
umba<i>dwa		*...		*...	*...
.um.ba.i.dwa.	*				
.um.bai.dwa.	*				
umbayidwa	*				

(In addition to the constraint violations which are shown, each of these candidates also incurs an ONSET violation as a result of the word-initial vowel. The fact that this ONSET violation is not rectified by Elision of this vowel /u/ or Epenthesis of a word-initial consonant indicates that both PARSE(F)-$[_w$ and *INS(F) are ranked above ONSET, although this is not shown in (56).)

The final context manifesting V_1 Elision in Mtenje's data involves a sequence of a passive suffix plus a causative suffix, in either order. Examples (Mtenje 1980:51) are shown below:

(57)	a. mang-a-itsa-idwa	→	mangitsidwa	'cause to get arrested'
	b. pond-a-edwa-etsa	→	pondedwetsa	'cause to be stepped on'

Since both suffixes have the form VCV, the constraint PARSE(F)-+V+ is irrelevant in this context, as of course is PARSE(F)-$[_w$, since we are not dealing with a word-initial context. PARSE(F)-lex is also irrelevant under the not unreasonable assumption that the two suffixes do not differ significantly in their degree of lexicalness. The decisive constraint is therefore PARSE(F)-$[_m$, which is violated by V_2 Elision but not V_1 Elision, regardless of which suffix comes first. V_1 Elision is therefore predicted, under any possible ordering of the constraints:

(58)	/...itsa-idwa/	other hiatus constraints	PARSE(F)-lex$_m$	PARSE(F)-+V+	PARSE(F)-$[_m$	PARSE(F)
⇒	...its<a>idwa		*...			*...
	...itsa<i>dwa		*...		*...	*...

It is worth asking at this point what improvement the present analysis has to offer over a rule-based account. It must be conceded from the outset that a rule-based approach has no difficulty in formalizing rules to account for the Chichewa Elision facts. The most straightforward way to do this, which is essentially the approach adopted by Mtenje (1980), is to formulate two Elision rules: a specific V_2 Elision rule marked as applying only to demonstratives, and a general V_1 Elision rule that applies to any vowel sequence regardless of morphological context. The V_2 Elision rule must of course apply first in order not to be bled in all contexts by V_1 Elision; this ordering is predicted by the Elsewhere Condition however and need not be stipulated.

While this approach correctly derives the data, there are two clear respects in which the Optimality-Theoretic approach adopted here is superior. First, the Optimality-Theoretic analysis provides an explanation for why V_2 Elision applies to the initial vowels of the demonstrative suffixes but not in other contexts: it is the non-lexical character of these suffixes which causes their initial vowels to be lost in preference to a preceding V_1 in a lexical (in this case, noun) root. From this point of view, the fact that a suffix-initial vowel (i.e. the first vowel of a causative or passive suffix) is not elided when it follows either another suffix or the semantically empty stem vowel /a/ is readily explained in terms of the same principles.[15] In the rule-based

[15] My account would of course be more compelling if it could be shown that the demonstrative suffixes themselves could trigger V_1 Elision in a preceding morpheme, providing this morpheme were non-lexical (e.g. another suffix of comparable semantic content). I have unfortunately been unable to find any test cases of this sort in Mtenje's data.

approach on the other hand, the behavior of the demonstrative vowels is aberrant; the analysis does not explain this behavior, but merely stipulates it.

A second deficiency of the rule-based analysis is related to the first one: since the approach is forced to countenance an Elision rule restricted explicitly to demonstratives, there is apparently nothing to rule out grammars with entirely analogous rules that are unattested (and, within the constraint-based approach advocated here, simply impossible). For example we might expect to find a language that systematically elided the initial vowel of a noun but elsewhere regularly elided V_1.

Glide Formation also occurs in Chichewa, as seen in the examples in (59). (Example (59a) also displays Epenthesis; this will be discussed below.)

(59)	a. munthu u-a-umphawi	→	munthu wawumphawi	'a poor man'
	b. mu-a-mwano	→	mwamwano	'rudely'
	c. mu-a-teŋga	→	mwateŋga	'you will take them'

Glide Formation is only possible however when V_1 is /u/. When /i/ occurs in V_1 position, it undergoes Elision instead, as illustrated in the examples in (53) above.[16] This fact indicates that the single constraint *CG we have so far been using to rule out Glide Formation is inadequate, and that we must distinguish between gliding of /u/ and gliding of /i/, using more specific constraints *Cw and *Cy. We can then

[16] No examples are given of underlying mid vowels occurring in V_1 position.

account for the fact that Chichewa glides /u/ but not /i/ by ranking *Cw below PARSE(F) but *Cy above PARSE(F). This gives rise to results like those shown below:[17]

(60)

	/Ci+V_2/	ONSET	*Cy	PARSE(F)	*Cw
⇒	C<i>V_2			...*	
	CyV_2		*		

(61)

	/Cu+V_2/	ONSET	*Cy	PARSE(F)	*Cw
	C<u>V_2			...*	
⇒	CwV_2				*

The claim that languages may distinguish between the acceptability of [Cy] sequences and [Cw] sequences is of course hardly surprising, and is supported for example by

[17] Mtenje's (1980) analysis implies that /u/ should also undergo V_1 Elision in some cases. He gives only two examples, both postlexical, where this happens, however:

munthu abwela	→	munthabwela	'a person will come'
galu ayenda	→	galayenda	'a dog walks'

I speculate that the failure of Glide Formation to apply to these examples may be due to the fact that in both cases the consonant preceding the word-final /u/ is a coronal. This is plausible in view of the fact that it is not uncommon for languages to permit only [Cw] clusters in which the consonant is non-coronal. (Also, none of the examples that Mtenje actually gives of gliding of /u/ involve a preceding coronal consonant.) If this hunch is right, it would argue for adopting a constraint (ranked above PARSE(F)) dispreferring coronal + w sequences.

Alternatively, we might take the failure of Glide Formation to apply in the two examples above as indicating a different constraint ranking postlexically from the one which obtains within single words. (All of Mtenje's examples where /u/ undergoes Glide Formation occur within single words.) Clearly, this issue can only be decided on the basis of further data.

the existence of a large number of West African languages which permit only the latter.[18]

In addition to Vowel Elision and Glide Formation, Chichewa also displays some instances of Epenthesis. Most of the Epenthesis examples discussed by Mtenje involve vowel sequences arising through prefixation of an infinitival prefix /ku-/, as in (62).

(62)	a. ku-ona	→	kuwona	'to see'
	b. ku-ika	→	kuyika	'to place'
	c. ku-umba	→	kuwumba	'to mould'
	d. ku-enda	→	kuyenda	'to walk'
	e. ku-a-peza	→	kuwapeza	'to find them'
	f. ku-a-funa	→	kuwafuna	'to look for them'

The inserted consonant is a glide that takes the backness and (except in the case where V_2 is /a/) roundness of the vowel which follows.

In addition to the infinitival examples in (62), there are four other examples of Epenthesis found in Mtenje's data. These are given in (63) below. (Note that (63a) is the same example that was already given in (59a) above).

[18] It may be that there is a universal or near-universal implicational generalization to the effect that languages glide front vowels if and only if they also glide round vowels (Casali 1995a).

(63)	a. munthu u-a-umphawi	→	munthu wawumpawi	'a poor man'
	b. anthu ena	→	anthuyena	'some people'
	c. galu ekha	→	galuyekə	'a dog only'
	d. ɲumba ya-i-kulu	→	ɲumba yayikulu	'a big house'

Proposing an account of Chichewa Epenthesis is made difficult by the fact that it is not at all clear what determines when Epenthesis will take place, in preference to Elision or Glide Formation. For example although the /Cu-a/ sequences in (62e,f) trigger Epenthesis, comparable sequences are elsewhere subject to Glide Formation, as in (64), where the /a/ prefix is the same third person plural object prefix that occurs in (62e,f).

(64)	mu-a-teŋga	→	mwateŋga	'you will take them'

Examples like this argue that the conditioning factors are in any case not strictly phonological. In the case of infinitives, moreover, there is some direct evidence that the occurrence of Epenthesis is limited to particular lexical items. In contrast with the verb root /umba/ 'mould' in (62c), the verb roots in (65) (Mtenje 1980:29) do not trigger Epenthesis after the prefix /ku-/:[19]

(65)	a. ku-uka	→	ku:kə	'to rise'
	b. ku-utsa	→	ku:tsa	'to cause to start'
	c. ku-uza	→	ku:za	'to tell'

[19] Although, as things stand, our present analysis predicts that Glide Formation should apply to a /u+u/ sequence, sequences of identical vowels are exempt from Glide Formation on a near-universal basis. An explanation for this is proposed in Casali (1995a).

It is not clear to me at present how to account for these facts. There are at least two separate problems to be solved. First, there is the question of how the roots that trigger Epenthesis are to be distinguished from those that do not, as well as from other roots which are glide-initial in all contexts, e.g. /wamba/ 'dry by fire', /yina/, 'something'. (Here there are basically two choices that present themselves: we could rely on additional, morpheme-specific versions of *INS(F) and/or PARSE(F), or we might posit an abstract difference in underlying representation, e.g. we might posit some sort of minimally specified initial consonant in the UF's of the roots that undergo Epenthesis, along the lines of "empty C" analyses proposed for various languages by Marlett & Stemberger (1983), Michelson (1986), and Roberts-Kohno (1995b), among others.) Second, there is the matter of how to account for the fact that the Epenthetic consonants show up only intervocalically. (Compare (62a) with [ona bwino] 'see carefully', for example.) As things stand, this fact is particularly puzzling, given that the failure of these initial glides to surface leads to an ONSET violation in both intervocalic and word-initial position. Why then do the glides surface only intervocalically?

Suppose however that in place of (or perhaps in addition to) the constraint ONSET on which we have been relying so heavily, there is a constraint that simply disprefers vocalic hiatus:

(66) *V.V Avoid heterosyllabic vowel sequences.

Crucially, this constraint is not violated in absolute initial position, but only as a result of hiatus deriving through morphemic concatenation. Hence, although details remain to be worked out, this approach at least suggests a plausible means of accounting for the fact that failure of initial Epenthesis appears to be less costly word-initially than in word-internal intervocalic position. At this point, I refrain from further speculation along these lines, which would take us too far afield from our main purposes.

2.5.2 Daga

A particularly challenging array of hiatus resolution outcomes is found in Daga, a language of Papua New Guinea described in Murane (1974).[20] This language displays both V_1 Elision and V_2 Elision at stem-suffix and suffix-suffix boundaries, as illustrated in (67). (Murane does not discuss hiatus resolution in other contexts.)

(67) V_1 Elision:

a.	yagiR-nege-iwan burn-me-3s/pr/cont	→	yaginegiwan 'it is burning me'
b.	to-nege-iwan hit-me-3s/pr/cont	→	tonegiwan 'he is hitting them'
c.	se-ivin put-1s/pr/cont	→	sivin 'I am putting'
d.	yama-e eye-his	→	yame[21] 'his eye'

[20] The genetic affiliation of Daga is listed in Grimes (1992) as Trans-New Guinea.

[21] Regarding examples (67d-f), Murane (1974:8) says that "the third singular intimate possessive suffix, which is -e, replaces the final vowel in vowel-final nouns." This wording leaves it unclear whether she regards these examples as instances of hiatus resolution via Elision, rather than simple allomorphy. Since V_1 Elision clearly does apply to comparable sequences in the language, however, the phonological analysis seems clearly preferable, in the absence of any evidence to the contrary.

e. meima-e husband-her	→	meime 'her husband'
f. ina-e mother-his	→	ine 'his mother'
g. waR-ingi-apen get-1s/cont-sub	→	waringapen 'I should get'
h. ta-ingi-an do-2s/cont-prolonged	→	taingan 'you keep on doing'

V_2 Elision:

i. to-mo-an hit-them-1s/p	→	tomon 'I hit them'
j. tunu-an cook-1s/p	→	tunun 'I cooked'

In addition, some input sequences are preserved intact; I assume that these are tautosyllabified, i.e. we have Diphthong Formation:

(68)	a. na-ivin eat-1s/pr/cont	→	naivin 'I am eating'
	b. to-mo-iwan hit-them-3s/pr/cont	→	tomoiwan 'he is hitting them'
	c. ta-ingi-an do-2s/cont-prolonged	→	taingan 'you keep on doing'

Although the facts are complex, a number of generalizations may be noted. First, the input sequences /a+i/ and /o+i/ result in the preservation of both vowels, while all others lead to Elision. The fact that only these two sequences, which occur as diphthongs in a great many languages, are preserved, strongly suggests that we are dealing with Diphthong Formation rather than Heterosyllabification. The fact that diphthongs are permitted in these cases is then sufficient evidence to motivate the ranking of *DIP below PARSE(F). In (68b), for example, Elision of the final /o/ of /mo/ would violate only PARSE(F); the fact that a diphthong results instead, in violation of *DIP, requires that *DIP be ranked below PARSE(F). Because the general constraint *DIP must be ranked below PARSE(F), we cannot rely on this constraint to rule out diphthongs from sequences other than /a+i/ and /o+i/. We must therefore appeal to some other constraint(s). Given that Daga has a five vowel system, the logically possible diphthongs which do not occur are the ones shown in (69):

(69)					
		ei			ui
	ie		ae	oe	ue
	ia	ea		oa	ua
	io	eo	ao		uo
	iu	eu	au	ou	

Since however Murane does not discuss hiatus examples involving /u/ or /o/ in V_2 position, it may well be that such sequences never arise to begin with and hence we do not actually need to rule them out.[22] If this is so, then the illicit diphthongs we must actually concern ourselves with reduces to the set in (70):

(70)					
		ei			ui
	ie		ae	oe	ue
	ia	ea		oa	ua

[22] Of the eight logically possible diphthongs ([io], [iu], [eo], [eu], [ao], [au], [ou], [uo]) which have /u/ or /o/ as V_2, all but two will be ruled out in any case by constraints posited below to rule out other unattested diphthongs. The two not ruled out by these constraints are [au] and [eu]. If it turns out that the hiatus sequences /a+u/ and /e+u/ do in fact arise, some other mechanism will be required to rule out these diphthongs. In the worst case, we might simply resort to an ad hoc constraint against diphthongs with /u/ as V_2.

I propose to divide these illicit diphthongs into two partly overlapping types: those in which V_1 is high ([ie], [ia], [ui], [ue], and [ua]), and those in which the auditory distance between V_1 and V_2 is insufficiently great ([ie], [ei], [ea], [ae], [oe], [oa], and [ui]), in a sense to be made precise below. Each type will be ruled out by a separate constraint.

Consider first the ill-formedness of diphthongs in which V_1 is high, i.e. rising diphthongs. Here I follow Rosenthall (1994) in assuming a constraint Sonority Fall which disprefers these diphthongs:

(71) Sonority Fall (SonFall)

$$*\begin{array}{c}\sigma \\ \diagup \quad \diagdown \\ \mu \qquad \mu \\ | \qquad | \\ V_i \quad V_j\end{array}$$ where the sonority of V_i is less than that of V_j.

This constraint will prohibit diphthongs like [ia] and [io], while allowing [ai] and [oi]. There is no evidence that this constraint is ever dominated in Daga. At a minimum, it must be ranked above PARSE(F)-$[_m$, which is violated in (67i,j), and of course ordinary PARSE(F).

To rule out sequences like /ae/ and /ao/, which I claim are ill-formed because the two vowels are not sufficiently distinct from each other, I posit a series of constraints that insist upon a minimum featural distance between the two vowels comprising a diphthong:

(72) MINDIP=2 — V_1 and V_2 in a diphthong must differ in at least two features.

MINDIP=3 — V_1 and V_2 in a diphthong must differ in at least three features.

MINDIP=4 — V_1 and V_2 in a diphthong must differ in at least four features.

etc.

These constraints may be viewed as a natural extension, to syntagmatic relationships, of ideas put forth in Flemming (1995) with reference to paradigmatic contrast relationships among lexical items. Note that a constraint MINDIP=1 would be superfluous, since a sequence which did not satisfy this constraint would simply not be a diphthong.

Given these constraints, the range of diphthongs allowed by a language will depend on which of them is ranked above PARSE(F) (or, more accurately, the particular PARSE(F)-P constraints relevant to the environment(s) where Diphthong Formation is a possibility). A language in which PARSE(F) is ranked above all MINDIP constraints will, other things being equal, permit diphthongs in which the two vowels differ by only one feature, as well as those in which the vowels differ in two or three (or more) features, as illustrated in (73). (Here I assume a language in which [ATR] plays no active role, so that feature differences are reckoned only in terms of [front], [round], [high], and [low].)

(73) a.

	/Ce+i/	PARSE(F)	MINDIP=2	MINDIP=3	MINDIP=4
	C<e>i	*...			
⇒	.Cei.		*	*	*

b.

	/Ca+e/	PARSE(F)	MINDIP=2	MINDIP=3	MINDIP=4
	C<a>e	*...			
⇒	.Cae.			*	*

c.

	/Ca+i/	PARSE(F)	MINDIP=2	MINDIP=3	MINDIP=4
	C<a>i	*...			
⇒	.Cai.				*

If on the other hand PARSE(F) is ranked below MINDIP=2 but above the other MINDIP constraints, the language will permit only diphthongs in which the two vowels differ in at least two features, while if PARSE(F) is ranked below MINDIP=3, the languages will only tolerate diphthongs where the vowels differ by at least three features. This effect of this latter ranking is illustrated in (74). (Here again I assume a language in which [ATR] is inactive.)[23]

(74) a.

	/Ce+i/	MINDIP=2	MINDIP=3	PARSE(F)	MINDIP=4
⇒	C<e>i			*...	
	.Cei.	*	*		*

[23] While the MINDIP family of constraints favors diphthongs in which the two halves are maximally distinct from each other, we must assume that this preference is balanced by other, articulatorily-based constraints which militate against a wide separation in quality, due to the more extreme articulatory gesture(s) which this entails. In languages where these latter constraints dominate, less well-separated diphthongs will be preferred. This will make it possible to account for processes which reduce the magnitude of a diphthongal gesture.

b.	/Ca+e/	MINDIP=2	MINDIP=3	PARSE(F)	MINDIP=4
⇒	C<a>e			*...	
	.Cae.		*		*

c.	/Ca+i/	MINDIP=2	MINDIP=3	PARSE(F)	MINDIP=4
	C<a>i			*...	
⇒	.Cai.				*

The results in (74) are those which obtain in Daga. (The sequence /o+i/, not shown in (74), also involves three feature differences, i.e. [round], [front], and [high], and thus behaves exactly like the sequence /a+i/.) We may therefore assume that Daga has the ranking MINDIP=3 >> PARSE(F). In actuality, we must assume, in addition, that MINDIP=3 is ranked above PARSE(F)-lex, which is violated by V_1 Elision in preference to Diphthong Formation in examples (67d,e,f). Since MINDIP=3 is never violated in Daga, I will assume that it is undominated.

An additional advantage of adopting the MINDIP family of constraints is that it renders *DIP superfluous as a separate constraint. A language with no diphthongs will simply be one which requires a greater minimum feature difference between the two elements of a diphthong than is logically possible, given the vowel inventory of the language. If we assume that the maximum number of feature differences possible in a language is probably four (this would be the difference for example between [a] and [i] or between [ɔ] and [i] in a language in which [ATR] is active), then diphthongs will be ruled out altogether in any language in which MINDIP=5 is ranked above the other hiatus resolution constraints. Looking at it from a slightly different angle, we might regard our original constraint *DIP as simply an alternative designation for MINDIP=5.

Before leaving the matter of diphthongs entirely, there is a residual problem which must be pointed out. Although [ai] and [oi] are the only diphthongs which Daga permits to arise via hiatus resolution, other diphthongs, /ei/, occur morpheme-internally, as in the examples below:

(75)	a. meima	'husband'
	b. oaen	'woman'
	c. uon	'finish'
	d. pokea	'empty'

In rule-based approaches, this fact could be handled by restricting the rule(s) responsible for eliminating these other sequences (through Elision) to derived environments. The problem of derived environment effects has not, to my knowledge, so far been squarely addressed within Optimality Theory, and I will not speculate on this solution here. The issue is clearly a very general one however.

We may now consider the factors affecting which vowel is elided in the examples in (67). To begin with, we may note that the vowels /i/ and /e/ are never elided in V_2 position; this is evident in the examples in (67a,b,c) (where V_1 is elided instead), as well as those in (68) (where V_2=/i/ is retained as the second element of a diphthong). This suggests that preservation of [front] and [+high] (the features of /i/) in morpheme-initial position is not crucially dominated by any competing constraint in

Daga. In particular, example (67c) justifies the ranking in (76a), while the examples in (68) justify the ranking in (76b).

(76) a. PARSE(+high)-$[_m$, PARSE(front)-$[_m$ >> PARSE(F)-lex

b. PARSE(+high)-$[_m$, PARSE(front)-$[_m$ >> *DIP

The other vowel to appear in V_2 position in the data is /a/. In contrast to the /i/-initial suffixes, the initial /a/ of a suffix is generally lost following both vowel-final roots (as in (67j)) and vowel-final suffixes (as in (67i)). According to Murane, the only exception to this behavior occurs when an /a/-initial suffix directly follows the suffix /ingi/ (first person singular continuous tense); in this case, the initial /a/ is preserved and the final /i/ of /ingi/ is elided, as shown in (67g,h). We thus have the following three cases to account for:

(77)	a. $V_1]_{root}$ + $[_{suffix}$ a	→	V_1 <a>
	b. $V_1]_{suffix}$ + $[_{suffix}$ a	→	V_1<a> (first suffix ≠ ingi)
	c. ingi + $[_{suffix}$ a	→	ing<i> a

There is some question as to whether the factors responsible for the different behaviors in these different cases are morphological or phonological. Since the only two examples (67i,j) in which /a/ undergoes V_2 Elision involve /u/ or /o/ in V_1 position, and since V_1 Elision occurs with /a/-initial suffixes only when V_1 is /i/ (i.e. the final vowel of /ingi/), we might suppose that it is the different phonological identity of V_1 in these cases which is responsible for the difference. (Murane does not actually say whether there are /i/-final suffixes other than /ingi/ which may occur in this position.) There are three facts which suggest that this is not correct. First, we have already seen that the features of /i/ are exceptionally resistant to Elision in morpheme-initial position. It would therefore be surprising if these features proved to be the most susceptible to Elision in another context, i.e. before an /a/-initial suffix. Second, there is a problem in formalizing an analysis based on differential feature-parsing. Suppose that we sought to account for the V_1 Elision in example (67j) by ranking preservation of [+high] and [round], the features of /u/, above preservation of [low] (which I assume to be the only feature for which /a/ is specified). While this assumption, appropriately formulated, would work for (67j), the preferential preservation of [+high] over [low] would wrongly predict preservation of /i/ in preference to /a/ in (67g,h). Third, although the only clear examples of V_2 Elision given by Murane involve /a/-initial suffixes, her discussion implies that V_2 Elision takes place with suffixes beginning with other vowels as well,[24] and that this is a general result in the language, V_1 Elision occurring only before suffixes commencing with front vowels or when a vowel-initial suffix follows /ingi/. In view of these factors, it seems more promising to regard the different behaviors in (77) as due to different morphological (or lexical) circumstances in the input.

[24] Murane actually does provide one other example (p.7) which she describes as V_2 Elision, involving a suffix /-en/ following a suffix /-nege/. In this case however we cannot be sure which vowel is elided, since the two input vowels are identical.

In pursuing such an approach, we may note to begin with that the V_2 Elision schematized in (77a) would follow straightforwardly from the non-lexical status of the suffix, were we to adopt the ranking PARSE(F)-lex >> PARSE(F)-$[_m$. I illustrate this with example (67j):

(78)

	/tunu-an/	PARSE(F)-lex	PARSE(F)-$[_m$
	tun<u>an	*...	
⇒	tunu<a>n		*...

An apparent problem with this approach is that it seems to conflict with the ranking PARSE(+high)-$[_m$, PARSE(front)-$[_m$ >> PARSE(F)-lex already posited to account for the occurrence of V_1 Elision with /i/-initial suffixes. This problem is only apparent, however. Since we are concerned in this case only with the vowel /a/ in morpheme-initial position, we can actually replace PARSE(F)-$[_m$ in (78) with the more specific constraint PARSE(low)-$[_m$. This gives us the overall ranking in:

(79) { PARSE(+high)-$[_m$, PARSE(front)-$[_m$ } >> PARSE(F)-lex >> PARSE(low)-$[_m$

The case involving /ingi/ in (77c) is even more straightforward. The occurrence of V_1 Elision in this case follows, under the present analysis, from the fact that Elision of V_1 in the non-lexical morpheme /ingi/ violates only ordinary PARSE(F), while Elision of V_2 necessarily violates PARSE(F)-$[_m$ as well. This is true under any ranking of the constraints, in the absence of any morpheme-specific PARSE(F) constraints that refer specifically to /ingi/.

The problematic case for our analysis is (77b). Here we would expect V_1 Elision rather than V_2 Elision, for exactly the reason that applies in the case of (77c) discussed in the preceding paragraph: while V_1 Elision violates only PARSE(F), V_2 Elision in this context violates both PARSE(F) and PARSE(F)-$[_m$. A way out of this apparent contradiction is not obvious; nevertheless, there are two possible solutions which might be entertained. The first would be to invoke a morpheme-specific PARSE(F) constraint that applies to the pronominal suffix /-mo/ in example (67i) (which is the only actual example illustrating the problematic case schematized in (77b)). Ranked above PARSE(low)-$[_m$, this constraint would correctly lead to V_2 Elision, rather than V_1 Elision in this example:

(80)

	/to-mo-an/	PARSE(F)-lex	PARSE(F)-/mo/	PARSE(low)-$[_m$
	tom<o>an		*...	
⇒	tomo<a>n			*

The viability of this approach will depend on how many other suffixes there are which behave exactly like /-mo/ in that they trigger V_2 Elision in a following /a/-initial suffix. Clearly, if it is necessary to formulate morpheme-specific constraints for more than a very few such suffixes then a generalization is being missed. What the actual facts are in this regard is unclear. Although Murane indicates that there are other such suffixes, the only examples she gives in this context are two /e/-final suffixes /-nege/ 'me' and /-ne/ 'us', and these are shown only before /e/-initial suffixes, in which context it is of course impossible to tell which underlying vowel has been elided.

If we were to assume that the Elision of /a/ suffix-initially following a suffix is indeed a well-established general pattern in Daga, then we would be forced to look for some factor that might favor preservation of features in the suffixes that precede these initial /a/'s. Assuming that these suffixes are always pronominal object suffixes, as they are in the examples Murane provides, we might claim that these suffixes have a privileged position in virtue of their close structural proximity to the verb, i.e. the object suffixes are internal arguments of the verb while the subject suffixes are not. On this basis, we might adopt a further position-sensitive PARSE constraint, rankable in some languages above PARSE(F)-$[_m$, which would favor preservation of features which are structurally close to the head element of a word or phrase. Under this approach, there would be no difficulty in explaining why /ingi/ is not also subject to the new PARSE constraint; this follows directly from the fact that /ingi/ is a subject suffix and not an object suffix, as is evident from the glosses in examples (67g,h).

In conclusion of this section, the Daga facts provide an interesting test case for our theory in several respects. First, they force us to account for the fact that although most vowel sequences are subject to Elision, the sequences /a+i/ and /o+i/ undergo Diphthong Formation instead. This behavior motivates a more refined theory of Diphthong Formation, in which the MINDIP family of constraints, founded on the notion that languages prefer the two elements of a diphthong to be as distinct from each other as possible, replaces the monolithic constraint *DIP which simply prohibits diphthongs altogether.

Second, Daga provides us with a case in which the choice of vowel elided is sensitive at least in part to the feature compositions of the vowels in hiatus, demonstrating the need for PARSE constraints to refer to specific feature values. A number of other cases of this type will be seen below.

Finally, Daga has presented us with an anomalous pattern whose treatment poses a problem for the theory, viz. the examples in (67i,j), involving V_2 Elision of the initial /a/ of a suffix following a vowel-final suffix (other than /ingi/). I have accounted for these using a PARSE(F) constraint that refers to a specific morpheme, the pronominal suffix /-mo/. Some device of this type seems clearly required in order to account for the idiosyncratic behavior of particular morphemes, which is an unavoidable property of languages.

2.5.3 Okpe

Okpe, a Benue-Congo language spoken in Nigeria, is discussed in Hoffman (1973), Omamor (1988), and Pulleyblank (1986). This language shows Glide Formation of a final high vowel of a verb root before a V suffix. Examples are shown in (81); note that the choice of suffix allomorph is determined by vowel harmony. (Here and throughout I use IPA symbols for vowels which Omamor generally symbolizes using orthographic or other symbols. I follow Omamor in distinguishing nine vowels phonetically. Hoffman does not distinguish [e] from [ɪ] nor [o] from [ʊ] phonetically, although he proposes that they are distinct phonologically. For evidence that they are distinct phonetically as well see Omamor (1973).)

(81)	Infinitive suffix /o/ ~ /ɔ/			
	a. e-ti-o	→	etyo	'to pull'
	b. e-ru-o	→	erwo	'to do/make'
	c. ɛ-sʊ-ɔ	→	ɛswɔ	'to sing'
	Imperfective suffix /ɛ/ ~ /a/			
	d. a-dʊ-a	→	adwa	'is big'
	e. e-fu-ɛ	→	efwɛ	'is swollen'
	f. a-rɪ-a	→	arya	'is eating'
	Future suffix /o/ ~ /ɔ/			
	g. ri-ɔ	→	ryɔ	'will eat'
	h. bi-o	→	byo	'will be black'
	i. hu-o	→	hwo	'will die'

If however the final vowel of the verb root is a non-high vowel, Glide Formation does not apply and the suffix does not surface. Following Pulleyblank (1986), I regard this as due to V_2 Elision:

(82)	a. e-se-o	→	ese	'to fall'
	b. ɛ-dɛ-ɔ	→	ɛdɛ	'to buy'
	c. e-ne-ɛ	→	ene	'is defecating'
	d. a-zɛ-a	→	azɛ	'is running'
	e. fe-o	→	fe	'will be rich'
	f. dɛ-ɔ	→	dɛ	'will buy'

The occurrence of Glide Formation with the examples in (81) requires, at a minimum, ranking of PARSE(F)-lex and either PARSE(F)-$[_m$ or PARSE(F)-+V+ above *CG. (For concreteness, I will assume that the latter possibility obtains.) Given this ranking, an input sequence like /ti-o/ (cf. (81a)) will be resolved by Glide Formation in preference to Elision of V_1 or V_2:

(83)	/ti-o/	PARSE(F)-+V+	PARSE(F)-lex	*CG
⇒	tyo			*
	t<i>o		*...	
	ti<o>	*...		

To rule out other candidates, involving Diphthong Formation, Heterosyllabification, or Epenthesis, we must also assume that the constraints *DIP, ONSET, and *INS(F) dominate *CG.

As things stand, the ranking { PARSE(F)-lex, PARSE(F)-+V+ } >> *CG wrongly predicts that Glide Formation should apply with mid vowels as well. This is shown in (84):

(84)	/se-o/	PARSE(F)-+V+	PARSE(F)-lex	*CG
⇒	syo			*
	s<e>o		*...	
	se<o>	*...		

(The analysis does not, however, necessarily predict that Glide Formation will also apply to the low vowel /a/, since this would violate the additional constraint GLIDEHOOD introduced in 2.3.1; I assume that, as in most languages, this constraint is not crucially dominated in Okpe.) To remedy this state of affairs, I adopt the following additional constraint.

(85) Hi-G Glides must be [+high].

Although a glide deriving from an underlying high vowel will satisfy this constraint, a glide arising from a mid vowel will not, since it lacks a [+high] specification. (Unless of course the glide both loses its underlying [-high] specification and acquires a [+high] specification through insertion; this option would violate *INS(F), however. Since I have no evidence that *INS(F) is ever violated in Okpe, we may safely assume that this constraint is ranked sufficiently high to rule out such a scenario.) Assuming that Hi-G is ranked above PARSE(F)-+V+ and PARSE(F)-$[_m$ (both of which are violated by V_2 Elision of a V suffix) in Okpe, the analysis now correctly prefers V_2 Elision to Glide Formation in cases where the root vowel is non-high:

(86)

	/se-o/	Hi-G	PARSE(F)-+V+	PARSE(F)-$[_m$	*CG
	syo -hi	*			*
⇒	se<o>		*...	*...	

Yet to be accounted for is the fact that it is the suffix vowel rather than the root vowel which is elided. This behavior follows straightforwardly from the ranking PARSE(F)-lex >> { PARSE(F)-+V+, PARSE(F)-$[_m$ }, which I now adopt:

(87) PARSE(F)-lex >> { PARSE(F)-+V+, PARSE(F)-[$_m$ } gives V_2 Elision in preference to V_1 Elision:

	/se-o/	Hi-G	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)-[$_m$	*CG
	syo | -hi	*				*
	s<e>o		*...			
⇒	se<o>			*...	*...	

(As before, we must further assume that *DIP, ONSET, and *INS(F) are all ranked above PARSE(F)-+V+ and PARSE(F)-[$_m$, since both of these constraints are violated by V_2 Elision. If this were not the case, we would have expected Diphthong Formation, Heterosyllabification, or Epenthesis instead.)

Our attention has so far been confined to root-suffix contexts. Although Hoffman's examples involve only these contexts, Omamor (1988) describes cases of Elision at the boundary between two words, the first of which is a pronoun. These are shown below. (Here the sequence asa ma/e in (88a,b,d,e) constitutes one way of marking future tense in Okpe; Omamor does not indicate the relative meaning contributions of the two constituent parts of this sequence. The construction in (88c,f) is described as a common stylistic variant of the asa ma/e construction.)

(88)

a. wʊ asa ma nya you go	→	wasamanya 'you are going to go'
b. wʊ asa me rhe you know	→	wasamerhe 'you are going to know'
c. wʊ esee fe you be rich	→	weseefe 'you are going to be rich'
d. ɔ asa ma nya he go	→	ɔsamanya 'he is going'
e. ɔ asa me rhe he know	→	ɔsamerhe 'he is going to know'
f. ɔ asaa dɛ he buy	→	ɔsaadɛ 'he is going to buy'

What is surprising about these examples is that the pronouns /wʊ/ 'you' and /ɔ/ 'she/he' give rise to different results: while /wʊ/ undergoes V_1 Elision, /ɔ/ triggers V_2 Elision. This very interesting asymmetry follows automatically from our analysis, provided we adopt the not unreasonable assumption that neither the subject pronouns nor the future marker asa are fully lexical words and hence are not subject to the constraint PARSE(F)-lex.[25] Consider first the cases in (88d-f) involving the third person pronoun /ɔ/. Here Elision of either /ɔ/ (V_1) or the initial vowel /a/ of the future marker will violate the constraints PARSE(F)-$[_m$ and PARSE(F)-$[_w$, as well as ordinary PARSE(F). Neither Elision possibility violates PARSE(F)-lex on the other hand. The outcome will therefore be decided by the remaining PARSE constraint, PARSE(F)-+V+, which is violated by Elision of /ɔ/ but not by Elision of /a/:

[25] In all probability, the present analysis' reference to a binary lexical/function distinction will need to be replaced by a more elaborated scale that refers to several degrees of "lexicalness." Thus, although pronouns carry less lexical content than full NP's, it seems clear that they carry more than determiners. However this may be, it seems plausible, pending further study, to treat the Okpe subject pronouns as not differing significantly in their degree of lexical content from the tense marker asa.

(89)	/ɔ asa/	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)-$[_w$	PARSE(F)-$[_m$	PARSE(F)
⇒	ɔ<a>sa			*...	*...	*...
	<ɔ>asa		*...	*...	*...	*...

As a consequence, Elision of /a/ is preferred under any relative ranking of these PARSE constraints.

In the case of the second person pronoun /wu/, on the other hand, it is the constraints PARSE(F)-$[_m$ and PARSE(F)-$[_w$, which in this context are violated only by V_2 Elision, that are decisive; the constraints PARSE(F)-lex and PARSE(F)-+V+ are not violated by either V_1 Elision or V_2 Elision, while PARSE(F) is of course violated by both:

(90)	/wu asa/	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)-$[_w$	PARSE(F)-$[_m$	PARSE(F)
	wu<a>sa			*...	*...	*...
⇒	w<u>asa					*...

Thus, V_1 Elision is necessarily the result. Notice that since this result does not depend on the relative rankings of the PARSE constraints, we are claiming that it must hold universally, i.e. we expect that V_1 Elision will always apply in preference to V_2 Elision at the boundary between two function words, provided that the first word is minimally CV.

Notice further that the V_2 Elision outcome in (89) depends critically on the fact that both words are non-lexical, so that neither V_1 Elision nor V_2 Elision violates

PARSE(F)-lex. If, instead, the pronoun /ɔ/ were to be followed by a lexical word, the result would necessarily depend on the relative ranking of PARSE(F)-+V+ and PARSE(F)-lex, since Elision of /ɔ/ would violate the former, while V_2 Elision would violate the latter. (The two Elision candidates would continue to tie with regard to their satisfaction of each of the other constraints.) We have already argued however that, in Okpe, it is PARSE(F)-lex which is ranked above PARSE(F)-+V+. Thus, we are committed to predicting V_1 Elision as the outcome in this context, as demonstrated in (91) (where the sequence /ata/ is used to represent a hypothetical lexical word).

(91)	/ɔ ata/	PARSE(F)-lex	PARSE(F)-+V+	PARSE(F)-$]_w$	PARSE(F)-$[_m$	PARSE(F)
	ɔ<a>ta	*...		*...	*...	*...
⇒	<ɔ>ata		*...	*...	*...	*...

This seemingly unlikely (from the viewpoint of most previous approaches to Elision) directionality reversal appears in fact to occur. Omamor (1988:49,50) gives several examples of the subject pronouns /mi/~/mɪ/ 'I' and /o/~/ɔ/ 'he/she' occurring before vowel-initial verbs. She states that while the utterances involving the former are subject to Glide Formation,[26] the examples involving the latter are resolved by Elision[27] of the subject pronouns:[28]

[26] Omamor also gives the examples /wu ene/ 'you are defecating' and /wʊ aze/, 'you are running (away)', which she says are resolved by V_1 Elision. Although we might have expected gliding of /u/~/ʊ/ instead, given that these vowels are regularly subject to Glide Formation elsewhere in the language, the failure of Glide Formation to apply in this case can presumably be attributed to the ill-

(92)				
	a. mi ene	→	myene	'I am defecating'
	b. mɪ azɛ	→	myazɛ	'I am running (away)'
	c. o ene	→	ene	'he/she/it is defecating'
	d. ɔ azɛ	→	azɛ	'he/she/it is running (away)'

It thus appears that the Okpe facts provide strong support for the framework advocated here, and in particular for the constraint PARSE(F)-lex.

In order to give Elision in Okpe in preference to Diphthong Formation, Heterosyllabification, or Epenthesis, we must posit the further ranking { *DIP, ONSET, *INS(F) } >> { PARSE(F)-$[_m$, PARSE(F)-+V+, PARSE(F)-$[_w$, PARSE(F) }. The rankings needed to handle the Okpe facts may now be summarized as in (93):

formedness of the [ww] sequence that would result. In fact, exemption of /wU+V/ (and /yI+V/) sequences from Glide Formation would seem to be the norm in languages that have this process.

[27] Omamor does not actually provide surface forms for the examples in (92), and her verbal description labels the process to which (92c,d) are subject as one of "assimilation" of the pronoun vowel to the initial vowel of the verb (which is an imperfective prefix--see note 28). Other examples in the paper make it clear however that her use of "assimilation" is equivalent to our "Elision" (with no compensatory lengthening).

[28] Word-initial /a/~/e/ in these examples is an imperfective prefix that undergoes [ATR] harmony with the root vowel. I assume that some mechanism analogous to bracket erasure ensures that the internal morphemic composition of words is invisible postlexically, so that Elision of the prefix vowels in these examples would not violate PARSE(F)-+V+. This assumption is not however crucial to the analysis: V_1 Elision is predicted for (92c,d) regardless of whether V_2 Elision would violate PARSE(F)-+V+, as the reader may verify.

(93)

Ranking	Reason(s):
{ *DIP, ONSET, *INS(F) } >> { PARSE(F)-+V+, PARSE(F)-$[_m$, PARSE(F)-$[_w$ }	*DIP, ONSET, *INS(F) must be ranked above the PARSE constraints which are violated in Okpe in order to give Elision rather than Diphthong Formation, Heterosyllabification, or Epenthesis.
PARSE(F)-lex >> { PARSE(F)-+V+, PARSE(F)-$[_m$ }	PARSE(F)-lex must be ranked above both PARSE(F)-+V+, PARSE(F)-$[_m$ to give V_2 Elision rather than V_1 Elision with V suffixes.
{ PARSE(F)-$[_w$, PARSE(F)-$[_m$, PARSE(F)-+V+, PARSE(F)-lex } >> PARSE(F)	(universal)
PARSE(F) >> *CG.	Required to give Glide Formation rather than V_2 Elision when V_1 is high.
Hi-G >> { PARSE(F)-+V+, PARSE(F)-$[_m$, PARSE(F)-$[_w$ }	Required to give V_2 Elision rather than Glide Formation when V_1 is non-high. (Hi-G >> PARSE(F)-$[_w$ is required to prevent Glide Formation in examples involving the /ɔ/ subject pronoun in V_1 position.)

There remains yet one more possible fact of interest in Okpe. Hoffman claims that high vowels fail to undergo Glide Formation, remaining in hiatus, just in case they bear a different tone from the following vowel. Thus, a form like /mì é ꜜsó/[29] 'I am stealing' is realized, according to Hoffman, as [mìéꜜsó] rather than [myéꜜsó] (or [myěsó]). By contrast, Omamor states that Glide Formation does apply in such cases.

I am unable to say whether this difference between Hoffman's data and Omamor's reflects inter-speaker variation or variation due to speech-rate or style or is simply a consequence of different auditory impressions on the part of two linguists whose data are otherwise in substantial agreement. It seems worthwhile, however, to

[29] Hoffman actually segments this form as /mìé ꜜso/, i.e. he analyzes the vowel /e/ as part of the pronoun (which is treated as a portmanteau morpheme marking both person-number and continuous tense). Omamor however treats this vowel as a morpheme in its own right, a continuous tense prefix. I have followed Omamor's analysis, which seems clearly correct.

briefly sketch how the facts as presented by Hoffman might be handled within the present framework since, whether or not his description of Okpe is completely accurate, there are other languages, e.g. Izi (Meier, Meier & Bendor-Samuel 1975), Nupe (Smith 1967) and Pero (Frajzyngier 1980) which exhibit somewhat similar behavior in suspending Elision or Glide Formation in certain tonal configurations.

The analysis that is required is extremely simple. First, we must assume that preservation of tonal features is ranked above ONSET. Assuming further that (1) glides are (universally) non-tone bearing, (2) tonal contours on short vowels are ruled out in Okpe (as in many languages) by an undominated constraint, and (3) Glide Formation can never give rise to a long vowel in Okpe (a fact which is observationally true, though its cause must remain unelucidated here), the result is that Heterosyllabification will be preferred to Glide Formation in cases where V_1 and V_2 bear different tones:

(94)	/mì éꜜsó/	(no contour on short V)	PARSE-tone	ONSET
⇒	mìéꜜsó			*
	myéꜜsó		*	
	myěꜜso	*		

Where V_1 and V_2 bear identical tones, on the other hand, Glide Formation may take place without violating PARSE-tone, provided we assume some kind of OCP effect whereby adjacent high tones do not count as distinct for the purpose of evaluating PARSE-tone:

(95)

	/mî é⁺só/	(no contour on short V)	PARSE-tone	ONSET
	mî é⁺só			*
⇒	myé⁺só			

2.5.4 Emai

Like Okpe, Emai is a Benue-Congo language spoken in Nigeria. Emai is of interest to us primarily because it is a clear example of the asymmetry we predict between lexical and function words in their behavior under Elision. According to Schaefer (1987:5,6), vowels in function words are more likely targets of Elision than those in lexical words:

> "Most susceptible to elision are vowels which are part of the sound shape of grammatical markers or function words...Overall, elision tends to obscure the sound shape that a function word exhibits in isolation, since its initial or final vowel is omitted."

Schaefer, who gives what is probably the most clear and complete discussion of the behavior of function words with respect to Elision of any source in my survey, lists the following "representative sample" of Emai function words:[30]

[30] Some of Schaefer's original symbols have been replaced with their IPA equivalents.

(96)	a. isi	Associative
	b. li	Indirect Object marker (with nouns)
	c. ni	Indirect Object marker (with pronouns)
	d. li	Relative Clause marker
	e. ki	Negative Focus marker
	f. βi	Locative marker

Schaefer gives examples of function words occurring both before and after lexical words. He also shows instances of hiatus involving lexical words only. I will demonstrate that in each of these contexts, correct results are obtained under the assumption that the ranking PARSE(F)-lex >> PARSE(F)-[$_w$ holds for Emai. It will however be necessary to posit one or two additional rankings in order to account for the fact that Emai also manifests Glide Formation with some sequences.

Consider first a situation in which a function word precedes a lexical word. Among the examples Schaefer gives illustrating this particular case are the following:

(97)	a. βi ọa in house	→	βoa
	b. ɔli ọa the house	→	ɔloa
	c. ɔli ẹbe the book	→	ɔlebe

In this context, V_1 Elision violates only ordinary PARSE(F), while V_2 Elision would violate not only PARSE(F), but PARSE(F)-lex and PARSE(F)-[$_w$ as well. Hence, only V_1 Elision is possible in this environment. (Note that this would be true even if the ranking PARSE(F)-lex >> PARSE(F)-[$_w$ did not hold in Emai.)

Where a function word <u>follows</u> a lexical word, the ranking PARSE(F)-lex >> PARSE(F)-$[_w$ predicts V_2 Elision instead of V_1 Elision, as we have already seen in section 2.3.3. This is in fact what we find in Emai, as seen in the additional data in (98).

(98)	a. ukpọde ɔ̣na road this	→	ukpodena
	b. ẹbe ɔnạ leaf this	→	ebena
	c. ɔli oa ɔnạ the house this	→	ɔloana
	d. ọa isị ɔ̣i house of his	→	oasɔi

The last two examples are particularly interesting. In (98c), the lexical word /oa/ 'house' is flanked by two function words, both of which lose their vowels. In (98d), a single VCV function word occurs between a vowel-final lexical word and a vowel-initial lexical word. Here, as the ranking PARSE(F)-lex >> PARSE(F)-$[_w$ predicts, the function word loses <u>both</u> its vowels, while the lexical words survive intact.[31] (Notice that this latter prediction only holds if we abandon our original assumption that pronouns are entirely non-lexical and employ instead the scalar notion of lexicalness discussed in section 2.5.1 above, along with the assumption that the pronoun /ɔi/ 'his' is more lexical than the preposition /isi/ 'of'.)

[31] Like the case of Daga discussed above, Emai presents us with the interesting situation in which hiatus is tolerated in underived, morpheme-internal environments, as the forms /oa/ 'house' and /ɔi/ 'his' in (98) make clear. Once again, I assume that an explanation for this fact must await a solution to the more general problem of structure preservation.

At the boundary between two lexical words, Elision in Emai consistently targets V_1, as shown in (99). (Examples (99b-d) are from Folarin-Schleicher (1992). Tone and nasality are ignored.)

(99)	a. kɔ ema plant yam	→	kema
	b. tɔ ɛwe roast goat	→	tɛwe
	c. fa edi pluck palm nut	→	fedi
	d. kɛ ɔka share maize	→	kɔka

This of course follows from the universal ranking of PARSE(F)-$[_w$ >> PARSE(F). PARSE(F)-lex is irrelevant in this context, because it is violated by V_1 Elision and V_2 Elision alike.

Hiatus also arises in some instances at the boundary between two roots in a compound. Here again, Elision regularly targets V_1:

(100)	a. ɔ-da-ɛnyɔn prefix-drink-wine	→	ɔdɛnyɔn 'drunkard'
	b. u-kpe-akɔn prefix-wash-teeth	→	ukpakɔn 'chewstick'

That V_1 Elision occurs in this context follows from the fact that this satisfies the constraint PARSE(F)-$[_m$, while V_2 Elision does not. The two types of Elision tie on the constraints PARSE(F)-lex (since both roots are of course lexical morphemes) and PARSE(F), which therefore have no affect on the outcome. PARSE(F)-$[_w$ is of course irrelevant since we are dealing with a word-medial environment, as is PARSE(F)-+V+, since neither of the roots is monosegmental.

In addition to Elision, Emai also displays Glide Formation. This applies only when V_1 is a high vowel (/i/ or /u/), as in the following examples:

(101)	a. fi ɔpia throw cutlass	→	fyɔpia
	b. ku amɛ throw water	→	kwamɛ
	c. u-su-ema prefix-tuber-yam	→	uswema 'tuber of yam'
	d. u-βi-akpoti prefix-small(?)-box(?)	→	uβyakpoti

That Glide Formation does not apply to non-high vowels is evident from the examples in (99).

Interestingly, Glide Formation affects only V_1's that occur in lexical words (as in (101a,b)) or compounds (as in (101c,d)); it does not apply to the final vowels of function words. This is clearly evident in the examples in (97), in which a final /i/ in a function word is consistently elided before a following vowel. If we view Glide Formation as a strategy for resolving hiatus while preserving the features of V_1 (and V_2), the fact that only vowels in lexical words are preserved through Glide Formation in Emai may be taken as further evidence that languages go to greater lengths to preserve features in lexical words, i.e. we have further justification for the constraint PARSE(F)-lex. Formally, we can account for the fact that only lexical words are subject to Glide Formation in Emai by ranking the constraint *CG, which disprefers Glide Formation, below PARSE(F)-lex but above ordinary PARSE(F). This will lead to results like those shown in (102):

(102) a. PARSE(F)-lex >> *CG >> PARSE(F) gives V_1 Elision with function word plus lexical word:

	/βi oa/	PARSE(F)-lex	*CG	PARSE(F)
⇒	β<i>oa			*...
	βyoa		*	

b. PARSE(F)-lex >> *CG >> PARSE(F) gives Glide Formation with lexical word plus lexical word:

	/fi ɔpia/	PARSE(F)-lex	*CG	PARSE(F)
	f<i>ɔpia	*...		*...
⇒	fyɔpia		*	

c. PARSE(F)-lex >> *CG >> PARSE(F) gives Glide Formation in lexical compound:

	/u-su-ema/	PARSE(F)-lex	*CG	PARSE(F)
	us<u>ema	*...		*...
⇒	uswema		*	

To account for the fact that only high vowels undergo Glide Formation, we must further adopt the ranking Hi-G >> PARSE(F)-lex. This will correctly give Glide Formation with high V_1's (in both compounds and at full lexical word boundaries) while yielding V_1 Elision with mid vowels:

(103)

	/Cu V_2.../	Hi-G	PARSE(F)-lex	*CG	PARSE(F)
	C<u>V_2		*...		*...
⇒	CwV_2			*	

(104)	/Co V_2.../	Hi-G	PARSE(F)-lex	*CG	PARSE(F)
⇒	C<o>V_2		*...		*...
	CwV_2	*		*	

There remains one final fact of interest to be addressed in Emai. Although short V_1's are regularly subject to Elision or Glide Formation, these processes are blocked when V_1 is long, as illustrated by the following contrastive pair:

(105) a. kɔ ema → kema
plant yam

b. kɔɔ ebe → kɔebe
read book

According to Schaefer, these underlying long vowels do however "tend to be shortened." Thus, he transcribes the outcome of (105b) with a short [ɔ] rather than a long [ɔɔ]. Resistance of long vowels to Elision is not unusual; similar effects are found in a number of other languages, including Central Kambari (Hoffman 1972), Engenni (Thomas 1978), Ila (Smith 1907), Moba (Russell 1985), and Nawuri (Casali 1988, 1995d).

This failure of underlying long vowels to undergo Elision can be accounted for by positing a constraint that favors preservation of features in vowels that are underlyingly long:

(106) PARSE(F,X:) Parse feature F in an underlyingly long segment.

Ranked above ONSET, this constraint will ensure that long vowels are not subject to Elision, as seen in (107). (Here we must assume that PARSE(F)-$[_w$ is ranked above

ONSET as well, in order to rule out V_2 Elision. This ranking is independently required in any case to account for the fact that word-initial vowels are not elided in absolute initial position.)

(107)	/kɔɔ ebe/	PARSE(F)-[$_w$	PARSE(F,X:)	ONSET
⇒	kɔɔebe			*
	k<ɔɔ>ebe		*...	
	kɔɔ<e>be	*...		

We might then regard the tendency of the surviving V_1's to be shortened as a matter of phonetic implementation. Alternatively, if we wish to maintain that this shortening is phonological, we might posit an additional constraint that disprefers phonetically long vowels in prevocalic position:

(108) SHORT Prevocalic V's should not be bimoraic.

This constraint will be ranked above a constraint PARSE-μ (Rosenthall 1994) that seeks to retain segment length. We will then have the results shown below:

(109)	/kɔɔ ebe/	PARSE(F)-[$_w$	PARSE(F,X:)	SHORT	ONSET	PARSE-μ
	kɔɔebe			*	*	
	k<ɔɔ>ebe		*...			**
⇒	kɔebe				*	*
	kɔɔ<e>be	*...				*

Note that we have not yet ruled out Glide Formation with an input sequence in which V_1 is a long high vowel. As things stand, this violates only *CG and PARSE-μ; it does not violate any of the PARSE(F) constraints. We therefore predict that this should be the preferred outcome when V_1 is /uu/ or /ii/, as illustrated in (110) with the hypothetical sequence /kuu ebe/.

(110)

/kuu ebe/	PARSE(F)-$[_w$	PARSE(F,X:)	SHORT	ONSET	PARSE-μ
kuuebe			*	*	
k<uu>ebe		*…			**
kuebe				*	*
⇒ kwebe					**
kuu<e>be	*…				*

Although Schaefer does not give or directly discuss any examples involving long high vowels in V_1 position, the most straightforward assumption suggested by his description is that these vowels (assuming they occur in V_1 position to begin with) behave exactly like long mid vowels, implying that the predicted result in (110) is incorrect. If this is in fact so, we might be led to assume that the failure to parse <u>two</u> moras which results from gliding a long vowel exacts a greater price than the language is willing to pay,[32] although in view of the uncertainty surrounding the actual facts I will not attempt to firmly resolve this issue here.

[32] One possible formalization of this notion is suggested by Kirchner's (1995) analysis of stepwise vowel raising, which relies on a "distantial" faithfulness constraint that penalizes raising of a vowel by more than one degree from its input value. Applying this basic strategy to the (presumed) realization of /uue/ as [ue] in Emai, we would posit an analogous constraint that penalizes realizations in which a vowel's surface duration differs by more than one mora from its input. Ranked high enough (and in particular above ONSET), this constraint would rule out a candidate in which both moras of the underlying long V_1 are lost.

2.6 Conclusion

In contrast to virtually all previous analyses of Vowel Elision, which have generally identified the vowel targeted by Elision in terms of its linear order with respect to the other vowel, I have outlined an approach in which the targeted vowel is determined by the interaction of constraints which refer not to linear order but to morphological or syntactic positions. In this approach, regularities which emerge regarding the linear position of the targeted vowel in a language are epiphenomenal. The analysis I propose is more explanatory, both in view of the fact that it suggests reasons for the tendency of Elision to target a particular vowel (e.g. the tendency of word-initial vowels to survive Elision is related to other characteristics of this position, such as the fact that it often supports a greater variety of featural contrasts, or may play a more significant role in lexical access), and in virtue of the interesting empirical predictions it makes (for example the prediction that no language will have unrestricted V_2 Elision at word boundaries). To the extent that these predictions are in general agreement with the observed facts, as they appear to be, the current framework represents a clear advance over previous analyses.

Chapter 3: Coalescence and Feature-Sensitive Elision

3.1 Coalescence

3.1.1 Symmetric Coalescence: Afar

A process that seems closely related to Vowel Elision, and often co-occurs with it, is Coalescence. An example of a language with this process is Afar, an Afro-Asiatic language described in Bliese (1981). In this language, the input sequences /e+u/ and /u+e/ are both realized as [o:]. Although, Bliese does not actually give examples involving /e+u/ or /u+e/ sequences, she is quite explicit in claiming (1981:223) that both sequences are realized as (long) [o]: "All the combinations involve complete assimilation of the less dominant vowel to the more dominant, except /eu/ combinations which become long [o], preserving the height of /e/ and the rounding of /u/. Vowel length or sequential order do not affect the assimilations."

Like Elision, Coalescence involves failure to preserve some vowel features of the input, e.g. realization of these sequences in Afar as [o:] involves loss of [+high] and [front]. The difference is that, whereas in the case of Elision, all the unpreserved features belong to the same vowel, Coalescence involves loss of (and preservation of) some features of each vowel. We might contrast the two processes by saying that whereas Elision is (at least in the typical cases we have considered so far) position-sensitive, targeting the features that occupy a particular position, Coalescence is feature-sensitive, preserving certain feature values in preference to others. In the fully symmetric form that it takes in Afar, Coalescence takes no regard of the position (V_1 or V_2) in which the features originate: the pair of vowels /e,u/ has the same realization in either input order.

Symmetric Coalescence of this type is predicted to be possible under fairly standard assumptions of Optimality Theory; all that is required is that PARSE(F) constraints referring to particular features may be ranked with respect to each other, i.e. a language may preserve certain features in preference to others. In Afar, for example, we require that [-high] is preserved in preference to [+high], while [round] is preserved in preference to [front]:

(111) Afar rankings:
a. PARSE(-high) >> PARSE(+high)
b. PARSE(round) >> PARSE(front)

Within a framework such as the one I am advocating, which makes use of position-sensitive PARSE(F) constraints, the analysis of Symmetric Coalescence is slightly more complicated than the discussion so far has assumed. In particular, it is not sufficient that PARSE(-high) be ranked above PARSE(+high). The fact that the realization of a sequence like /e##u/ as [o:] violates not only PARSE(+high) but also PARSE(+high)-$[_w$ requires the ranking PARSE(-high) >> PARSE(+high)-$[_w$.[33]

[33] Here I assume for simplicity that we are dealing with a situation in which there are no crucial relative rankings among the various (feature-sensitive) PARSE(F)-lex constraints; otherwise things

Similarly, the fact that the realization of the sequence /u##e/ as [o:] violates not only PARSE(front) but also PARSE(front)-$[_w$ requires the ranking PARSE(round) >> PARSE(front)-$[_w$. Henceforth, I refer to this type of situation, in which there is one or more crucial rankings of the form PARSE(F) >> PARSE(G,P) (where F and G may be either different features, or, as in the Afar case considered here, opposite values of the same feature and where P = word-initial, morpheme-initial, in a monosegmental morpheme, or in a lexical word or morpheme) as <u>interleaving</u>. Notice that this type of ranking does not violate the proposed universal ranking schema PARSE(F)-P >> PARSE(F), under the reasonable assumption that this schema only applies to constraints that refer to the same feature, i.e. it says nothing about the relative ranking of PARSE(F)-P and PARSE(G), where F and G are different features (or opposite values of the same feature).

Notice that the rankings PARSE(-high) >> PARSE(+high)-$[_w$ and PARSE(round) >> PARSE(front)-$[_w$ make other predictions as well. For example, they dictate (assuming, as in fact we must, that superordinate constraints rule out front rounded vowels in Afar) that the input sequences /e+o/ and /o+e/ will both be realized as [o:]; this is shown in (112) and (113). (Here the notation o(-hi_1) describes a candidate, phonetically [o], in which the specification [-high] originates in the

---

become more complicated, e.g. a ranking PARSE(+high)-lex >> PARSE(-high)-lex would prevent the realization of /e##u/ as [o:] even if PARES(-high) is ranked above PARSE(+high)-$[_w$, as the reader may verify.

underlying V_1, i.e. the outcome is the result of Coalescence. Similarly, the candidate o(-hi$_2$) describes a phonetic output candidate [o] in which the specification [-high] originates in the underlying V_2. Notice that although the realization of /o+e/ as [o:] superficially to involve V_2 Elision, the winning candidate in (113) actually involves Coalescence, since the [-high] specification that survives in the output is the one that originated in V_2.)

(112)

	/e+o/	PARSE(-hi)-[$_w$	PARSE(-hi)	PARSE(rnd)	PARSE(+hi)-[$_w$	PARSE(frt)-[$_w$
⇒	<e>o		*			
	e<o>	*	*	*		
	o(-hi$_1$)	*	*			

(113)

	/o+e/	PARSE(-hi)-[$_w$	PARSE(-hi)	PARSE(rnd)	PARSE(+hi)-[$_w$	PARSE(frt)-[$_w$
	<o>e		*	*		
	o<e>	*	*			*
⇒	o(-hi$_2$)		*			*

And this is in fact the case, as the following examples show:

(114) a. daro exe → darooxe
'I gave grain'

b. diidaale oobbe → diidaaloobbe
'I heard a bee'

We have seen that surface realizations in Afar involving the pairs of input vowels /e/ and /o/ or /e/ and /u/ do not depend on the linear order of the vowels in the input. This turns out to be true in fact for all other input sequences in Afar as well. This is shown in (115), which gives the full set of realizations for all possible combinations of Afar vowels:

(115)	iV, Vi	→ V	(where V is /a/, /e/, /o/, or /u/)
	eV, Ve eu, ue	→ V → o	(where V is /a/ or /o/)
	uV, Vu	→ V	(where V is /a/ or /o/)
	oa, ao	→ a	

Actual examples illustrating some of these realizations at lexical word boundaries are given in (116).[34]

(116)	a. cissi eeḍege 'I knew the hill'	→	cisseeḍege
	b. cale irgice 'I cut a mountain'	→	caleergice
	c. daro exe 'I gave grain'	→	darooxe
	d. diidaale oobbe 'I heard a bee'	→	diidaaloobbe
	e. kimmiro urte 'the bird got well'	→	kimmiroorte
	f. anu ọkme 'I ate'	→	anookme
	g. daro akme 'I eat grain'	→	daraakme
	h. adeena uble 'toothbrush I saw'	→	adeenaable

In order to complete the analysis of Afar, we may note that any combination involving the vowel /a/ is realized as [a], i.e. /a/ takes precedence over any other vowel. This can be accounted for by assuming that PARSE(low) is ranked above PARSE(front)-$[_w$, PARSE(round)-$[_w$, and PARSE(+high)-$[_w$ (this will of course

[34] Although Vowel Elision is generally accompanied by compensatory lengthening in Afar, as seen in the examples in (116), this lengthening is nullified in some cases by a constraint which disfavors long vowels in closed syllables. For simplicity, the effect of this latter constraint has been ignored, so that all Afar Elision examples are shown with compensatory lengthening.

entail that PARSE(low)-[$_w$ is also ranked above these three constraints, as well as above ordinary PARSE(front), PARSE(round), and PARSE(+high), given the universal ranking schema PARSE(F)-[$_w$ >> PARSE(F)), provided we further assume (as indeed we must) that the features [front] and [round] are incompatible with [low] in Afar, in keeping with the following undominated constraints:

(117)	*ɒ	A vowel should not be both [round] and [low] (Kaun 1995).
	*æ	A vowel should not be both [front] and [low].

([+high], on the other hand, is assumed to be universally incompatible with [low].) Given these assumptions, and provided that the other hiatus constraints ONSET, *INS(F), *DIP, and *CG are ranked above all relevant PARSE constraints, we now correctly predict that both /V_1##a/ and /a##V_2/ will always be realized in Afar as [a]. I illustrate this for a few sequences in (118).

(118) a.

	/a##e/	*ɒ, *æ	PARSE(lo)-[$_w$	PARSE(lo)	PARSE(frt)-[$_w$	PARSE(+hi) -[$_w$
	<a>e			*		
⇒	a<e>				*	
	æ	*				

b.

	/e##a/	*ɒ, *æ	PARSE(lo)-[$_w$	PARSE(lo)	PARSE(frt)-[$_w$	PARSE(+hi) -[$_w$
	e<a>		*	*		
⇒	<e>a					
	æ	*				

c.

/a##u/	*ɒ, *æ	PARSE(lo)-[$_w$	PARSE(lo)	PARSE(rnd)-[$_w$	PARSE(+hi) -[$_w$
<a>u			*		
⇒ a<u>				*	*
o			*		*
ɒ	*				*

d.

/u##a/	*ɒ, *æ	PARSE(lo)-[$_w$	PARSE(lo)	PARSE(rnd)-[$_w$	PARSE(+hi) -[$_w$
u<a>		*	*		
⇒ <u>a					
o		*	*		
ɒ	*				

The full set of crucial PARSE rankings for word boundary contexts in Afar may now be summarized as in (119).

(119)

$$\begin{tikzcd}
\text{PARSE(low)} \arrow[d] \arrow[dr] & \text{PARSE(-high)} \arrow[d] \\
\text{PARSE(round)-}[_w \arrow[d] & \text{PARSE(+high)-}[_w \\
\text{PARSE(round)} \arrow[d] & \\
\text{PARSE(front)-}[_w &
\end{tikzcd}$$

In addition to the cases we have examined directly, these rankings correctly yield all of the other Afar outcomes schematized in (115). For example, the fact that both PARSE(+high)-[$_w$ and PARSE(front)-[$_w$ are dominated by (ordinary) PARSE(F) constraints for all features with which [+high] and [front] are in direct competition (i.e. [-high] and [low] in the case of the former and [round] and [low] in the case of the latter) entails that the vowel /i/ necessarily loses out to all other vowels.

(Verification that the analysis yields the correct outcomes for the remaining sequences is left to the reader.)

Finally, although the examples we have seen so far all involve hiatus at word boundaries, the Elision patterns in (115) also apply at stem-suffix and suffix-suffix boundaries in Afar, as illustrated in the additional examples in (120):[35]

(120)	a. rabbi-ow 'master'	→	rabboow
	b. urru-ow 'children'	→	urroow
	c. sool-a-u-k 'standing'	→	soolaak
	d. rad-a-i-h 'while descending'	→	radaah

The fact that the stem-suffix context displays the same kind of "mirror-image" behavior as is evident at word boundaries requires an interleaving of PARSE(F) and PARSE(F)-lex constraints (the latter being violated by V_1 Elision in this context) that is exactly analogous to the interleaving of PARSE(F) and PARSE(F)-$[_w$ constraints given in (119), i.e. we have the additional rankings in (121):

[35] Although Bliese does not gloss the morphemes in these examples, it is possible to identify them with reasonable confidence based on information she provides elsewhere. As far as I can tell, their identities are as follows: /sool/ = 'stand' /a/ = imperfect (?), /uk/ (probably actually a single morpheme) = imperfect participle, /rad/ = descend, /ih/ (probably actually a single morpheme) = 'as' participle, /ow/ = vocative.

(121) PARSE(low) PARSE(-high)

$$\begin{array}{ll} \text{PARSE(low)} & \text{PARSE(-high)} \\ \downarrow & \downarrow \\ \text{PARSE(round)-lex} & \text{PARSE(+high)-lex} \\ \downarrow & \\ \text{PARSE(round)} & \\ \downarrow & \\ \text{PARSE(front)-lex} & \end{array}$$

It should be stressed that there is nothing unorthodox about this analysis of Afar. The assumption that there are separate PARSE(F) constraints corresponding to individual features seems by now fairly standard. Once the need for position-sensitive constraints like PARSE(F)-$[_w$ is recognized, the possibility of ranking a particular constraint PARSE(F)-P above a different constraint PARSE(G)-Q, where F and G are different features and P and Q are different (possibly null) positional specifications, becomes quite natural. If anything, what is more surprising than the existence of languages like Afar which apparently make use of this possibility is the fact that such languages seem to be relatively rare. The far more common state of affairs seems to be for the target of Elision to depend primarily on the positions in which the vowels appear, and not, as in Afar, entirely on their featural identities. Tentatively, I propose that the relative markedness of non-directional, "feature-sensitive" Elision is due to a default UG ranking, for each position P, of all PARSE(F)-P constraints together in a contiguous block. The possibility of interleaving two families of constraints, i.e. of a feature-sensitive ranking PARSE(F)-P >> PARSE(G)-Q in place of a more general ranking PARSE(F)-P >> PARSE(F)-Q that applies to every feature, is only entertained by the language learner in the face of positive evidence.

3.1.2 Asymmetric Coalescence

Fully symmetric Coalescence of the type found in Afar appears to be cross-linguistically rare. More frequently, Coalescence only applies when a sequence of input vowels occurs in a particular order. This may be illustrated with reference to a very common form of Coalescence in Niger-Congo languages, in which the sequences /a+i/ and /a+u/ are realized as [e] (or, in some languages, [ɛ]) and [o] (in some languages [ɔ]) respectively. Such a process occurs for example in Xhosa, as seen in the following data, from Aoki (1974):

(122)	a. wa-inkosi 'of the chiefs'	→	wenkosi
	b. na-impendulo 'with the answer'	→	nempendulo
	c. wa-umfazi 'of the woman'	→	womfazi
	d. na-um-ntu 'with the person'	→	nomntu

"Height Coalescence" of this sort will be discussed in considerable detail below. What is important for our present purposes is that the process is usually not symmetric: the reverse sequences /i+a/ and /u+a/ do not undergo Coalescence to [e] and [o], but are typically resolved instead by either Glide Formation or Vowel Elision. In the case of Xhosa, both of these possibilities are attested: /u+a/ undergoes Glide

Formation, while /i+a/ is apparently generally subject to V_1 Elision.[36] This is illustrated in the additional data below (from Aoki (1974) and McLaren (1955)):

(123) Glide Formation with u+a:

a. uku-ahlula → ukwahlula
'to divide'

b. uku-amkela → ukwamkela
'to receive'

V_1 Elision with i+a:

c. ndi-akha → ndakha
'I build'

d. ni-enza → nenza
'you make'

I propose that this type of process, which I refer to hereafter as Asymmetric Coalescence, represents a case that is intermediate between Symmetric Coalescence of the Afar sort, which subordinates positional factors fully to a preference for particular feature values over others, and ordinary Elision, which typically targets a particular position, regardless of the feature composition of the vowel which occupies that position (modulo the case where vowels specified for certain features, e.g. [+high], are preserved through Glide Formation). My claim is that Asymmetric Coalescence is sensitive to both feature content and position. The type of Height

[36] McLaren (1955:4) states that /i/ undergoes Glide Formation before another vowel, although he gives only a single example /ionke/ 'into' → [yonke]. (It is not clear whether this form is morphemically complex). It may be that whether /i/ glides or is elided in V_1 position depends on whether it occurs in absolute word-initial position or is preceded by a consonant. The Elision examples given by Aoki are all of the latter type. Also McLaren's vocabulary list contains some examples that appear to involve postconsonantal Elision of /i/, e.g. is-enzo 'deed' (p.230) is apparently /isi-enzo/, is-onka 'bread' (p.240) is apparently /isi-onka/.

Coalescence found in Xhosa and many other languages, for example, respects the following generalizations:

1. Feature Preservation Preference: [-high] is always preserved in preference to [+high], so that if either input vowel is [-high], the phonetic result will also be [-high].

2. Position Preservation Preference: Otherwise, all features of V_2 are preserved in preference to those of V_1. (Here I assume a context, e.g. prefix + root, as in the Xhosa examples above, that favors preservation of V_2 in rather than V_1.)

The second of these generalizations manifests itself in two ways. First, in cases where V_2 is non-high to begin with, or where both vowels are [+high] (i.e. in all cases other than those where V_1 is non-high and V_2 is high), the result is straightforward Elision of V_1 (or, in some languages Glide Formation). In the case of a language with a five-vowel system like Xhosa, for example, we have the realizations in (124). (Here the parenthesized glides indicate the possibility of Glide Formation, depending on the language.)

(124)		e+a > a	o+a > (w)a	i+a > (y)a	u+a > (w)a
	a+e > e		o+e > (w)e	i+e > (y)e	u+e > (w)e
	a+o > o	e+o > (y)o		i+o > (y)o	u+o > (w)o
					u+i > (w)i
				i+u > (y)u	

Second, in cases where Coalescence does occur, [-high] is the only feature of V_1 that is preserved. All other features of the output, in particular its frontness/roundness, are drawn from V_2.

It is worth emphasizing that from the viewpoint of the theory offered here, Symmetric Coalescence, Asymmetric Coalescence, and Elision are not three disparate phenomena, but simply represent different points on a continuum ranging from a situation in which position-sensitivity is fully determinate (giving ordinary Vowel Elision), to one in which both positional and featural preferences play a role (Asymmetric Coalescence) to one in which position-sensitivity is fully subordinated to a preference for preservation of particular features (Symmetric Coalescence). This contrasts with the view expressed by Haas (1988b), who treats Coalescence as a fundamentally different process that must be handled by a novel formal mechanism not required for an other process. At the same time, we may agree with Haas' contention that Symmetric Coalescence processes do in fact pose a serious problem for the standard formal devices of rule-based phonology.[37] It appears, then, that the present Optimality-Theoretic analysis is the first to provide an empirically adequate account in which all three processes are given a unified treatment using the same formal mechanisms, viz. alternative rankings of position-sensitive and feature-

---

[37] A detailed presentation of Haas' arguments here would take us too far afield from our main focus; the reader is therefore referred directly to Haas for discussion.

sensitive PARSE constraints. The effects of these alternative rankings are summarized below:

(125)

ranking	result
position-sensitive constraints undominated	ordinary Elision
interleaving between position-sensitive and feature-sensitive constraints	Asymmetric Coalescence
feature-sensitive constraints undominated	Symmetric Coalescence

The formal account of Asymmetric Coalescence within the present framework is straightforward. Assuming that we are dealing, as in the Xhosa examples above, with a prefixal context, the Feature Preservation Preference (generalization 1) for [-high] must be encoded by means of a ranking PARSE(-high) >> PARSE(+high)-lex. The effects of this ranking on an input sequence /a+i/ is illustrated in (126), where I use the Notation F' to stand for features other than [high], i.e. PARSE(F') represents the constraints PARSE(round), PARSE(front), and PARSE(low), which, based on the available evidence, are not crucially ranked with respect to each other.

(126)

	/a+i/	PARSE(-high)	PARSE(+high)-lex	PARSE(F')-lex	PARSE(F')
	<a>i	*			**
	a<i>		*	*	**
⇒	e		*		**

By contrast, this same ranking gives ordinary V_1 Elision, rather than Coalescence, with the reverse input sequence /i+a/:

(127)

	/i+a/	PARSE(-high)	PARSE(+high)-lex	PARSE(F)-lex	PARSE(F)
	i<a>	*		*	**
⇒	<i>a				**
	e			*	**

I emphasize once again that the ranking PARSE(-high) >> PARSE(+high)-lex does not contradict the posited universal ranking PARSE(F)-lex >> PARSE(F), which I take to be a schema that properly applies only to instantiations of PARSE(F)-lex and PARSE(F) that refer to the same feature value. In other words, while this schema requires that for any specific feature value F, the PARSE(F)-lex constraint (as well as the other position-sensitive PARSE constraints, e.g. PARSE(F)-$[_w$) referring to that feature value is always ranked above the position-neutral PARSE(F) constraint referring to the same feature value, no universal ranking holds between a constraint PARSE(F)-lex and PARSE(G), where F and G are different feature values. At the same time, it seems entirely reasonable to assume a default ranking provided by Universal Grammar in which, in the absence of language-specific evidence to the contrary, PARSE(F)-lex constraints for all feature values are grouped together above all PARSE(F) constraints, i.e. we have the default ranking in (128):

(128) PARSE(low)-lex, PARSE(front)-lex, PARSE(round)-lex, PARSE(-high)-lex, PARSE(+high)-lex >> PARSE(low), PARSE(front), PARSE(round), PARSE(-high), PARSE(+high)

Under this view, the ranking of the type PARSE(-high) >> PARSE(+high)-lex which occurs in languages with Coalescence, represents a marked ranking.

A noteworthy aspect of the analysis is that it places interesting restrictions on the varieties of Asymmetric Coalescence patterns which may occur. Suppose we are dealing with one of the contexts (chiefly prefix-root and lexical word boundaries) in which the position-sensitive PARSE constraints universally favor preservation of V_2 in preference to V_1, and that a particular interleaved ranking PARSE(G) >> PARSE(F)-P (where P refers to the relevant position in which preservation is favored) gives rise to Asymmetric Coalescence in this context. It must then follow (by transitivity) from the universal ranking PARSE(G)-P >> PARSE(G) that PARSE(G)-P is ranked above PARSE(F). This fact would rule out, for example, a language in which /Ca+i/ is realized at a prefix-root boundary as [Ce] and the reverse sequence /Ci+a/ as [Ci]. This would be ruled out because the ranking PARSE(-high) >> PARSE(+high)-lex required to realize /Ca+i/ as [Ce] necessarily entails the ranking PARSE(-high)-lex >> PARSE(+high). But this latter ranking forces /Ci+a/ to be realized as [Ca] in preference to *[Ci]:

(129)

	/Ci+a/	PARSE(-high)-lex	PARSE(-high)	PARSE(+high)-lex	PARSE(+high)
⇒	C<i>a				*
	Ci<a>	*			

In a rule-based approach, on the other hand, it is entirely possible to conceive of natural rules which would conspire together to yield this unattested pattern, e.g. those shown below:

(130) a. Fronting

$$V \rightarrow [\text{front}] \: / \: \underline{\quad} \underset{[\text{front}]}{V}$$

b. V_2 Elision

$$V \rightarrow \emptyset \: / \: V \: \underline{\quad}$$

(Here we may assume a constraint that disallows the combination [low, front], leading to automatic delinking of [low] in vowels which undergo (130a).) To the extent that patterns of this sort prove not to be attested (and as far as I know they are not), we have further evidence for the present framework, and in particular for the claim that position-sensitive PARSE constraints are justified not only by the role they play in accounting for Elision patterns, but also for the role they play in Asymmetric Coalescence.

3.2 Feature-Sensitive Elision: Modern Greek

We have so far assumed that the only constraints violated by Coalescence are PARSE constraints. Notice however that Coalescence involves not only loss of some features (a characteristic which it shares with Elision), but also an alteration of the timing relations among those features which are preserved. In the case where a sequence /a+i/ coalesces to form [e], for example, the features [-high] and [front], which were sequenced in the input, are realized simultaneously in the output. I argue that this realignment should not be achieved at no cost, but should rather constitute an additional Faithfulness violation of some type. In any language in which vowels merge, I propose that the constraint which is violated is a type of "all or none" constraint (Steriade 1995) that disprefers partial loss of a segment:

(131) Segment Integrity (Seg-Int) If one feature of a segment is preserved, all its features should be preserved.

Seg-Int has not played a crucial role in accounting for the languages we have seen so far. In languages with Coalescence (whether Symmetric or Asymmetric), this constraint is freely violated. In languages with Elision only, Seg-Int is never violated. In this latter case however we are not necessarily forced to attribute this fact to an undominated ranking of Seg-Int, since the absence of one or more interleaved rankings (which we have taken to be marked) would be sufficient to account for the lack of Coalescence in such a language. There is however one ranking (not so far considered) involving Seg-Int that does have significant empirical consequences. Where a language does have PARSE(F) interleaving, and where Seg-Int is moreover undominated, we predict a type of Elision that we have not so far encountered, in which certain input vowels are always preserved in preference to others, regardless of the positions which they occupy in the input. Suppose for example a languages with the interleaved ranking in (132). (I further assume, for the sake of concreteness, that we are dealing with a lexical word boundary context.)

(132) PARSE(low)-$[_w$
↓
PARSE(low)
↓
PARSE(round)-$[_w$
↓
PARSE(round)
↓
PARSE(-high)-$[_w$
↓
PARSE(-high)
↓
PARSE(front)-$[_w$
↓
PARSE(front)
↓
PARSE(+high)-$[_w$
↓
PARSE(+high)

If Seg-Int is ranked below all the PARSE constraints, this type of ranking gives rise to the type of Symmetric Coalescence seen in the case of Afar /e+u/ and /u+e/ above, in which the output vowel simply selects the most highly preferred set of compatible features from both input vowels. In a language in which Seg-Int is undominated, on the other hand, recombination of features originating in different vowels will be impossible, so that what we will wind up with instead is a kind of "strength hierarchy," in which certain vowels will always be selected in preference to others, the winning vowel for any competing pair of input vowels being the one which has the most highly valued feature(s). Assuming a language with a five-vowel system, for example, the ranking in (132) will give rise to the following strength hierarchy:

(133) Weakest ⟶ Strongest

i e u o a

For any given pair of input vowels, the phonetic result will always be the stronger of the two vowels, regardless of their original input order. This is illustrated below for the sequences /e+u/ and /u+e/. Notice here that although in both cases the candidate [o] is optimal with respect to the PARSE constraints alone, it loses out because of the undominated position of Seg-Int, which it violates.

(134)

	/e##u/	Seg-Int	PARSE(md)-[$_{\omega}$	PARSE(md)	PARSE(-hi)-[$_{\omega}$	PARSE(-hi)	PARSE(+hi)-[$_{\omega}$	PARSE(+hi)
⇒	<e>u				*	*		
	e<u>		*	*			*	*
	o	*					*	*

(135)

	/u##e/	Seg-Int	PARSE(md)-[$_{\omega}$	PARSE(md)	PARSE(-hi)-[$_{\omega}$	PARSE(-hi)	PARSE(+hi)-[$_{\omega}$	PARSE(+hi)
⇒	u<e>				*	*		
	<u>e			*				*
	o	*						*

An example of a language which exhibits exactly this type of behavior is Modern Greek. According to Kaisse (1977), most dialects of Modern Greek have precisely the strength hierarchy in (133) (and therefore, we may assume, the constraint ranking in (132)).[38] Some illustrative examples (from Kaisse 1977:5,6) are given in (136) (some of Kaisse's symbols have been changed to IPA symbols):

(136)	a. ta éxo them I have	→	táxo
	b. me aɣapápai me he loves	→	maɣapái
	c. ta onirévome them I dream	→	tanirévome
	d. to alázo it I change	→	talázo
	e. to urliázi it he howls	→	torliázi
	f. tu oðiɣó to him I lead	→	toðiɣó
	g. to éðosa it I gave	→	tóðosa
	h. me oðiyî me he leads	→	moðiyî
	i. me íde me he saw	→	méde

We have identified four different possible hiatus outcomes involving loss of input vowel features: ordinary (Position-sensitive) Elision, Feature-Sensitive Elision, Symmetric Coalescence, and Asymmetric Coalescence. The first, and most common, of the four processes is ordinary Elision. This will occur when there is no interleaving of PARSE(F) constraints. Full interleaving gives rise to either Symmetric Coalescence or Feature-Sensitive Elision; the former will occur when Seg-Int is

[38] According to Kaisse, there is evidence that a different hierarchy, o > a > u > i > e, occurs in one dialect, urban Athenian. It is not clear how this hierarchy could be handled within my proposed framework, since the ranking PARSE(round) >> PARSE(low)-[$_w$ which is apparently required by the dominance of /o/ over /a/ in the hierarchy should predict, contrary to fact, that /u/ (which is [round]) should also win out over /a/.

dominated by the relevant PARSE constraints, while the latter will arise where Seg-Int is undominated. Finally, Asymmetric Coalescence occurs with partial interleaving of the PARSE(F) constraints in combination with dominance of these constraints over Seg-Int. These different possibilities are summarized in the chart below:

(137)

Interleaving	Seg-Int ranking	Result
none	Seg-Int >> PARSE constraints	Elision
none	PARSE constraints >> Seg-Int	Elision
partial	Seg-Int >> PARSE constraints	?
partial	PARSE constraints >> Seg-Int	Asymmetric Coalescence
extensive	Seg-Int >> PARSE constraints	Feature-Sensitive Elision
extensive	PARSE constraints >> Seg-Int	Symmetric Coalescence

There remains one more logical possibility, represented by the question mark in (137), which we have not so far considered. Where there is partial PARSE(F) interleaving and Seg-Int is undominated, we actually predict a combination of ordinary Elision and Feature-Sensitive Elision. Consider for example a five-vowel language with the single interleaved ranking PARSE(-high) >> PARSE(+high)-$[_w$ and undominated Seg-Int. These rankings would ensure that in combinations involving a word-final non-high vowel and a word-initial high vowel, the non-high vowel would be preserved in its entirety, i.e. we would have the realizations in (138); note that these appear to manifest V_2 Elision.

(138) a+i > a   a+u > a
e+i > e   e+u > e
o+i > o   o+i > o

With all other input sequences, however, the result will be V_1 Elision, i.e. we will have the realizations in (139):

(139)		e+a > a	o+a > a	i+a > a	u+a > a
	a+e > e		o+e > e	i+e > e	u+e > e
	a+o > o	e+o > o		i+o > o	u+o > o
					u+i > i
				i+u > u	

It is not clear to me at this point to what extent such patterns are attested. At present, I have no clear examples of a language which manifests this type of behavior, although certain languages (e.g. Yoruba) come fairly close. In any event, my theory makes a clear prediction that languages which exhibit this behavior should be possible.

Chapter 4: Height Coalescence

4.1 Two types of Height Coalescence

Given the definition of Coalescence as a situation in which an underlying /V_1+V_2/ sequence is realized as a third vowel sharing features of both V_1 and V_2, there are quite a few logically possible patterns of Coalescence that might conceivably occur. There is one type however that seems to occur with particularly great frequency. This is a type of Coalescence (henceforth referred to as 'Height Coalescence') which applies only to sequences in which V_1 is non-high and V_2 is high (or, in some instances, a mid vowel which is nevertheless higher than V_1). The phonetic result of Coalescence is always a non-high vowel with the frontness and roundness of V_2.

Height Coalescence occurs in two main varieties. The first type, which I refer to as "e-Coalescence," most typically involves the realization of /a+i/ as [e] and/or /a+u/ as [o]. In many languages, some or all of the additional realizations in (140) may occur as well.[39] (The parenthesized glides in (140) indicate that the input sequences /o+i/ and /e+u/ will, in some languages, be realized with Glide Formation in addition to Coalescence, e.g. the sequence /o+i/ is realized in Nawuri as [we].)

---

[39] In languages with more than five vowels, e-Coalescence may involve yet additional realizations, e.g. /a+ɪ/ is realized in some languages as [ɛ]. The manifestation of e-Coalescence in languages with larger inventories is taken up in chapter 6 below.

(140) a+i > e   a+u > o
e+i > e   e+u > (y)o
o+i > (w)e   o+u > o

Descriptively, this type of Coalescence involves the preservation of the [-high] specification of V_1 together with the non-height features of V_2. Within a rule-based framework, this analysis might encoded as a pair of ordered rules, the first of which lowers a high vowel following a non-high vowel, and the second of which deletes the first vowel:

(141)	Lowering:	$V \rightarrow [\text{-high}] \,/\, \underset{[\text{-high}]}{V}$ ___
	V_1 Elision:	$V \rightarrow \varnothing \,/$ ___ V

This type of analysis, which has been employed for example by Aoki (1974) and Snider (1985, 1989c), gives rise to derivations like the following:

(142)	Underlying Sequence:	/a+i/
	Lowering:	ae
	V_1 Elision:	Øe

The second type of Coalescence, which I refer to as "ɛ-Coalescence," characteristically involves the realization of /a+e/ as [ɛ] and/or /a+o/ as [ɔ]. Descriptively, these realizations involve the preservation of the [-ATR] specification of V_1 together with the frontness or roundness of V_2. In rule-based terms, this might be expressed using the following ordered rules:

(143) [-ATR] Spread: $V \rightarrow [-ATR] / \underset{[-ATR]}{V}$ ___

V_1 Elision: $V \rightarrow \emptyset$ / ___ V

These rules give rise to several other realizations as well; the full predicted pattern is shown below (restricting our attention to non-low vowels):

(144)

a+e > ɛ	a+o > ɔ
ɛ+e > ɛ	ɛ+o > (y)ɔ.
ɔ+e > (w)ɛ	ɔ+o > ɔ

Not all of the languages in my survey which have some measure of ɛ-Coalescence (e.g. with /a+e/ or /a+o/) manifest the full range of realizations in (144). Among those which do not, the unattested realizations may in most cases be due to the fact that the relevant sequences never arise in the first place,[40] although unfortunately not all the sources are explicit on this point.

It is also common, in languages which display ɛ-Coalescence among the non-high vowels, for sequences with high V_2's to be affected as well, giving rise to some or all of the additional patterns shown below:

(145)

a+i > ɛ	a+u > ɔ
ɛ+i > ɛ	ɛ+u > (y)ɔ
ɔ+i > (w)ɛ	ɔ+u > ɔ

The patterns in (145) could be treated as involving preservation of both [-high] and [-ATR]. In at least two languages, Anufɔ (Adjekum, Holman & Holman 1993) and

[40] This appears to be the case for example in Kamba (Whitely & Muli 1962, Roberts-Kohno 1995b)

Owon Afa (Awobuluyi 1972) in fact, there are examples to show that [-high] may be preserved independently of [-ATR], since in addition to realizations like /a+e/ > [ɛ] and /a+i/ > [ɛ], we also find realizations like /e+u/ > [o] and /o+i/ > [(w)e]. Note however that, in the absence of realizations of this type, the realizations in (145) do not by themselves necessarily provide evidence for independent preservation of [-high]. Provided we are dealing with a language which lacks [-ATR] high vowels (and in fact this type of Coalescence seems limited to languages which lack these vowels, as we shall see below), the lowering of V_2 that these realizations involve can be attributed to structure preservation: since all underlying [-ATR] vowels in the language are [-high], a high V_2 which becomes [-ATR] necessarily becomes [-high] as well.

In languages with Height Coalescence, whether of the ɛ-Coalescence or the e-Coalescence variety, underlying sequences which are not subject to Coalescence (i.e. those in which V_1 is high and/or V_2 is non-high) are most typically resolved by Elision or Glide Formation.

4.2 Height Coalescence and vowel inventories

A striking fact, which has not, as far as I am aware, been previously noted, is that the type of Height Coalescence (whether ɛ-Coalescence or e-Coalescence) in a language can apparently be predicted from the language's vowel inventory. I will argue that this fact poses a significant problem for current theories of vowel height features. As background to these arguments, I first describe the vowel systems we will be dealing with.

Many Niger-Congo languages have symmetric vowel systems with an equal number of front and back vowels. Among the more common instantiations of this type of system are the five-, seven, and nine-vowel systems in (146). (Similar systems, in particular the five- and seven-vowel varieties, are of course common in non-Niger-Congo languages as well.)

(146) a. five-vowel system:

```
i       u
e       o
    a
```

b. seven-vowel system:

```
i       u
e       o
ɛ       ɔ
    a
```

c. nine-vowel system:

```
i       u
ɪ       ʊ
e       o
ɛ       ɔ
    a
```

Alongside the systems in (146), it is also common to find symmetric systems with one or more non-low central vowels, for example those in (147):

(147) a. six-vowel systems:

```
i       u          i   ɨ   u
e   ə   o          e       o
    a                  a
```

b. eight-vowel systems:

i		u		i	ɨ	u
e	ə	o		e		o
ɛ		ɔ		ɛ		ɔ
	a				a	

c. ten-vowel systems:

i		u		i	ɨ	u
ɪ		ʊ		ɪ		ʊ
e	ə	o		e		o
ɛ		ɔ		ɛ		ɔ
	a				a	

What is relevant to our purposes is not the total number of vowels in a system, but rather the number of heights which are present. Thus we may ignore the possible existence of non-low central vowels in a system and concern ourselves exclusively with the abstract types below:

(148) a. two-height system:

i	(ɨ)	u
e	(ə)	o
	a	

b. three-height system:

i	(ɨ)	u
e	(ə)	o
ɛ		ɔ
	a	

c. four height system:

i	(ɨ)	u
ɪ		ʊ
e	(ə)	o
ɛ		ɔ
	a	

(Note that here I do not consider the central vowel /a/ to constitute a separate height, i.e. only front and back-round vowels are taken into account in determining the number of 'heights" in a language. This is purely a terminological choice; the substantive question of whether /a/ should be assigned separate height features from the lowest front and back vowels in these systems is discussed in section 7.3.)

Languages with Height Coalescence show a strong correlation between the type of Coalescence they manifest and the kind of vowel system they have. Specifically, three-height systems of the type in (148b) manifest ε-Coalescence, while four-height systems always have e-Coalescence. This is evident in the tables in (149), which shows the languages in my survey with Height Coalescence. These are arranged by vowel inventory type: languages with two-height systems are given in (149a), languages with three-height systems in (149b), and languages with four-height systems in (149c). (Capital letters are used in the rightmost column in (149a) to represent vowels which are described as having both [+ATR]/close/tense and [-ATR]/open/lax allophones, or which are described as qualitatively intermediate between [+ATR]/close/tense and [-ATR]/open/lax vowels.[41] The consistent use of capital E in the middle column in (149a), on the other hand, is intended to represent the claim that the Coalescence which occurs in a two-height system should not really be viewed as distinctively either ε-Coalescence or e-Coalescence, for reasons discussed below. I have omitted a few languages whose inventories do not conform

[41] For example, Nupe /e/ and /o/ are described by Smith (1967) as "half-close," while (/i/ and /u/) are described as "nearly-close."

to any of the systems in (148); one such inventory is of considerable importance to our purposes and will be discussed at length below.)

(149) a. two-height systems:

language	type of Coalescence	vowel system
Bemba	E	5V: /iEaOu/
Chagga	E	5V: /ieaou/ (?)
Chiyao	E	5V: /ieaou/
Ila	E	5V: /IEaOU/
Kinyarwanda	E	5V: /ieaou/
KiYaka	E	5V: /iɛaɔu/
Kizeela	E	5V: /ieaou/
Kongo	E	5V: /IɛaɔU/
Lamba	E	5V: /iEaOu/
Lugisu	E	5V: /ieaou/ (?)
Nupe	E	5V: /IEaOU/
Pero	E	5V: /ieaou/
Santee Dakota	E	5V: /ieaou/
Shona	E	5V: /ieaou/
SiLuyana	E	5V: /ieaou/
SiSwati	E	5V: /ieaou/
Swahili	E	5V: /ieaou/
Teton Dakota	E	5V: /IEaOU/
Xhosa	E	5V: /IEaOU/
Zulu	E?	?

b. three-height systems:

language	type of Coalescence	vowel system
Anufɔ	ɛ	7V: /ieɛaɔou/
Central Kambari[42]	e	9V: /ieɛəɨaɔou/
Dangme	ɛ	7V: /ieɛaɔou/
Edo (Bini)[43]	ɛ	7V: /ieɛaɔou/
Efik[44]	ɛ	7V: /ieɛaɔou/ (?)
Ewe	ɛ	7V: /ieɛaɔou/
Owon Afa	ɛ	7V: /ieɛaɔou/

c. four-height systems:

language	type of Coalescence	vowel system
Chumburung	e	9V: /iɪeɛaɔoʊu/
Gichode	e	9V: /iɪeɛaɔoʊu/
Kasem	neither: a+ɪ>ɛ, ɵ+i>e, ɔ+ɪ>wɛ, o+i>we	10V: /iɪeɛɵaɔoʊu/
Krachi	e	9V: /iɪeɛaɔoʊu/
Nandi	neither: e+i>ee, o+i>ee ɵ+i>ee	10V: /iɪeɛɵaɔoʊu/
Nawuri	e	9V: /iɪeɛaɔoʊu/
Nuni	neither: a+ʊ>ɔɔ ɵ+u>oo	10V: /iɪeɛɵaɔoʊu/
S. Sotho	e (limited)	9V(?): /iɪeɛaɔoʊu/

---

[42] The vowel which I have represented (for typographical convenience) as /ɨ/ is actually symbolized by Hoffman (1972) as [ɵ] with a dot beneath it. He describes this vowel as "a central vowel slightly higher than [ɵ], but at times difficult to distinguish from the latter."

[43] Only one of my four sources on Edo, Wescott (1962) describes Edo as having Coalescence. It is not clear whether this is due to the fact that the sources describe different dialects or whether there is some other explanation. The discrepancy is somewhat puzzling, however, in view of the fact that the other three sources (especially Omozuwa 1992) contain between them a sizable number of hiatus examples (which are in these sources regularly resolved by Elision).

[44] There is some controversy concerning the Efik vowel system. Welmers (1968) and Cook (1969?) posit a seven-vowel system /ieɛaɔou/, with /ɛ/ being (according to Welmers) very rare. Ward (1933) has a six-vowel system /ieaɔou/.

Before discussing the significance of these tables, I wish to call attention to several points. First, it is evident that the non-low vowels of the two-height systems in (149a) exhibit considerable variation in their phonetic realizations, both within and across languages. This fact is unfortunately obscured somewhat by the nearly universal practice of using only the five vowel symbols [ieaou] in the data transcriptions for these languages. In fact, it would be a mistake to assume that the languages whose systems are represented simply as /ieaou/ in (149a) do in fact consistently realize these vowels as [ieaou]. In most of these cases, the sources I consulted are simply silent concerning how the vowels are actually pronounced. The issue of how the vowels in five-vowel systems are realized phonetically will be taken up in more detail below (section 7.4), as it turns out to have considerable significance for the competing models of vowel height we will be dealing with.) Second, in three of the languages in (149c), Kasem, Nandi, and Nuni, V_1 and V_2 always agree in their values of [ATR] to begin with (at least within non-compound words) as a result of extensive vowel harmony, hence inputs like /a+i/ and /a+e/ never arise to begin with. Although such sequences might conceivably arise across word boundaries or between roots in a compound, no relevant examples are given in the sources. Thus, it is not possible to classify these languages as distinctively either e-Coalescing or ɛ-Coalescing. Finally, there is some controversy over whether Southern Sotho has a three- or a four-height system. Although it has four heights on the surface, Doke &

Mofokeng (1957)[45] attempt to derive the surface system from an underlying three-height, seven-vowel system /iɪɛaɔʊu/. Their attempt is not entirely successful in my opinion: although [e] and [ɛ] (and [o] and [ɔ]) are nearly in complementary distribution, there are clear examples where they contrast (e.g. in word-final position).

The two-height systems in (149a) are of relatively little interest, as they shed little light on the proposed correlation between the type of Coalescence displayed by a language and its vowel system. Although two-height systems superficially appear to manifest either ɛ-Coalescence or e-Coalescence, depending on the language (i.e. both realization of /a+i/ as [e] and /a+i/ as [ɛ] are reported) [ATR] is in fact not contrastive in these languages and the real generalization appears simply to be that an input sequence /a+i/ will be realized with a phonetic quality identical to that of the mid front vowel of the language as realized in other contexts, whether this vowel happens to be more [e]-like or more [ɛ]-like. Hence, these systems may be treated as involving preservation of only [-high], a fact which may be viewed as following trivially from the non-distinctive status of [ATR] in these languages. In keeping with this, the type

[45] Guma (1971) actually gives five vowel heights (in addition to /a/), although he too posits a three-height system underlyingly. Tucker (1929), who discusses the problem at length (without reaching a firm conclusion) indicates that there is (or was, at that time!) considerable variation among speakers in the degree to which they differentiate [e] from [ɛ] and [o] from [ɔ].

of Coalescence displayed by the languages in (149a) has been designated non-committally as E.

What is significant is the strong tendency evident in (149b) and (149c) for three-height languages to display ɛ-Coalescence and four-height languages e-Coalescence. Setting aside Kasem and Nuni (which do not conform exactly to either type of Coalescence as presently defined), there is only one exception to this correlation: Central Kambari manifests e-Coalescence, even though it is reported to have a three-height system. While this exception seems to contradict the proposed correlation, it seems to me that it would be premature at this point to abandon this generalization on the basis of this single apparent counterexample. The Central Kambari facts are based on a single source, Hoffman (1972). Given that a significant number of four-height Niger-Congo languages have (due to the frequent difficulty in auditorily distinguishing high [-ATR] vowels from mid [+ATR] vowels) been incorrectly analyzed as having only three heights (Casali 1995c, Rennison 1986), it is at least conceivable that Central Kambari actually has an additional vowel height present. Hoffman himself gives indication in several places that his study is preliminary and tentative in nature; even the way he presents the vowel system ("the following vowels are distinguished here:...") could in fact be taken as indicative that a thorough analysis of the vowel system had not yet been carried out.[46] In view of this, I will tentatively set aside the Central Kambari case, pending further investigation, and assume henceforth that the proposed correlation between type of Height Coalescence and vowel inventory type is in fact a valid one.[47] To the extent that the correlation is valid, it presents a significant problem for most theories of vowel height, which give us no basis for expecting that this kind of non-trivial correlation between a language's vowel system and the type of Coalescence it may display should exist. This is discussed in more detail in the sections which follow.

---

[46] David Crozier (personal communication) informs me that Central Kambari does have phonetic [ɪ] and [ʊ] and that there is some uncertainty over the phonemic status of these vowels.

[47] It also needs to be pointed out that four of the languages with e-Coalescence in (149c), Chumburung, Gichode, Krachi, and Nawuri, are all closely related Kwa languages belonging to a group that Snider (1989b) labels Oti-Guang. Admittedly, this makes the evidence for the proposed correlation somewhat less impressive than if these languages were from widely separated families. The remaining language in (149c), Southern Sotho is a Bantu language and genetically quite distant from the four Oti-Guang languages. Moreover, the Oti-Guang languages are closely related (in view of their membership within Tano, a subfamily of Kwa) to one of the languages, Anufɔ, which has a three-height system and ɛ-Coalescence. They are somewhat less closely related to another of the ɛ-Coalescence languages, Owon Afa, which also belongs to Kwa. Even this relationship is considerably closer than that of the Oti-Guang languages to Southern Sotho. It is thus evident that the correlation between vowel system and Coalescence type cuts across genetic groupings.

Chapter 5: Height Coalescence and Theories of Vowel Height

5.1 A Standard view of height features

Although other approaches to height features exist (e.g. Clements 1991, Schane 1987), by far the most common approach to characterizing vowel heights is one that makes use of three features [high], [low], and [ATR]. [high] is almost always taken to be binary, while [low] and [ATR] are sometimes assumed to be monovalent. If [ATR] is taken to be monovalent, a further monovalent feature [RTR] (Retracted Tongue Root) is generally assumed in addition, in order to account for languages (e.g. Yoruba) in which it is the "[-ATR]" (=RTR) vowels that appear to be phonologically active. There are also a number of other issues concerning these features over which opinions differ, particularly with respect to underspecification. Nevertheless, it seems reasonably accurate to say that a fairly standard approach to vowel height has emerged, which is based on the features [high], [low], and [ATR] and is characterized by the following assumptions:

1. The features [high], [low], and [ATR], like phonological features generally, are defined in phonetic terms. In principle, these terms may be either acoustic or articulatory (or both). In practice, however, articulatory definitions have tended to predominate, particularly with respect to [ATR].

2. In keeping with point 1, a given phonetic vowel quality (as identified for example by its IPA symbol) will normally have the same feature specifications in any languages in which it appears, modulo the possibility that some features may be unspecified underlyingly (or even on the surface) in some languages.

Hereafter, I refer to this basic view of height features, in any of its particular manifestations, as the Standard Height Theory. For purposes of discussion, I will assume a version of this theory in which both [high] and [ATR] are binary. In keeping with the practice I have employed so far, I continue to assume that [low] is privative. Nothing crucial hinges on these assumptions however.

Within the Standard Height Theory, the vowel systems presented in (146) above will have the height feature specifications in (150). (The feature specification [+ATR] has been placed in parenthesis in the five-vowel system because it is non-distinctive in this system and in some analyses would be assigned only in the phonetic component. However, some recent theories that utilize the Standard framework (Archangeli & Pulleyblank 1994, Calabrese 1995) assume that [ATR] may nevertheless be specified in a five-vowel system, at least in surface representations.

(150) a. two-height system:

	+high	(+ATR)	i	u
	-high	(+/-ATR)	e	o
low			a	

b. three-height system:

	+high	+ATR	i	u
	-high	+ATR	e	o
		-ATR	ɛ	ɔ
low			a	

c. four-height system:

	+high	+ATR	i	u
		-ATR	ɪ	ʊ
	-high	+ATR	e	o
		-ATR	ɛ	ɔ
low			a	

Notice here that a particular vowel always has the same features in any of the systems in which it occurs, e.g. the vowel [ɛ] is [-high, -ATR] in both the three- and four-height systems.

The analysis of the seven-vowel system in (150b) is not the only conceivable one; an alternative analysis, which has been posited on a number of occasions (cf. Capo 1985, Hyman 1988), is the one in (151):

(151) three-height system (alternative specification):

	+high	i		u
	-high	e		o
low		ɛ	a	ɔ

This analysis, which obviates the need for [ATR], of course violates the fundamental tenet of Standard Height Theory that a given phonetic vowel qualities should receive an invariant characterization across languages (assuming, as appears to be the case, that the vowels [ɛ] and [ɔ] are phonetically identical in the three- and four-height systems.) The problem is that the specification of [ɛ] and [ɔ] in this system as [low] is at odds with their specification (assumed by virtually all analyses) as [-ATR] (and <u>not</u> [low]) in the four-height system. In view of this, it is perhaps not surprising that the analysis in (151) is not employed that frequently in current practice.

Although not very popular in recent years, the analysis in (151) has recently been resurrected by Goad (1993). Goad argues for a theory in which the height feature specifications of vowels are determined by the shape of the vowel inventory, rather than by the phonetic identities of the vowels or their behavior with respect to phonological rules. This general viewpoint, which was also expressed by Goldsmith (1987), is the one which I will adopt below, though the specific mechanisms I propose differ considerably from Goad's.

5.2 A challenge for height feature theories

The Standard approach to height features generally has no difficulty accounting for the occurrence of either e-Coalescence or ɛ-Coalescence within an individual language. Using a conventional rule-based approach, this can be done with rules along the lines of (141) or (143), expressed in whatever formal notation is desired. Within the framework of Optimality Theory, we might hope to account for both types of Coalescence using PARSE(F) interleaving. For e-Coalescence, the crucial ranking required is PARSE(-high) >> PARSE(+high])-$[_w$ (assuming we are dealing with a word-boundary context), while in the case of ε-Coalescence, the crucial ranking is PARSE(-ATR) >> PARSE(+ATR])-$[_w$. In order to account for the full range of hiatus resolution behavior (including the behavior of sequences not subject to Coalescence) in any particular language, other rankings must of course be specified; there is however every reason to expect that an Optimality-Theoretic analysis, in conjunction with the Standard Height Theory, is capable in principle of handling the patterns that emerge within an individual language manifesting either e-Coalescence or ε-Coalescence.

The cross-linguistic behavior of Height Coalescence is another matter. Although the lack of a contrast between languages with ε-Coalescence and languages with e-Coalescence among two-height languages might be held to follow, trivially, from the absence of phonemic non-low [-ATR] vowels in such systems (i.e. we are dealing with structure preservation), there is no obvious reason why a three-height system should not manifest e-Coalescence nor a four-height system ε-Coalescence, given that the features specifications of the corresponding vowels are the same in the two types of system, as indicated in (150). e-Coalescence in a three-height system should occur under exactly the same conditions that it occurs in a four-height system, i.e. whenever the language happens to have the rules in (141) (or, in an Optimality-

Theoretic approach, the constraint ranking PARSE(-high) >> PARSE(+high])-[$_w$). Similarly, ε-Coalescence is expected in a four-height system whenever a language has the rules in (143) (or the constraint ranking PARSE(-ATR) >> PARSE(+ATR])-[$_w$). It is clear, then that under the Standard Height Theory, there is simply no reason to expect non-trivial correlations between the shape of a language's vowel inventory and its phonological behavior under processes like Coalescence.

Moreover, the fact that it is the three-height systems which preserve [-ATR] under Coalescence (i.e. which have ε-Coalescence) is surely no accident. Rather, this fact seems clearly related to a further generalization: according to Goad (1993), it is precisely this type of three-height system in which [-ATR] has been posited as the lexically active value based on facts unrelated to Coalescence, e.g. evidence of spreading across morpheme and/or word boundaries. In contrast, the lexically active value in four-height systems is always [+ATR]; in these systems, [-ATR] is completely inert. If this generalization is correct, then it is hardly surprising that nine-vowel systems fail to preserve [-ATR] under Coalescence, manifesting e-Coalescence instead.

It seems to me that the putative complementary distribution of [+ATR] and [-ATR] (which Goad reanalyzes as [low]) warrants a good deal of further research.[48]

[48] A difficulty which must be recognized here is that many descriptions do not contain clear evidence of which [ATR] value is active, either because the language itself lacks clear evidence of this type, or because the description simply does not provide it.

Nevertheless, the facts that I am familiar with suggest to me that this correlation is correct. As partial documentation, I offer the following pieces of evidence:

1. Having examined descriptive material on over fifty four-height Niger-Congo and Nilo-Saharan languages with [ATR] harmony, I have yet to come across a single such language for which an analysis posits [-ATR] as the lexically marked value of ATR or in which [-ATR] exhibits clear evidence of phonological activity.[49]

2. In addition to the well known case of Akan (Archangeli & Pulleyblank 1994, Clements 1981, 1984, Kiparsky 1985), there are numerous other four-height languages for which [+ATR] has been analyzed as the lexically active value of [ATR] and/or in which [+ATR] exhibits spreading or other clear evidence of phonological activity. These include Baka (Parker 1985), Bila (Lojenga 1994a), Bongo (Kilpatrick 1985), Chumburung (Snider 1985, 1989c), Dilo (Jones 1987), Kɔnni (Cahill 1993), Nawuri (Casali 1995d), Ngiti (Lojenga 1994b), Tépo (Dawson 1975), and Vata (Kaye 1982, Kiparsky 1985), to name just a few.

3. There are quite a few three-height languages in which [-ATR] (or [RTR]) has been posited as the lexically marked value or in which [-ATR] exhibits clear evidence of spreading (i.e. in which underlying [+ATR] vowels assimilate to

[49] I have come across two four-height languages outside of these families in which a feature analyzable as [-ATR] has been described as phonologically active: Javanese (Archangeli & Pulleyblank 1994), and Tibetan (Dawson 1985).

[-ATR] vowels), including Bijagó (Goad 1993),[50] Edo (Wescott 1962), Ewe (Westermann 1930), Komo (Thomas 1992), Wolof (Archangeli & Pulleyblank 1994), Yakata (Motingéa 1993), Yoruba (Archangeli & Pulleyblank 1994), and several Bantu C languages (Leitch, in progress).

4. Cases of three-height languages for which [+ATR] has been posited as the lexically marked value do exist, for example Goad (1993) cites Ka (1988) as having analyzed [+ATR] as the active value in Wolof, while Archangeli & Pulleyblank (1994) treat [+ATR] as the lexically marked value in Ngbaka. My impression is however that such cases are both rarer and often less clearly justified than the three-height languages analyzed as involving [-ATR]. Wolof has in fact elsewhere been analyzed (Archangeli & Pulleyblank 1994) as having [-ATR] rather than [+ATR] underlyingly, while the Ngbaka facts do not, as far as I can see, unequivocally implicate [+ATR] rather than [-ATR] as the underlying value, for example there is no evidence of [+ATR] spreading.[51]

If the suggested correlation between the active value of [ATR] and a language's vowel system holds up, it means that only two of the four possible three- and four-height systems predicted by Standard Height Theory (under the usual

---

[50] Goad cites Wilson (1963) as the original source on Bijagó; this source is not listed in her references however.

[51] As we shall see below, [+ATR] spreading <u>is</u> amply attested in a three-height system of a different type (found for example in Kamba) having the vowels /iɪɛaɔʊu/ rather than /ieɛaɔou/

assumption that either [+ATR] or [-ATR]/[RTR] may be active in either type of system) are actually found, i.e. those in (152):

(152) a. three-height system

	+high		i	u
	-high		e	o
		-ATR	ɛ	ɔ
low			a	

b. four-height system

	+high	+ATR	i	u
			ɪ	ʊ
	-high	+ATR	e	o
			ɛ	ɔ
low			a	

A striking characteristic of these systems is the very limited role played by [-ATR]. It serves only to distinguish the "lower-mid" vowels /ɛaɔ/ from the "higher-mid" vowels /eo/ in the three-height system. Significantly, it is precisely this contrast which could be (and has been) distinguished instead by means of the feature [low]. What would provide clear evidence for the existence of [-ATR] would be a system in which it played an active role in distinguishing [+high] vowels, a function which [low] could obviously not perform. In this role, however, [-ATR] is strikingly absent: [ATR] contrasts among high vowels are apparently always distinguished by means of [+ATR]. These facts make [-ATR] a strong candidate for elimination, as proposed by Goad (1993). If we were to eliminate [-ATR] from the inventory of vowel features supplied by UG, then the three-height system in (152a) would be specified instead as in (151) (repeated as (153)), with [low] replacing [-ATR]:

(153)

	+high	i		u
	-high	e		o
low		ɛ	a	ɔ

An alternative to eliminating [-ATR] is to retain it and search for some other explanation for why this feature is active only in the three-height system. Note that a similar explanatory debt is incurred in any case by the alternative proposal as well; given that both tongue root advancement and tongue root retraction are possible gestures (and in all likelihood are both actively employed in languages with [ATR] harmony), it will not do to simply stipulate that [-ATR] does not exist as a phonological feature. Ultimately, we would like some explanation for why it does not exist. We are thus faced with two alternatives: either we propose that [-ATR] does not exist and attempt to explain its non-existence, or we continue to assume that it does exist and attempt to explain why it is never contrastive among high vowels, its use being (apparently) limited to distinguishing contrasts among the higher-mid and lower-mid vowels in three-height systems.

Deciding between these alternatives in principal an empirical matter, since the two proposals make different predictions about possible phonological behavior in three-height systems. The crucial difference is that the 'low" vowel /a/ is uniquely specified as [low] under the proposed system in (152a), but not under the one in

(153) (in which it shares this specification with /ɛ/ and /ɔ/). Given this difference, a rule which derives [a] from /ɛ/ and/or /ɔ/ via lowering is predicted to be possible under the specifications in (152a) but not under those in (153), in which /ɛaɔ/ form a single height. Similarly, a symmetric Coalescence or Feature-Sensitive Elision process in which /a+ɔ/, /ɔ+a/, /a+ɛ/, and /ɛ+a/ are all realized as [a] is predicted to be possible in a three-height system specified as in (152a) (in a case where PARSE(low) is ranked above both PARSE(front) and PARSE(round) as well as the constraints ruling out front or round low vowels) but not under the specifications in (153), in which the height specifications of /ɛ/ and /ɔ/ are already identical to those of /a/.

In fact, height-sensitive processes which distinguish the height of /a/ from that of /ɛ/ and /ɔ/ do appear to exist in three-height systems. One case involves Esimbi (Hyman 1988), a three-height language that has a process in which certain prefixes are systematically realized at a height one level lower than that of the stem vowel. When the stem vowel is /i/ or /u/, for example, the prefix surfaces as [o], while if the stem vowel is /o/ or /ə/ the prefix is [ɔ] and if the stem vowel is /e/, the prefix is [ɛ]. Crucially, the prefix vowel surfaces as [a] when the stem vowel is /ɛ/ or /ɔ/, implying that the height of /a/ is lower than that of /ɛ/ and /ɔ/. (The prefix also surfaces as [a] when the stem vowel is /a/; presumably this is due to the absence of an even lower height to which /a/ could assimilate.)

A second possible case of this type is found in Dangme (Dakubu 1987). Dangme displays a number of realizations characteristic of the ɛ-Coalescence pattern described above, e.g. /a+o/ > [ɔ:], /ɛ+o/ > [ɔ:], /ɛ+e/ > [ɛ:]. In addition, however, the pair of vowels /ɛ/, /a/ and /ɔ/, /a/ are both realized, in either order, as [a], i.e. we have the realizations /ɛ+a/ > [a:], /a+ɛ/ > [a:], /ɔ+a/ > [a:], and /a+ɔ/ > [ɔ:].[52] From the perspective of the present framework, this symmetric dominance of /a/ over /ɛ/ and /ɔ/ can be analyzed as a preferential preservation of the lowness of /a/ over those of /ɛ/ and /ɔ/. This analysis is only possible however if we assume that /a/ is specified for some (lower) height feature that /ɛ/ and /ɔ/ lack. The most obvious candidate of course is the feature [low], a specification which distinguishes /a/ from /ɛ/ and /ɔ/ under the proposal in (152a) but not the one in (153).

[52] Some caution is perhaps necessary in assuming that this apparent featural dominance of /a/ over /ɛ/ and /ɔ/ represents the whole story, in view of the facts that (1) the number of relevant examples in Dakubu (1987) is relatively small and (2) it is not entirely clear to what extent the outcome might depend on the identity of the particular morphemes involved. It seems to me however that the most natural interpretation of the data presented by Dakubu (and the one that she herself appears to suggest) is that the symmetric realizations of these sequences as [a] is a fairly general, phonologically determined result.

On the basis of this evidence, I tentatively assume that /a/ is distinguished from /ɛ/ and /ɔ by a height feature in three-height systems and that the feature specifications for the three-height system are as in (152a). Along with the four-height system in (152b), this is repeated for convenience below.

(154) a. three-height system

	+high		i	u
	-high		e	o
		-ATR	ɛ	ɔ
low			a	

b. four-height system

	+high	+ATR	i	u
			ɪ	ʊ
	-high	+ATR	e	o
			ɛ	ɔ
low			a	

If our reasoning so far is correct, it is clear that this dependence of height feature specifications on the number of heights in a system poses a considerable challenge to an adequate theory of height features, since the reasons for this dependence, which is completely unexpected under almost all existing theories (a notable exception being Goad 1993), are far from obvious. I address this challenge in chapter 7. Here however I wish to stress that the claim that the specifications of the three- and four-height systems are universally as in (154) represents a pretheoretical, empirically determined result that any height feature theory must confront. This statement is of course only coherent if the features in (154) are construed not as theoretical constructs but as descriptive labels. In other words, the empirical content of my claim that the height levels /ɛɔ/ and /eo/ are universally distinguished in three-height systems by means of a feature specification [-ATR] is not that the actual feature distinguishing these heights must be the feature [-ATR] posited within many theories. Rather, the claim is that whatever feature(s) is used to distinguish /ɛɔ/ from /eo/ in a three-height system, it must (in conjunction with other theoretical proposal) yield the empirical result that it is the latter class of sounds which always assimilates (and coalesces) to the former in languages with this system, i.e. the system behaves as though, from the viewpoint of Standard terminology "[-ATR]" rather than "[+ATR]" is phonologically present. The choice of features used and how they are defined, and whether they are privative, binary, or even n-ary, are theoretical questions which admit various possible answers, provided only that the resulting theory yield the desired predictions.[53]

The discussion so far has ignored the existence of an alternative three-height system, found in languages like Kikuyu and Kikamba, in which the vowels /ɪ/ and /ʊ/

[53] Here I also stress that theories in which both values of [ATR] (or its equivalent) are underlyingly specified are not being ruled out in advance. Such theories of course merit the same consideration as any other theory, provided they can suggest some alternative explanation for why [+ATR] (though present, under such views) fails to exhibit phonological activity in three-height systems.

appear in place of the vowels /e/ and /o/ that are found in the more familiar three-height system in (154a). This alternative system is given in (155):

(155)	i		u
	ɪ		ʊ
	ɛ		ɔ
		a	

For our purposes, the important questions to ask about this system are whether its phonologically active feature values are universally predictable, as they appear to be for the systems in (154), and, if so, which values are in fact active. In light of our earlier claim that [-ATR] is systematically inactive as a feature distinguishing /iu/ from /ɪʊ/ in the systems in (154), we might expect that the active value in this system should also be [+ATR] rather than [-ATR]. There is some reason to believe that this is in fact the case. It seems to be fairly common for languages with this type of system to have an allophonic [+ATR] spreading processes in which the underlying [-ATR] vowels /ɛ/ and /ɔ/ are realized as the (non-phonemic) [+ATR] vowels [e] and [o] in the context of a neighboring /i/ or /u/. This type of process occurs for example in Burun (Andersen 1993), Kinande (Hyman 1989), Lese-Mvuba (Constance Kutsch Lojenga p.c.), and Mayogo (Constance Kutsch Lojenga p.c). (In Kinande, the high vowels /ɪ/ and /ʊ/ are also affected [+ATR] spreading in some cases, surfacing as [i] and [u].) I have not, on the other hand, come across any cases of [-ATR] spreading (e.g. a process in which /i/ and /u/ become [ɪ] and [ʊ] in the context of [-ATR] vowels) in languages with this type of system. Also, we shall see in the next chapter that the Height Coalescence displayed by languages with this system shows no clear evidence of preserving [-ATR]) e.g. a sequence /ɪ+i/ is realized as [i] rather than [ɪ]. I tentatively propose, then, that this alternative three-height system is universally specified as in (156).

(156) three-height system (Kikuyu type)

	+high	+ATR	i	u
			ɪ	ʊ
	-high		ɛ	ɔ
low			a	

The attested systems (including a two-height system which has played relatively little role in the discussion) are presented together for comparison in (157).

(157) a. two-height system:

	+high	i	u
	-high	e	o
low		a	

b. three-height system (Yoruba type)

	+high		i	u
	-high		e	o
		-ATR	ɛ	ɔ
low			a	

c. three-height system (Kikuyu type)

	+high	+ATR	i	u
			ɪ	ʊ
	-high		ɛ	ɔ
low			a	

d. four-height system

	+high	+ATR	i	u
			ɪ	ʊ
	-high	+ATR	e	o
			ɛ	ɔ
low			a	

In the final chapter of this dissertation, I consider possible explanations, within an auditorily based theory of height features, for why these systems have the specifications they do. In addition to accounting for the predictable specifications of these systems, however, we also desire a detailed account of the Height Coalescence patterns (which, as we shall see, are surprisingly intricate when considered in full detail) displayed by these systems. This is taken up in the next chapter, chapter 6.

Chapter 6: An Analysis of Height Coalescence

6.1 Basic constraint ranking

The goal of this chapter is to show how, given the specifications proposed in (157) or their equivalents, the detailed behavior of these systems under Height Coalescence can be shown to follow from a few simple and plausible assumptions about the mechanisms (constraint rankings) which gives rise to this process. As discussed in chapter 3 above, the basic mechanism posited to account for Coalescence is PARSE(F) interleaving. I suggest that there is a fixed universal ranking among the PARSE(F) constraints referring to height features, as given in (158).

(158) PARSE(low) >> PARSE(-ATR) >> PARSE(-high) >> PARSE(+high)

Although I have insufficient evidence to fix the position of [+ATR] within this hierarchy, for reasons of symmetry we might suppose that PARSE(+ATR) is ranked below PARSE(+high).[54] For concreteness, I tentatively adopt this assumption in the discussion which follows.

Motivation for this ranking comes from the following sources. First, it is consistent with the rankings required for both Symmetric Coalescence in Afar (which

[54] Note that, with the exception of [low], [+ATR] is not generally in competition with the other height features in the systems we are dealing with. [+ATR] is fully compatible with both values of [high]. (Although it could, in principle, be forced into competition with [+high] and [-high] in a language with Feature-Sensitive Elision and an [ATR] contrast, I have seen no examples of such a language.) It is not in competition with [-ATR], moreover, since, as discussed in the preceding chapter, there are no systems in which both values of [ATR] are simultaneously present.

requires the ranking of PARSE(-high) above PARSE(+high)) and Feature-Sensitive Elision in Modern Greek (which requires the ranking not only of PARSE(-high) above PARSE(+high) but also of PARSE(low) above PARSE(-high])).[55] Second, it can be partly justified on the basis of typical assumptions about sonority and phonetic markedness. The preference for auditorily low vowels and the dispreference for auditorily high vowels can be related to a universal preference for more sonorous vowels, given the common assumption that lower vowels are more sonorous than higher vowels. Third, we will see that this ranking gives the desired results in the Height Coalescence cases we are about to examine.

Note that the claim that this fixed ranking is motivated by a preference for auditorily low vowels is only coherent if we regard the feature [ATR] as an auditorily-based height feature and not, as is often assumed, an articulatory feature. In chapter 7, I consider in more detail an approach which explicitly characterizes all features relevant to vowel height levels, including [ATR], in auditory rather than articulatory terms. In the meantime, I continue to use the label [ATR], with the understanding that I regard this as an auditory-acoustic rather than an articulatorily feature.

---

[55] This ranking is not however consistent with the ranking PARSE(+high)-$[_m$ >> PARSE(+low)-$[_m$ posited in my analysis of Daga. While this seems to suggest that the ranking in (158) cannot be universally fixed (in which case we might adopt the weaker assumption that it simply represents a default or more usual ranking), we might hope instead that some other account can be found for Daga, especially in view of the uncertainty surrounding a number of relevant facts in that language. I will not attempt to definitively resolve this contradiction here. Instead, I simply note that until clearer counterexamples arise, the hypothesis that the ranking in (158) is a fixed universal ranking is at least worthy of serious exploration.

I propose that in the unmarked case in which there is no PARSE(F) interleaving, all PARSE(F)-P constraints referring to any position P are ordered in a contiguous block above all PARSE(F) constraints (which are also ordered in a contiguous block). This assumption, together with the ranking in (158) leads to the situation schematized in (159). (Here I use a double downward arrow to indicate rankings which are universally determined. A single downward arrow represents a default ranking which is reversible in some languages. I ignore for now the non-height features.)

(159)

PARSE(low)-P — position-sensitive PARSE(F) constraints
⇓
PARSE(-ATR)-P
⇓
PARSE(-high)-P
⇓
PARSE(+high)-P
⇓
PARSE(+ATR)-P
↓
PARSE(low) — general PARSE(F) constraints
⇓
PARSE(-ATR)
⇓
PARSE(-high)
⇓
PARSE(+high)
⇓
PARSE(+ATR)

Nothing is said here about the ranking of PARSE(F) constraints referring to non-height features. We have already seen two languages, Afar and Modern Greek, which preserve [round] in preference to [front], and we might entertain the possibility that this is indicative of a fixed ranking PARSE(round) >> PARSE(front). Tentatively, I assume that this is in fact the case, though nothing crucial hinges on this.

While one might consider the possibility that there are some fixed universal rankings relating height-sensitive and non-height-sensitive PARSE(F) constraints, I will not pursue this possibility here but will assume for our purposes that height and non-height PARSE(F) constraints comprise independent hierarchies whose interaction is determined on a language-specific basis. Adding the non-height PARSE (F) constraints to the picture yields the default hierarchies in (160). Note that although the height and non-height PARSE(F) default hierarchies are essentially independent, there are rankings of PARSE(front)-P above PARSE(low) and PARSE(+ATR)-P above PARSE(round) which are imposed by the default requirement (which may be overridden in the fact of positive language-specific evidence) that all position-sensitive PARSE(F)-P constraints are ranked above all general PARSE(F) constraints).

(160)

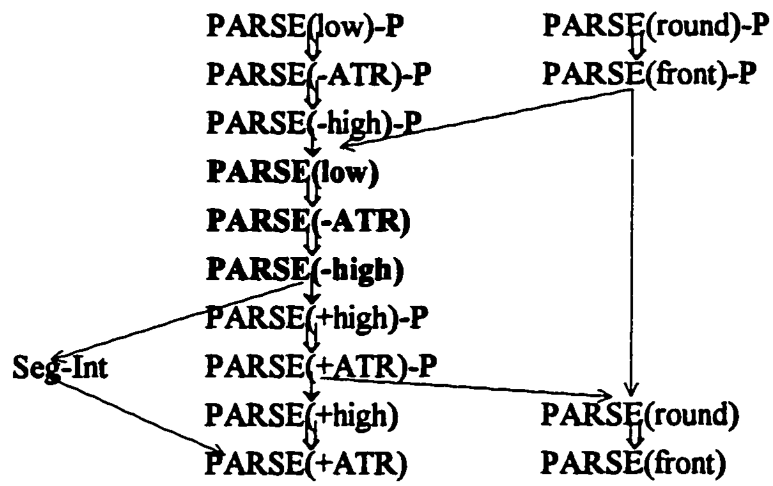
	height hierarchy:	non-height hierarchy:
	PARSE(low)-P	PARSE(round)-P
	PARSE(-ATR)-P	PARSE(front)-P
	PARSE(-high)-P	
	PARSE(+high)-P	
	PARSE(+ATR)-P	
	PARSE(low)	PARSE(round)
	PARSE(-ATR)	PARSE(front)
	PARSE(-high)	
	PARSE(+high)	
	PARSE(+ATR)	

PARSE(F) interleaving, the mechanism that drives Coalescence, involves the elevation of one or more ordinary PARSE(F) constraints to a position above one or more of the position-sensitive PARSE(F)-P constraints. In the case of Asymmetric Height Coalescence, I propose that the required interleaving involves the elevation of PARSE(-high) to a position above PARSE(+high)-P. Note however that this also requires elevation of PARSE(-ATR) and PARSE(low), given our assumption that these constraints are universally ranked above PARSE(-high). This leads to the overall ranking in (161), where the promoted constraints are in bold type. (The ranking PARSE(+ATR)-P >> PARSE(round), not actually crucial to the treatment of Height Coalescence, has been retained, in the absence of contrary evidence, as representative of the default situation.)

(161)	PARSE(low)-P	PARSE(round)-P
	PARSE(-ATR)-P	PARSE(front)-P
	PARSE(-high)-P	
	PARSE(low)	
	PARSE(-ATR)	
	PARSE(-high)	
	PARSE(+high)-P	
	PARSE(+ATR)-P	
	PARSE(+high)	PARSE(round)
	PARSE(+ATR)	PARSE(front)

In order to fully account for the attested Height Coalescence patterns, this ranking must be supplemented by other rankings. First, as we have observed previously, it is also necessary to assume that the constraints which rule out other hiatus resolution strategies, in particular ONSET, *DIP, and *INS(F), are not crucially dominated. (Since Glide Formation does co-occur with Coalescence in some languages, the ranking of *CG with respect to the PARSE constraints relevant to Coalescence will vary depending on which Height-Coalescing language we are dealing with. For simplicity in presenting tableaux, I will consistently assume a language without Glide Formation, i.e. a language in which *CG is ranked above the PARSE constraints. Extension of the results illustrated in the tableaux to languages which also display Glide Formation is generally straightforward, although there are certain facts whose full treatment requires additional machinery discussed in Casali (1995a)). Second, it proves necessary to assume a crucial ranking of the constraint Seg-Int with respect to the constraints in (161) in Height Coalescing languages with four-height systems or three-height Kikuyu type systems. Specifically, Seg-Int must be ranked below PARSE(-high) but above PARSE(+ATR). (Its ranking with respect to the constraints intervening between PARSE(-high) and PARSE(+ATR) is not crucial.) This gives rise to the overall ranking in (162):

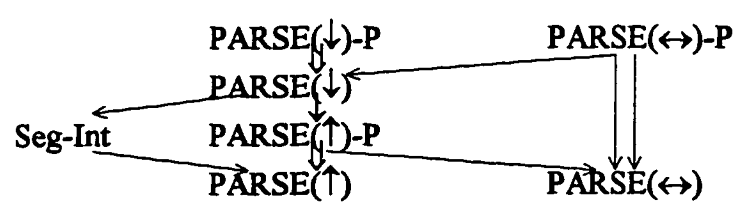
(162)



Although positive evidence for this ranking is found only in the four-height and three-height Kikuyu type systems, this ranking can also be assumed in the three-height Yoruba type languages, in which it gives rise to no undesired effects. This will be seen below. Also, it is not necessary to stipulate that the ranking of Seg-Int in this position is universally fixed. Although other positionings of Seg-Int do not yield Height Coalescence of the usual type, they nevertheless give patterns which seem plausible and/or are at least partially attested.

Since the three promoted constraints PARSE(low), PARSE(-ATR), and PARSE(-high) are ranked adjacently, and since these constraints are not, in the cases we shall be dealing with, in competition with each other, we may treat them for simplicity as a single constraint that incurs one violation for each instance of [low], [-ATR], or [-high] that is lost. I designate this constraint as PARSE(↓); this is of course symbolic of the fact that all three features involve some type of preference for relatively low auditory height. In similar fashion, I also represent the constraints PARSE(+high) and PARSE(+ATR), which involve a preference for relatively high auditory height (and are also ranked adjacently) as PARSE(↑). Finally, although the constraints PARSE(round) and PARSE(front) can in principle be in competition with each other in the languages we will be dealing with, it happens that in hiatus contexts a competition between a [front] specification on V_1 and a [round] specification on V_2 (or vice versa) will always be decided positionally (in favor of V_2's frontness or roundness) rather than by feature content, as dictated by the subordination of both PARSE(front) and PARSE(round) to (both of) the position-sensitive constraints PARSE(front)-P and PARSE(round)-P. At the risk, then, of pushing the arrow shorthand to an extreme, I also combine PARSE(front) and PARSE(round) into a single constraint PARSE(↔), which is violated by every loss of either [front] or [round]. Employing these abbreviatory conventions, the hierarchy in (162) may now be represented more compactly as in (163):

(163)



For now, we may take these abbreviations as purely expository simplifications. Later, I consider the possibility that these conflated constraints should be given theoretical status.

We are now ready to consider the Coalescence patterns which this ranking predicts for the different vowel systems. We shall see that, given this ranking, the different patterns that arise in these systems follow from the different height feature specifications which are assumed to be present in these systems.

6.2 Height Coalescence in two-height systems

Consider first the case of the two-height system, which has the specification in (157a), repeated as (164).

(164)

	+high	i	u
	-high	e	o
low		a	

Although the mid vowels have here been symbolized as /e/ and /o/, it should be kept in mind that the actual phonetic realization of these vowels is expected to vary both within and across two-height languages, as discussed previously. Thus, in many, perhaps most, two-height languages, the usual realization is expected to be closer to [ɛ] and [ɔ].

Given these specifications, the ranking in (163) will entail that the inputs /a+i/ and /a+u/ will be realized as [e] and [o] respectively, as demonstrated in (165) below for the former. (Here I assume, for concreteness, a prefix plus root context. To save space in listing the constraints in the tableaux, I abbreviate PARSE as just P. In presenting each candidate, I list preserved and deleted (in angled brackets) features beneath each input vowel. The original features of both vowels are also listed with the underlying form.)

(165)

/a + i/ frt -hi +hi lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
[i] frt <-hi> +hi <lo>			**				
[a] <frt> -hi <+hi> lo		*			*	*	*
⇒ [e] frt -hi <+hi> <lo>			*	*	*	*	

An additional candidate [æ], not shown in (165), would involve the preservation of the underlying [low] specification of /a/ in addition to its [-high] specification, together with the frontness of /i/. We may assume that such a candidate is ruled out by an undominated constraint that disallows the combination [front, low]; some such constraint is warranted in any case to account for the absence of [æ] throughout the language.

In contrast to /a+i/ and /a+u/, the reverse sequences /i+a/ and /u+a/ will not undergo Coalescence, but will instead be subject to V_1 Elision. This is illustrated in (166) for the case of /i+a/. (Here and in subsequent tableaux I assume for concreteness a language in which sequences that do not undergo Coalescence are resolved by Vowel Elision rather than Glide Formation, i.e. a language in which *CG is ranked above the PARSE(F) constraints. Note also that I assume once again that an additional candidate preserving the features [front], [-high], and [low] is ruled out by an undominated constraint that accounts for the absence throughout the language of vowels which are both [front] and [low]).

(166)

		P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	/i + a/ frt +hi -hi lo							
	[i] frt +hi <-hi> <lo>	**		**				
⇒	[a] <frt> <+hi> -hi lo						*	*
	[e] frt <+hi> -hi <lo>	*		*	*		*	

The constraint ranking PARSE(↓) >> PARSE(↑)-lex predicts that the inputs /e+i/, /e+u/, /o+i/, and /o+u/ should also be subject to Coalescence, being realized respectively as [e], [o], [(w)e], and [(w)o].[56] I illustrate this below for the case of /o+i/.

[56] For independent reasons discussed in Casali (1995a), Glide Formation is impossible on a universal or near-universal basis with the sequences /e+i/ and /o+u/.

(167)	/o + i/ rnd -hi +hi	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[i] <rnd> frt <-hi> +hi			*				*
	[o] rnd <frt> -hi <+hi>		*			*	*	*
⇒	[e] <rnd> frt -hi <+hi>				*	*	*	*

Some or all of these further realizations are in fact attested in many two-height languages with Height Coalescence. SiSwati, for example, has the realizations /e+i/ > [e] and /o+i/ > [we], as seen in the data below, adapted from Cahill (1994):

(168) a. ẹ-t'inwẹ:lẹ-ini → et'inwe:le:ni
'in the hair'

b. ẹ-siɬalo-ini → esiɬalwe:ni
'in the seat'

Quite a number of two-height systems do not have these additional realizations, however, but display only the Coalescence patterns /a+i/ > e and/or /a+u/ > o. In most, if not all, of these languages, the absence of the Coalescence patterns involving the mid V_1's /e/ and /o/ may well be accidental, since the sources give no evidence that the sequences /e+i/, /e+u/, /o+i/, and /o+u/ ever arise to begin with.[57] (And indeed, the absence of the further realizations /a+u/ > [o], /e+u/ > o and /o+u/ > [o] in SiSwati is due to the fact that /u/ never occurs as V_2 to begin with, as Cahill makes clear.)

[57] Quite a number of the languages in (149a) are Bantu languages in which most or all of the Coalescence examples cited involve the boundary between a noun root and a preceding noun class prefix. Since it is often the case in these languages that the mid vowels /e/ and /o/ not to occur in noun class prefixes, the absence of examples involving mid V_1's is not surprising.

6.3 Height Coalescence in three-height Yoruba type systems

Consider next the three-height Yoruba type system in (157b) (repeated as (169)).

(169)

	+high		i	u
	-high		e	o
		-ATR	ɛ	ɔ
low			a	

We will begin once again with the input sequence /a+i/. The vowel /a/ is specified as [-high, -ATR, low], while /i/ is [front, +high]. [-high] and [+high] are of course mutually incompatible; the ranking PARSE(↓) >> PARSE(↑)-lex (assuming once again that we are dealing with a prefix plus root context) requires that it is [-high], rather than [+high] which is preserved. Crucially, preservation of [-ATR] (which is present in this vowel system though not the two-height system considered above) is also mandated, as a consequence of the fact that PARSE(-ATR) (collapsed into PARSE(↓)) is ranked above both Seg-Int (which militates against Coalescence) and PARSE(+high) (collapsed into PARSE(↑)). As in the case of the two-height system, preservation of [low] is however impossible with this input, given (1) the incompatibility of [front] and [low] (expressed as an undominated constraint not shown in the tableaux) and (2) the ranking of PARSE(↔)-lex above PARSE(↓). The winning candidate is therefore one which preserves the [-high] and [-ATR] values of /a/ along with the frontness of /i/, viz., [ε]:

(170)

/a + i/ frt -hi +hi -atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
[i] frt <-hi> +hi <-atr> <lo>			***				
[a] <frt> -hi <+hi> -atr lo		*			*	*	*
[e] frt -hi <+hi> <-atr> <lo>			**	*	*	*	
⇒ [ε] frt -hi <+hi> -atr <lo>			*	*	*	*	

As in the case of the two-height system, the reverse sequence /i+a/ is realized (assuming a language in which Glide Formation is ruled out by the ranking of *CG above PARSE(F)) as [a], with straightforward Elision of V_1 rather than Coalescence. This is illustrated in (171):

(171)

	/i + a/ frt +hi -hi -atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[i] frt +hi <-hi> <-atr> <lo>	***		***				
⇒	[a] <frt> <+hi> -hi -atr lo						*	*
	[e] frt <+hi> -hi <-atr> <lo>	**		**	*		*	
	[ɛ] frt <+hi> -hi -atr <lo>	*		*	*		*	

I now turn to the sequence /a+e/. Here again, this sequence involves preservation of [-ATR]:

(172)

	/a + e/ frt -hi -hi -atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[e] frt <-hi> -hi <-atr> <lo>			***				
	[a] <frt> -hi <-hi> -atr lo	*	*	*				*
⇒	[ɛ] frt <-hi> -hi -atr <lo>			**	*			

For analogous reasons, we predict (correctly) that /a+o/ will be realized as [ɔ].

The Yoruba type system is also predicted to display Coalescence (in this case involving preservation of [-high] only) when V_1 is /e/ or /o/ and V_2 is /i/ or /u/. This is illustrated below for the case of /e+u/:

(173)

	/e + u/ frt rnd -hi +hi	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[u] <frt> rnd <-hi> +hi			*				*
	[e] frt <rnd> -hi <+hi>		*			*	*	*
⇒	[o] <frt> rnd -hi <+hi>				*	*	*	*

Here the ranking of PARSE(↓) above both PARSE(↑)-lex and Seg-Int forces preservation of the [-high] specification of V_1, together with the roundness of V_2, which is preserved due to the high ranking of P(↔)-lex.

The full set of realizations predicted for this system is given in (174).[58]

[58] Glide Formation has not been shown as a possibility in (174) with sequences in which V_1 and V_2 agree in frontness/roundness and in which V_2 is as high or higher than V_1 (i.e. /i+i/, /e+i/, /ɛ+i/, /e+e/, /ɛ+e/, /e+ɛ/, /ɛ+ɛ/, /u+u/, /o+u/, /ɔ+u/, /o+o/, /ɔ+o/, /o+ɔ/, /ɔ+ɔ/), since these sequences are (except in the special case where V_1 occurs in absolute word-initial position, i.e. in a /##V_1+V_2.../ sequence) immune to Glide Formation on a near-universal basis. It should also be noted that although Glide Formation has been shown as a possibility with the sequences /i+e/, /i+ɛ/, /u+o/, and /u+ɔ/, Glide Formation usually fails to apply to these sequences in languages with Coalescence. (Many languages without Coalescence do however manifest Glide Formation with these sequences.) An explanation for these facts is proposed in Casali (1995a).

(174)	i+i > i	e+i > e	ɛ+i > ɛ	a+i > ɛ	ɔ+i > (w)ɛ	o+i > (w)e	u+i > (w)i
	i+e > (y)e	e+e > e	ɛ+e > ɛ	a+e > ɛ	ɔ+e >(w)ɛ	o+e > (w)e	u+e > (w)e
	i+ɛ > (y)ɛ	e+ɛ > ɛ	ɛ+ɛ > ɛ	a+ɛ > ɛ	ɔ+ɛ > (w)ɛ	o+ɛ > (w)ɛ	u+ɛ > (w)ɛ
	i+a > (y)a	e+a > (y)a	ɛ+a > (y)a	a+a > a	ɔ+a > (w)a	o+a > (w)a	u+a > (w)a
	i+ɔ > (y)ɔ	e+ɔ > (y)ɔ	ɛ+ɔ > (y)ɔ	a+ɔ > ɔ	ɔ+ɔ > ɔ	o+ɔ > ɔ	u+ɔ > (w)ɔ
	i+o > (y)o	e+o > (y)o	ɛ+o > (y)ɔ	a+o > ɔ	ɔ+o > ɔ	o+o > o	u+o > (w)o
	i+u > (y)u	e+u > (y)o	ɛ+u > (y)ɔ	a+u > ɔ	ɔ+u > ɔ	o+u > o	u+u > u

One of the Yoruba type languages listed in (149b), Owon Afa, manifests exactly the full set of realizations in (174), all of which are exemplified at least once in the data in Awobuluyi (1972). In the case of a second language, Anufɔ, the data and description in Adjekum, Holman & Holman (1993) suggest that this language also conforms fully to the pattern (174). Although Anufɔ lacks most of the realizations in which V_2 is non-high, since these sequences do not arise in the relevant environment to begin with,[59] the realizations which do occur are sufficient to establish that both [-ATR] and [-high] are systematically preserved, and there are no realizations which depart from the pattern in (174). Data illustrating Coalescence in these languages is given in (175) (from Adjekum, Holman & Holman (1993)) and (176) (from Awobuluyi (1972)). (Tone and certain irrelevant phonetic details are ignored. Notice that Anufɔ manifests Glide Formation along with Coalescence, e.g. /o+i/ is realized as [we:] rather than just [e:]. The two languages also differ in that while Anufɔ

[59] While Adjekum, Holman & Holman (1993:40) do give examples involving sequences like /oe/ and /ɔɛ/, in which V_2 is non-high, these are all morpheme-internal and do not involve any alternations; it is therefore not possible to prove that the surface forms (in these cases [we:] and [wɛ:]) which they derive through Coalescence and Glide Formation are not simply present underlyingly.

consistently manifests compensatory lengthening, Owon Afa displays such lengthening only under certain circumstances.)

(175)	Anufɔ			
	a. yɛ-i	→	yɛ:	'raise it'
	b. jɔ-u	→	jɔ:	'cool you'
	c. bu-i	→	bwi:	'break it'
	d. fa-i	→	fɛ:	'take it'
	e. bo-i	→	bwe:	'beat it'
	f. sɔ-i	→	swɛ:	'carry it'
	g. fa-u	→	fɔ:	'take you'
	h. bo-u	→	bo:	'beat you'
	i. jɔ-u	→	jɔ:	'marry you'
	j. n-de-u	→	ndo:	'I will take it fro you'
(176)	Owon Afa			
	a. ri ɛmɛ	→	rɛmɛ	'see leaves'
	b. ri aka	→	ra:ka	'see monkey'
	c. ewo ɔba	→	ewɔ:ba	'king's money'
	d. bu iwɛ	→	bi:wɛ	'hit Iwe'
	e. ke ibɔ	→	kebɔ	'make gun'
	f. ewo iwɛ	→	ewe:wɛ	'Iwe's money'
	g. da iwe	→	dɛwe	'buy book'
	h. da opu	→	dɔ:pu	'buy dog'
	i. dɔ iwe	→	dɛwe	'burn books'
	j. tɛ esi	→	tɛ:si	'press on the ground'
	k. da ehwe	→	dɛhwe	'buy book'
	l. da uju	→	dɔju	'buy pounded yam'

In each of the remaining Yoruba type ε-Coalescencing languages (Edo, Dangme, Efik, and Ewe) in (149b), examples of Coalescence are limited to a very few sequences. In many cases the non-occurrence of a particular manifestation may be due to the fact that the relevant sequence never arises to begin with. Even so, while each of these languages displays at least some of the realizations diagnostic of ε-Coalescence (e.g. /a+e/ > [ε]), each language also departs from the pattern in (174) in at least one respect. Since it is difficult to tell, based on the available data, to what extent these departures reflect systematic shortcomings in the predictions of the model rather than idiosyncratic properties of the individual languages, there is little to be gained from discussing these cases in detail here, nor are the facts even sufficiently clear in all these cases to permit serious speculation.

6.4 Excursus on the status of PARSE(↓)

Before moving on to consider the next vowel system, it will be expedient at this point to fulfill an earlier promise to discuss the possibility of treating the conflation of PARSE(-high), PARSE(-ATR), and PARSE(low) into a single constraint PARSE(↓) as a serious theoretical proposal rather than simply an expository convenience. This is an attractive possibility, both because it directly captures the very intuitive idea that Height Coalescence systematically seeks to preserve all features leading to auditory lowness, and because it leads to a significant simplification in the constraint system (particularly if analogous conflations are adopted elsewhere, for example if the conflation of PARSE(+high) and PARSE(+ATR) into a single constraint PARSE(↑) is also elevated to theoretical status). The result is a more restrictive theory which makes some interesting predictions not made by the present constraint system.

One such prediction is that languages with ε-Coalescence will always preserve [-high] in addition to [-ATR] in three-height Yoruba type systems, since (1) the constraint PARSE(↓) refers to both of these feature values alike and (2) there are no co-occurrence restrictions in this vowel system which would treat these features differently, i.e. both features are fully compatible with [front] and [round], while neither is compatible with [+high]. Consequently, this approach predicts that Yoruba type systems with Height Coalescence should always display the realizations /e+i/ > [e], /o+i/ > [(w)e], /e+u/ > [(y)o], and /o+u/ > [o] in addition to more prototypical realizations like /a+i/ > [ε] and /a+e/ > [ε]. (Note that realizations like /a+i/ > [ε] do not actually demonstrate a preference for preserving [-high] in these languages, since this realization can be viewed as following from a high-ranked constraint PARSE(-ATR) in combination with a structure-preserving effect related to the fact that all [-ATR] vowels in this system are also [-high].)

In light of the actual evidence available to me, this is a tantalizing prediction. While only two of the ε-Coalescing languages in my survey, Anufɔ and Owon Afa, actually display these [-high]-preserving realizations, it is precisely these languages which have, of all the languages with Yoruba type systems, by far the most complete data available. It should also be emphasized that while these languages are both Kwa languages, they are not that closely related within the Kwa family. Moreover, it is possible that in most if not all of the remaining languages with ε-Coalescence, the absence of [-high]-preserving realizations can be attributed to the fact that the relevant sequences do not arise to begin with. In any case, there are no clear examples from any of my sources on these languages which show that these sequences are realized in some other fashion.

If the three constraints PARSE(-high), PARSE(-ATR), and PARSE(low) were in reality one single constraint PARSE(↓), a further prediction is that no constraint should be rankable between them. We have already seen an apparent counterexample to this prediction: Modern Greek apparently requires the ranking PARSE(low) >> PARSE(round) >> PARSE(-high), as argued in section 3.2 above. If this is correct, then PARSE(low) and PARSE(-high) must clearly be separate constraints. While it is of course conceivable that some alternative account of the Greek facts might be found which would not force us to treat PARSE(low) and PARSE(-high) as separate constraints, I can see no obvious workable solution. Since the question of whether these three constraints can be replaced by a single constraint PARSE(↓), is not, in any case, crucially related to the primary goals of this chapter, I adopt the weaker assumption that PARSE(-high), PARSE(-ATR), and PARSE(low) are in fact separate constraints, though I will continue to represent them for expository simplicity as a single constraint PARSE(↓).

Although I have opted not to replace these three constraints with a single constraint, I continue to assume that these constraints conform to a strict universal ranking PARSE(low) >> PARSE(-ATR) >> PARSE(-high). It is not completely clear however how crucial the ranking PARSE(-ATR) >> PARSE(-high) is to my account. On the one hand, even if the opposite ranking PARSE(-high) >> PARSE(-ATR) were permitted, it would still not be possible to generate e-Coalescence in a three-height Yoruba type system (a state of affairs which would violate our generalization that such systems always manifest ɛ-Coalescence rather than e-Coalescence). This is because in order for Coalescence to preserve [-high] in an input sequence like /a+i/, it is necessary to violate the constraint Seg-Int, which militates against Coalescence of any type. Once violation of Seg-Int (which I take to be a non-gradient constraint) is forced in any case, however, there is nothing left to prevent 'free" preservation of the underlying [-ATR] specification of /a/, since this specification is fully compatible with the preserved frontness of V_2. This is shown in the tableau in (177), in which I split PARSE(↓) into its three component constraints

PARSE(low), PARSE(-ATR), and PARSE(-high), with PARSE(-high) ranked above PARSE(-ATR). Note that the same outcome results if Seg-Int is ranked below PARSE(-ATR) instead of above it. (If Seg-Int is ranked above PARSE(-high), on the other hand, Height Coalescence will of course simply be impossible and the optimal outcome will be V_1 Elision.)

(177)

	/a + i/ frt -hi +hi -atr lo	P(↔)-lex	P(lo)	P(-hi)	Seg-Int	P(-ATR)	P(↑)-lex	P(↑)	P(↔)
	[i] frt <-hi> +hi <-atr> <lo>		*	*		*			
	[a] <frt> -hi <+hi> -atr lo	*					*	*	*
	[e] frt -hi <+hi> <-atr> <lo>		*		*	*	*	*	
⇒	[ɛ] frt -hi <+hi> -atr <lo>		*		*		*	*	

While the ranking PARSE(-high) >> PARSE(-ATR) cannot give rise to the prototypical e-Coalescence pattern, it does, provided that Seg-Int is crucially ranked above PARSE(-ATR)), give rise to a language realizes /a+e/ as [e] rather than [ɛ]. This latter realization is illustrated in (178). (To conserve space, I have not shown the constraints PARSE(↑)-lex and PARSE(↑), which are vacuously satisfied by all candidates, in this tableau.)

(178)	/a + e/ frt -hi -hi -atr lo	P(-hi)-lex	P(↔)-lex	P(lo)	P(-hi)	Seg-Int	P(-ATR)	P(↔)
⇒	[e] frt <-hi> -hi <-atr> <lo>			*	*		*	
	[a] <frt> -hi <-hi> -atr lo	*	*		*			*
	[ɛ] frt <-hi> -hi -atr <lo>			*	*	*		

The case differs from that of /a+i/ in (177) in that violation of Seg-Int is not forced by the need to preserve [-high] in preference to [+high], since both vowels are [-high] to begin with. The fact that the candidate [e] satisfies Seg-Int while also satisfying PARSE(-high) means that the violation of Seg-Int incurred by the coalescent candidate [ɛ] is in this case fatal. The optimal result therefore is simple Elision of V_1.

Whether or not such languages exist is an open question. Although this pattern does not seem implausible, I have come across no examples of it so far. In the interest of restrictiveness, I therefore tentatively assume that it is not possible, and that languages which realize /a+i/ as [ɛ] will necessarily also realize /a+e/ as [ɛ] rather than [e]. This requires maintaining the fixed ranking PARSE(-ATR) >> PARSE(-high).

6.5 Height Coalescence in three-height Kikuyu type systems

Let us next consider the Kikuyu type three-height system in (157c) (repeated in (179)).[60]

(179)

	+high	+ATR	i	u
			ɪ	ʊ
	-high		ɛ	ɔ
low			a	

We may begin once again with the sequence /a+i/. Here the ranking of PARSE(↓) above PARSE(↑)-lex will require preservation of [-high] in preference to both [+high] and [+ATR], yielding a [front, -high] vowel, i.e. [ɛ]. The fact that the underlying [low] specification of /a/ is not preserved is to be attributed once again to an undominated structure-preserving constraint against the combination [front, low]. Similarly, the failure of a candidate [e] (not shown) which combines the [-high] specification of /a/ with the [+ATR] specification (and frontness) of /i/ must be attributed to a structure-preserving constraint against the combination [-high, +ATR],

[60] Armstrong (1940) actually transcribes the second highest vowels in Kikuyu as [e] and [o] rather than [ɪ] and [ʊ]. Nevertheless, her description of the auditory qualities of these vowels suggest that they are in fact quite similar to the English vowels /ɪ/ and /ʊ/. Leakey (1959) explicitly states that these Kikuyu vowels are closest to the English vowels in *it* and *good*.

which is absent in the underlying system. I illustrate the behavior of this sequence in the tableau below:

(180)

	/a + i/ frt -hi +hi +atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[i] frt <-hi> +hi +atr <lo>			**				
	[a] <frt> -hi <+hi> <+atr> lo		*			**	**	*
⇒	[ɛ] frt -hi <+hi> <+atr> <lo>			*	*	**	**	

The sequences /a+ɪ/ and /a+ʊ/ will also be realized as [ɛ] and [ɔ] respectively, as shown below for the case of the former:

(181)		/a + ɪ/ frt -hi +hi lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
		[ɪ] frt <-hi> +hi <lo>			**				
		[a] <frt> -hi <+hi> lo		*			*	*	*
	⇒	[ɛ] frt -hi <+hi> <lo>			*	*	*	*	

Coalescence is also predicted to occur with sequences in which V_1 is /ɛ/ or /ɔ/ and V_2 is /i/, /ɪ/, /u/, or /ʊ/. This is illustrated below for the case of /ɔ+ɪ/:

(182)		/ɔ + ɪ/ rnd frt -hi +hi	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
		[ɪ] <rnd> frt <-hi> +hi			*				*
		[ɔ] rnd <frt> -hi <+hi>		*			*	*	*
	⇒	[ɛ] <rnd> frt -hi <+hi>				*	*	*	*

Here I assume that a further candidate [o] (not shown in (182)) is ruled out both by the fact that it would require inserting a [+ATR] specification, in violation of undominated *INS(F), and because of structure preservation, i.e. there is an undominated constraint ruling out the unattested combination [-high, +ATR].

Finally, consider the case where V_1 is /i/ or /u/ and V_2 is /ɪ/ or /ʊ/. In these cases, we predict simple Elision of V_1 rather than Coalescence. This is illustrated below for the case of /u+ɪ/:

(183)

	/u + ɪ/ rnd frt +hi +hi +atr	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
⇒	[ɪ] <rnd> frt <+hi> +hi <+atr>						**	*
	[u] rnd <frt> +hi <+hi> +atr		*			*	*	*
	[i] <rnd> frt <+hi> +hi +atr				*		*	*

Here the constraint Seg-Int plays a crucial role. Were it not for the ranking of this constraint above PARSE(↑), the outcome would have been a coalescent realization [i] instead, since this violates PARSE(↑) less severely than the actual predicted outcome [ɪ].

The full range of predicted outcomes for this vowel system is given in (184).

(184)

(184)	i+i > i	ɪ+i > i	ɛ+i > ɛ	a+i > ɛ	ɔ+i > (w)ɛ	ʊ+i > (w)i	u+i > (w)i
	i+ɪ > ɪ	ɪ+ɪ > ɪ	ɛ+ɪ > ɛ	a+ɪ > ɛ	ɔ+ɪ > (w)ɛ	ʊ+ɪ > (w)ɪ	u+ɪ > (w)ɪ
	i+ɛ > (y)ɛ	ɪ+ɛ > (y)ɛ	ɛ+ɛ > ɛ	a+ɛ > ɛ	ɔ+ɛ > (w)ɛ	ʊ+ɛ > (w)ɛ	u+ɛ > (w)ɛ
	i+a > (y)a	ɪ+a > (y)a	ɛ+a > (y)a	a+a > a	ɔ+a > (w)a	ʊ+a > (w)a	u+a > (w)a
	i+ɔ > (y)ɔ	ɪ+ɔ > (y)ɔ	ɛ+ɔ > (y)ɔ	a+ɔ > ɔ	ɔ+ɔ > ɔ	ʊ+ɔ > (w)ɔ	u+ɔ > (w)ɔ
	i+ʊ > (y)ʊ	ɪ+ʊ > (y)ʊ	ɛ+ʊ > (y)ɔ	a+ʊ > ɔ	ɔ+ʊ > ɔ	ʊ+ʊ > ʊ	u+ʊ > ʊ
	i+u > (y)u	ɪ+u > (y)u	ɛ+u > (y)ɔ	a+u > ɔ	ɔ+u > ɔ	ʊ+u > u	u+u > u

These predictions may be compared with the actual observed outcomes in two of the Height Coalescence languages in my survey, Kamba (Roberts-Kohno 1995a,b, Whitely & Muli 1962) and Kikuyu, which have this vowel system.[61] (My available data on Coalescence in a third language which has this system, Kinande, are too limited to reveal much that is useful, consisting only of two examples, from Hyman (1989) in which /a+i/ is realized as [ɛ].) The realizations of those sequences that are attested in my sources on Kamba are given in (185); note that all of these realizations are in agreement with those for the corresponding sequences in (184). (Note that some of these realizations involve Glide Formation, which shows that Kamba has *CG ranked below the PARSE constraints).[62]

[61] Although Roberts-Kohno (1995a) transcribes the second highest vowels in Kamba as [e] and [o] rather than [ɪ] and [ʊ], this appears to be simply a notational preference. She confirms (personal communication) that these vowels do in fact sound more like [ɪ] and [ʊ] and that her informant did not readily accept her own attempts to pronounce them as [e] and [o], interpreting these instead as tokens of /ɛ/ and /ɔ/.

[62] Compensatory lengthening, which occurs consistently according to Roberts-Kohno (1995a,b) but not Whitely & Muli (1962), has not been indicated in (184).

(185)		ɪ+i > i		ʊ+i > wi	
		ɪ+ɪ > ɪ	a+ɪ > ɛ	ʊ+ɪ > wɪ	
		ɪ+ɛ > yɛ	a+ɛ > ɛ	ʊ+ɛ > wɛ	
	i+a > ya	ɪ+a > ya	a+a > a	ʊ+a > wa	
		ɪ+ɔ > yɔ	a+ɔ > ɔ	ʊ+ɔ > wɔ	
	i+ʊ > yʊ	ɪ+ʊ > yʊ	a+ʊ > ɔ	ʊ+ʊ > ʊ	u+ʊ > ʊ
				ʊ+u > u	

The attested realizations for Kikuyu are given in (186):

(186)			a+i > ay		
		ɛ+ɪ > ɛ	a+ɪ > ɛ	ɔ+ɪ > wɛ	
			a+ɛ > ɛ		
		ɛ+a > ya		ɔ+a > wa	
		ɛ+ɔ > yɔ			ʊ+ɔ > wɔ
	ɪ+ʊ > yʊ	ɛ+ʊ > yɔ	a+ʊ > ɔ	ɔ+ʊ > ɔ	
	ɪ+u > yu	ɛ+u > yɔy	a+u > ɔy	ɔ+u > ɔy	ʊ+u > u

All of these sequences conform to the pattern in (184) except for the four sequences /a+i/, /a+u/, /ɛ+u/, and /ɔ+u/; these are the only attested sequences in which V_1 is non-high /a/, /ɛ/, or /ɔ/, and V_2 is /i/ or /u/. Each of these sequences departs from the predicted realization in that the actual outcome is unexpectedly realized with a [y] offglide. At this point, I have no account for this fact. I note however that while the predicted realizations (in (184)) of these four sequences are well-attested cross-linguistically, the Kikuyu realizations are attested in no other language that I am aware of. In view of this, I am confident that, whatever the explanation for the idiosyncratic behavior of these sequences in Kikuyu may be, languages like Kikuyu but with the predicted realizations of these particular sequences will prove to exist.

While the realization of /a+i/ and /a+u/ in this system as [ɛ] and [ɔ] respectively through Height Coalescence is perhaps not very surprising, in view of the structure of the vowel inventory (e.g. it might have been surprising if these sequences had been realized as [e] and [o] instead, given the absence of underlying /e/ and /o/ in the system), it must be noted that there is no reason, within most versions of the Standard Height Theory, not to expect that such a system could instead manifest Coalescence of /a+i/ and /a+u/ to [ɪ] and [ʊ] rather than [ɛ] and [ɔ]. Similarly, there is no reason not to expect Coalescence of /ɪ+u/ to [ʊ] or /u+i/ to [ɪ]. All these Coalescence patterns (which are not, as far as I am aware, attested) would simply involve preservation of a [-ATR] value of V_1, together with the frontness and roundness of V_2. If it is indeed true that such patterns are unattested, it provides strong evidence for the claim that [-ATR] is not phonologically present in Kikuyu type systems.

6.6 Height Coalescence in four-height systems

Remaining to be considered is the four-height system in (197d), repeated as (187).

(187)

	+high	+ATR	i	u
			ɪ	ʊ
	-high	+ATR	e	o
			ɛ	ɔ
low			a	

As a consequence of the fact that the /eo/ and /ɛɔ/ heights are distinguished in this system by means of a [+ATR] specification on the former height rather than a [-ATR] specification on the latter, we predict that the sequences /a+i/ and /a+e/ will be realized as [e] rather than [ɛ], while /a+u/ and /a+ɔ/ will be realized as [o] rather than [ɔ]. This is illustrated in (188) and (189) for the cases of /a+i/ and /a+e/ respectively. (Note once again that the failure of an additional candidate, not shown, which preserves both the [-high] and [low] specifications of /a/ in combination with the frontness of /i/ or /e/, is assumed to be due to an undominated constraint which accounts for the general ill-formedness of the combination [front, low] within this system.)

(188)

/a + i/ frt -hi +hi +atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
[i] frt <-hi> +hi +atr <lo>			**				
[a] <frt> -hi <+hi> <+atr> lo		*			**	**	*
[ɛ] frt -hi <+hi> <+atr> <lo>			*	*	**	**	
⇒ [e] frt -hi <+hi> +atr <lo>			*	*	*	*	

(189)

/a + e/ frt -hi -hi +atr lo	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
⇒ [e] frt <-hi> -hi +atr <lo>			**				
[a] <frt> -hi <-hi> <+atr> lo	*	*	*		*	*	*
[ɛ] frt <-hi> -hi <+atr> <lo>			**	*	*	*	

Consider now the sequences /e+i/, /e+u/, /o+i/, /o+u/, /ɛ+i/, /ɛ+u/, /ɛ+ɪ/, /ɛ+ʊ/, /ɔ+i/, /ɔ+u/, /ɔ+ɪ/, and /ɔ+ʊ/, which are all the sequences in which V_1 is mid and V_2 is high, excluding those in which V_1 is [+ATR] and V_2 is [-ATR] (these involve a significant difference in their behavior and will be discussed below). Here again, the ranking PARSE(↓) >> PARSE(↑)-lex forces the preservation of the [-high] specification of V_1, which combines (due to the ranking PARSE(↔)-lex >> PARSE(↔)) with the frontness or roundness (and [+ATR] specification, if any) of V_2, giving rise to the realizations in (190).

(190)				
	e+i > e	o+i > (w)e	ɛ+i > e	ɔ+i > (w)e
	e+u > (y)o	o+u > o	ɛ+u > (y)o	ɔ+u > o
			ɛ+ɪ > ɛ	ɔ+ɪ > (w)ɛ
			ɛ+ʊ > (y)ɔ	ɔ+ʊ > ɔ

Tableaux illustrating the behavior of a few of these sequences are given below:

(191)

/o + i/ rnd frt -hi +hi +atr +atr	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
[i] <rnd> frt <-hi> +hi <+atr> +atr			*			*	*
[o] rnd <frt> -hi <+hi> +atr <+atr>		*			**	**	*
[ɛ] <rnd> frt -hi <+hi> <+atr><+atr>				*	**	***	*
⇒ [e] <rnd> frt -hi <+hi> <+atr> +atr				*	*	**	*

(192)

	/ɔ + i/ rnd frt -hi +hi +atr	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[i] <rnd> frt <-hi> +hi +atr			*				*
	[ɔ] rnd <frt> -hi <+hi> <+atr>		*			**	**	*
	[ɛ] <rnd> frt -hi <+hi> <+atr>				*	**	**	*
⇒	[e] <rnd> frt -hi <+hi> +atr				*	*	*	*

(193)

	/ɔ + ɪ/ rnd frt -hi +hi	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[ɪ] <rnd> frt <-hi> +hi			*				*
	[ɔ] rnd <frt> -hi <+hi>		*			*	*	*
⇒	[ɛ] <rnd> frt -hi <+hi>				*	*	*	*

The sequences /e+ɪ/, /e+ʊ/, /o+ɪ/, and /o+ʊ/, which differ from those in (190) in that V_1 is [+ATR] while V_2 is [-ATR], similarly involve preservation of [-high] of V_1 together with the frontness or roundness of V_2. With these sequences there is an additional factor that comes into play, however, arising from the fact that only V_1 is specified for [ATR]. As a consequence, this [+ATR] specification of V_1 is not incompatible with any feature of V_2. In other situations we have seen of this type, in which V_1 contains some feature that is compatible with all features of V_2, preservation of this feature has been prevented by the ranking of Seg-Int (which is violated by such automatic preservation) above most of the PARSE(F) constraints. In the case of inputs like /u+ɪ/ in Kikuyu type systems, for example, the preservation of the [+ATR] specification of /u/, leading to an output candidate [i], is sub-optimal because of the ranking of Seg-Int above PARSE(+ATR) (= PARSE(↑)), so that this candidate loses out to a candidate ([ɪ]) with simple Elision of V_1, as shown previously in (183). And indeed, the same input sequence /u+ɪ/ is also predicted (correctly) to surface as [ɪ] in the four-height system (and for precisely the same reasons). The fate of the four sequences we are now addressing is different however. With these sequences, we do in fact predict preservation of [+ATR], as illustrated below for the sequence /o+ɪ/.

(194)	/o + ɪ/ rnd frt -hi +hi +atr	P(↓)-lex	P(↔)-lex	P(↓)	Seg-Int	P(↑)-lex	P(↑)	P(↔)
	[ɪ] <rnd> frt <-hi> +hi <+atr>			*			*	*
	[o] rnd <frt> -hi <+hi> +atr		*			*	*	*
	[ɛ] <rnd> frt -hi <+hi> <+atr>				*	*	**	*
⇒	[e] <rnd> frt -hi <+hi> +atr				*	*	*	*

Notice that the preservation of [+ATR] in the winning candidate [e] violates Seg-Int, even though this constraint dominates the constraint PARSE(↑). What makes this state of affairs possible is the fact that violation of Seg-Int is forced in any case in order to satisfy still higher constraints, i.e. PARSE(↓) and PARSE(↔)-lex. Since all viable candidates necessarily violate Seg-Int, and since preserving [+ATR] of V_1 does not make matters worse by incurring further violations of Seg-Int (which I assume to be a non-gradient constraint), preservation of [+ATR] is preferable to loss of this feature, which violates PARSE(↑) (leading to [ɛ]) without offering any improvement with respect to other constraints.

The full set of realizations predicted for the four-height system under the ranking we have established is shown in (195).

(195)	i+i>i	ɪ+i>i	e+i>e	ɛ+i>e	a+i>e	ɔ+i>(w)e	o+i>(w)e	ʊ+i>(w)i	u+i>(w)i
	i+ɪ>ɪ	ɪ+ɪ>ɪ	e+ɪ>e	ɛ+ɪ>ɛ	a+ɪ>ɛ	ɔ+ɪ>(w)ɛ	o+ɪ>(w)e	ʊ+ɪ>(w)ɪ	u+ɪ>(w)ɪ
	i+e>(y)e	ɪ+e>(y)e	e+e>e	ɛ+e>e	a+e>e	ɔ+e>(w)e	o+e>(w)e	ʊ+e>(w)e	u+e>(w)e
	i+ɛ>(y)ɛ	ɪ+ɛ>(y)ɛ	e+ɛ>ɛ	ɛ+ɛ>ɛ	a+ɛ>ɛ	ɔ+ɛ>(w)ɛ	o+ɛ>(w)ɛ	ʊ+ɛ>(w)ɛ	u+ɛ>(w)ɛ
	i+a>(y)a	ɪ+a>(y)a	e+a>(y)a	ɛ+a>(y)a	a+a>a	ɔ+a>(w)a	o+a>(w)a	ʊ+a>(w)a	u+a>(w)a
	i+ɔ>(y)ɔ	ɪ+ɔ>(y)ɔ	e+ɔ>(y)ɔ	ɛ+ɔ>(y)ɔ	a+ɔ>ɔ	ɔ+ɔ>ɔ	o+ɔ>ɔ	ʊ+ɔ>(w)ɔ	u+ɔ>(w)ɔ
	i+o>(y)o	ɪ+o>(y)o	e+o>(y)o	ɛ+o>(y)o	a+o>o	ɔ+o>o	o+o>o	ʊ+o>(w)o	u+o>(w)o
	i+ʊ>(y)ʊ	ɪ+ʊ>(y)ʊ	e+ʊ>(y)ɔ	ɛ+ʊ>(y)ɔ	a+ʊ>ɔ	ɔ+ʊ>ɔ	o+ʊ>o	ʊ+ʊ>ʊ	u+ʊ>ʊ
	i+u>(y)u	ɪ+u>(y)u	e+u>(y)o	ɛ+u>(y)o	a+u>o	ɔ+u>o	o+u>o	ʊ+u>u	u+u>u

These realizations are consistent with the facts available for each of the five four-height languages with e-Coalescence listed in (149c), i.e. Chumburung, Gichode, Krachi, Nawuri, and Southern Sotho. Southern Sotho has only limited instances of

Coalescence; Doke & Mofokeng (1957) cite only the following realizations: /a+i/ > [e], /e+a/ > [a:], /e+ɪ/ > [e:], /e+ʊ/ > [o:].[63] (Note however that among these few attested realizations are two, /e+ɪ/ > [e:] and /e+ʊ/ > [o], which illustrate the surprising but automatically predicted preservation of [+ATR] in cases where V_1 is [-high, +ATR] and V_2 is [+high, -ATR].) The remaining four languages, Chumburung, Gichode, Krachi, and Nawuri, are all closely related languages classified as Guang, a genetic entity within Kwa. These languages each generally display about half of the realizations in (195), lacking only those in which V_2 is a high round vowel or a mid front vowel, omissions which follow from the facts that (1) V_2 is almost always a word-initial prefix in the hiatus contexts that arise in these languages and (2) there are no /u/, /ʊ/ prefixes in these languages, while /e/ and /ɛ/ prefixes are relatively rare at best. In (196) I give data from Gichode illustrating the behavior of some of the sequences in (195).[64]

(196)	a. okuli ansidɔ	→	okulansidɔ	'husband's face'
	b. okuli otu	→	okulotu	'husband's heart'
	c. fʊlɪ idʒo	→	fʊlidʒo	'deer's yams'
	d. fʊlɪ ɔlɔ	→	fʊlɔlɔ	'deer's sore'

[63] In addition, Doke & Mofokeng cite some cases in which it is not clear whether a surface [e] has arisen from /a+i/ or /a+ɪ/. Note that a realization /a+ɪ/ > e would not only be inconsistent with the pattern in (195), but would be anomalous in virtually any feature framework.

[64] The examples are from the extensive unpublished field notes of Keith Snider, to whom thanks are due for kindly making them available to me. Certain irrelevant phonetic details (e.g. allophonic vowel centralization word-medially) are ignored.

e. dɔɔbʊ itʃiŋ	→	dɔɔbwitʃiŋ	'farmer's veins'
f. dɔɔbʊ otʃiŋ	→	dɔɔbotʃiŋ	'farmer's vein'
g. atanatʃɪsɛ ansidɔ	→	atanatʃɪsansidɔ	'female twin's face'
h. atanatʃɪsɛ ɔlɔ	→	atanatʃɪsɔlɔ	'female twin's sore'
i. obilimbu atɔ	→	obilimbwatɔ	'young woman's things'
j. obilimbu idʒo	→	obilimbwidʒo	'young woman's yams'
k. ɔka ɔlɔ	→	ɔkɔlɔ	'wife's sore'
l. ɪsafɔ otʃiŋ	→	ɪsafotʃiŋ	'wife's vein'
m. gibide otu	→	gibidotu	'slave's heart'
n. gibide ɪdʒaŋ	→	gibidedʒaŋ	'slave's thighs'
o. dʒono itʃiŋ	→	dʒonetʃiŋ	'dog's veins'
p. dʒono ɪlɔ	→	dʒonelɔ	'dog's sores'
q. dɪga otu	→	dɪgotu	'young man's heart'
r. dɪga idʒo	→	dɪgedʒo	'young man's yams'
s. atanatʃɪsɛ ɪlɔ	→	atanatʃɪsɛlɔ	'female twin's sores'
t. atanatʃɪsɛ itʃiŋ	→	atanatʃɪsetʃiŋ	'female twin's veins'

The only point at which these languages do not clearly conform to the pattern in (195) involves the sequences /i+ɪ/ and /u+ɪ/, i.e. those in which a high [+ATR] V_1 precedes a high [-ATR] V_2. (The other logically possible sequences of this type, /i+ʊ/ and /u+ʊ/, do not arise, due to the general absence of word-initial /ʊ/ in these languages.) The realizations of these sequences are the subject of some uncertainty. In my own work on Nawuri (Casali 1988, 1995d), I have claimed that these sequences are both realized as [ɪ], i.e. they involve Elision of V_1. On the other hand, Snider has instead the realizations /i+ɪ/ > [i] and /u+ɪ/ > [i] for all four Guang languages Chumburung, Gichode, Krachi, and Nawuri.

While I do not dispute the fact that the surface vowels which arise from these sequences may in some instances tend more toward the [+ATR] quality transcribed by Snider, I claim that this quality (which I believe, at least in Nawuri and I suspect in the other languages as well, to be more likely to occur in casual speech) can be attributed to independent factors that have nothing to do with hiatus resolution. Specifically, Chumburung and Nawuri (and quite likely the other languages as well) have a postlexical process of rightward [+ATR] spreading which causes an underlying high [-ATR] vowel in the first syllable of a word to assimilate to the [+ATR] quality of a [+ATR] vowel in the last syllable of a preceding word (Casali 1995d, Snider 1985, 1989c). In Nawuri at least, this process is speech-rate dependent and typically leads only to partial assimilation, which would indicate that it is a likely candidate for a phonetic rule within standard frameworks.[65] Where V_1 is preceded by another [+ATR] vowel in the same word in one of the sequences (/i+ɪ/, /u+ɪ/, /i+ʊ/, /u+ʊ/) with which we are dealing, the fact that the phonetic result tends toward a [+ATR] version of V_2 may plausibly be attributed to postlexical [+ATR] spreading (however

[65] Snider does not discuss the presence or absence of these characteristics in the case of rightward [+ATR] spreading in Chumburung.

this process is to be characterized within Optimality Theory). Crucially, such an attribution is only possible where V_1 is preceded by other [+ATR] vowels; otherwise, the Elision of V_1 which is claimed to occur would remove the only possible trigger for the phonetic rightward [+ATR] spreading. In virtually all the examples of these four sequences in both my data and Snider's, V_1 is in fact preceded by another [+ATR] vowel(s) within the same phonological word. In view of the further fact that these sequences are typically realized as [-ATR] vowels in my own data, I will tentatively assume that the realizations in (195) are in fact correct.

Chapter 7: An Approach to Height Feature Specification

In the preceding chapter I showed how the Height Coalescence patterns associated with the clearly attested two-, three- and four-height systems could all be derived from the same constraint ranking, assuming that the specifications of these systems are, within the notation of Standard Height Theory, as shown in (157) (repeated in (197)).

(197) a. two-height system:

	+high	i	u
	-high	e	o
low		a	

b. three-height system (Yoruba type)

	+high		i	u
	-high		e	o
		-ATR	ɛ	ɔ
low			a	

c. three-height system (Kikuyu type)

	+high	+ATR	i	u
			ɪ	ʊ
	-high		ɛ	ɔ
low			a	

d. four-height system

	+high	+ATR	i	u
			ɪ	ʊ
	-high	+ATR	e	o
			ɛ	ɔ
low			a	

While this is an interesting result in and of itself, a larger challenge is to explain <u>why</u> these systems are specified as they are, i.e. we would like to know why it is that other, seemingly analogous systems (e.g. a three-height system in which the higher-mid vowels /e/ and /o/ are actively specified as [-high] and [+ATR]) are apparently unattested. The current chapter pursues an explanation of this fact. Although a fully satisfying solution will remain beyond our grasp, it will at least prove possible to raise some issues and suggest avenues that might be explored.[66]

My account employs a set of height features designated H, L, XL, h, and l that are characterized in auditory-acoustic rather than articulatory terms. These features, which are defined in section 7.1, correspond to the Standard features [high], [low] and [ATR]/[RTR] as follows:

[66] A very different approach to essentially the same generalizations regarding inventory specification is found in Goad (1993). Although Goad's model appears capable of coping quite well with most of the empirical facts related to Height Coalescence, it is based on an approach to phonological explanation (feature geometry) which is fundamentally different from the one being pursued here. Because the conceptual approaches which underlie our theories are so radically different, it does not seem worthwhile to me to undertake a direct comparison of the two models here. Instead, the reader is referred to Goad for detailed discussion of her model.

(198)	H	corresponds to	[+high]
	L	corresponds to	[-high]
	h	corresponds to	[+ATR]
	l	corresponds to	[-ATR]/[RTR]
	XL	corresponds to	[low]

I wish to make it clear from the outset that this use of auditory features is not absolutely crucial to the account I propose; the same formal mechanisms (i.e. constraints on feature specification) could be readily translated into the featural vocabulary of Standard Height Theory. There are however three reasons behind my use of auditory features. First, at least some of the constraints posited below can be given a more appealing rationale if they refer to auditory, rather than articulatory properties of vowel heights. Second, I contend that the close connection between preservation of [-high] and preservation of [-ATR] under Height Coalescence seen in the preceding chapter is best understood if both are regarded as a preference for lower height levels. This view is only coherent if "lower height" is construed in auditory terms, since articulatory tongue root retraction is not consistently correlated with tongue lowering in actual vowel production. Finally (for reasons not confined to phenomena discussed in this study), I believe that an auditory approach to height features is the one which is most likely to succeed in the long run and that this understanding of height features is more consistent with the way these features (including the Standard feature [ATR]) are actually employed in practice. In particular, while it seems extremely unlikely that anything resembling an invariant articulatory gesture underlies all the uses which have been made of [ATR] in various vowel systems, the proposal that [+ATR] (as used in phonological descriptions) correlates consistently with auditory raising and that [-ATR] correlates consistently with auditory lowering seems quite tenable. In effect then, the framework here may reasonably be construed not as an entirely new height feature theory but as (1) an explicit attempt to cast Standard Height Theory in auditory rather than articulatory terms, together with (2) some reasonably explicit mechanisms (discussed below) for mapping abstract height feature specifications onto auditory height levels (defined our purposes in terms of IPA vowel qualities but in principle expressible in terms of F1 frequency values or some appropriate auditory transform of these values). My general views on the articulatory implementation of auditory height features are also outlined (in section 7.4), though only in very rough terms.

7.1 Auditory height features

Versions of the Standard Height Theory are not always clear on whether the height features [high], [low], and [ATR] are properly characterized in articulatory terms or in auditory-acoustic terms (or both). While it has been customary to describe the features [high] and [low] in terms of raising or lowering of the tongue body, it is well known (Lindau 1975) that tongue height does not correlate very closely with the vowel height classes "high," "low," and "mid" as standardly conceived. It seems that in actuality, the height distinctions characterized by phonologists using [high] and [low] are better conceived of as auditory in nature.

In the case of [ATR], it is fair to say that this feature has been most commonly defined in articulatory terms, as its very name suggests. Such debate as has arisen over the nature of [ATR] has tended to center on which of several alternative articulatory characterizations (e.g. advancing or retraction of the tongue root versus expansion or contraction of the pharynx) is most appropriate rather than dealing with the relative merits of an auditory-acoustic or an articulatory definition. In fact, there have been very few proposals (one of the few being Goad (1993)) which characterize [ATR] exclusively and unequivocally in acoustic terms.

In contrast to the general tendency to favor articulatory definitions of vowel height (and other) features, the theory of height features I propose is unabashedly acoustic in its orientation. Height features are defined in terms of position or displacement within the vertical vowel space, roughly characterizable in terms of first formant frequency.

In addition to the height features themselves, we must also consider the principles by which they are assigned. In particular, it will be necessary to explain why only certain logically possible combinations are actually employed. I will claim that the specificational possibilities which are attested can be motivated as attempts to satisfy certain preferences, for example a preference for minimal use of secondary features. In some cases these preferences may be in competition with each other and/or with certain logical or definitional requirements (e.g. the requirement that all contrastive vowel heights be minimally distinguished). As a result, not every preference will be fully satisfied. This kind of competition among different aims naturally lends itself to treatment using ranked and violable constraints within the spirit of Optimality Theory. This is in fact the approach I will adopt. Preferences or dispreferences for certain types of specification will be expressed as constraints which are violated to varying degrees by the particular specifications employed within various candidate systems. The constraints are ranked in a particular order which is at least in part universally determined. The constraints must be chosen in such a way that they converge on single candidates in the cases of the two- and four-height systems (for which only a single representational possibility is attested) but not in the case of three-height systems (for which two different possibilities, i.e. the Yoruba type system in (197b) and the Kikuyu type system in (197c)), exist).

This application of OT style constraints to the problem of the featural analysis of vowel inventories raises the question of the theoretical status of these constraints. It will be clear that they are not phonological constraints of the usual sort, which evaluate mappings of underlying phonological forms to candidate output forms. Rather, I view them as constraints which characterize a speaker's innate knowledge of possible specifications of vowel inventories. I assume that they serve as a guide to inventory construction by ruling out in advance certain logically possible mappings of features onto height levels while admitting others. Since however the specifications of a system are not universally determined, at least in the case of those with three heights, it is clear that some other principles must also interface with these constraints in determining the actual specifications employed in any given three-height system. Exactly what these additional principles might be is an interesting question which is, however beyond the scope of the present study.[67]

Turning now to a more detailed discussion of auditory height features, I propose to subclassify these into two types: primary and secondary. There are two (privative) primary height features, H and L. These are given the straightforward definitions in (199).

(199)	H	characterizes a vowel that is in the upper region of auditory vowel space.
	L	characterizes a vowel that is in the lower region of auditory vowel space.

[67] The two most obvious candidates for consideration are (1) the possibility that a choice between the two competing featural analyses of a particular three-height system are determined by the phonetic qualities of the vowels (in particular, those at the second highest level) or (2) that the choice is determined by phonological behavior, e.g. by assimilation and/or Coalescence patterns. It is also possible that some combination of these is employed.

Although H and L are mnemonic respectively for "high" and "low," it must be cautioned that L corresponds not to [low] but to [-high] within Standard Height Theory. (H, on the other hand, corresponds consistently to [+high].)

Using only the primary features L and H, it is possible to distinguish a maximum of two heights. Ignoring the status of the vowel /a/ (which, as I argue below, warrants special treatment), these features are thus adequate to distinguish the heights in a two-height system:

(200)

H	i	u
L	e	o
	a	

It is clear, however, that the features L and H are not sufficient by themselves to account for all the height contrasts in the three- and four-height systems. In order to capture the remaining height distinctions, we are in need of additional features; these are the secondary features alluded to earlier.

Whereas primary height features locate vowels within a general region, secondary features, designated h and l, further localize the position of a vowel within one of the two primary height regions by characterizing its height relative to other vowels in the region:

(201)

	h	characterizes a vowel that is auditorily raised with respect to the center of its region.
	l	characterizes a vowel that is auditorily lowered with respect to the center of its region.

The secondary feature h corresponds to the feature [+ATR] in Standard Height Theory, while the feature l corresponds to [-ATR].[68] Thus, the attested vowel systems given in (197) above are specified within the present framework as shown below (ignoring once again the possibility of additional specification on the vowel /a/):

(202) a. two-height system:

H	i	u
L	e	o
	a	

b. three-height system (Yoruba type)

H		i	u
L		e	o
	l	ɛ	ɔ
		a	

c. three-height system (Kikuyu type)

H	h	i	u
		ɪ	ʊ
L		ɛ	ɔ
		a	

[68] The proposal that [ATR] is, in effect, a secondary height feature was made previously be Hyman (1988), to which the reader is referred for some interesting discussion.

d. four-height system

H	h	i	u
		ɪ	ʊ
L	h	e	o
		ɛ	ɔ
		a	

7.2 Constraining the specification of auditory height features

If we assume that the specification of primary and secondary height features is constrained only by the requirement that all height levels which are contrastive among front and back-round vowels be minimally distinguished, there are fully 20 possible three-height and 15 four-height systems which are consistent with these assumptions. These are given in abbreviated form in (203) and (204). (Here I list the height specification corresponding to each level in the system on a separate row, separating the primary and secondary height features by a comma. Possibilities which correspond to actual attested systems are italicized, e.g. the italicized system in (203p) corresponds to the Yoruba type three-height system.)

(203) three-height systems:

	a.	b.	*c.*	d.	e.	f.	g.
	H,h	H,h	*H,h*	H,h	H,h	H,h	H
	H	H	*H*	H	H,l	H,l	H,l
	H,l	L,h	*L*	L,l	L,h	L	L,l

	h.	i.	j.	k.	l.	m.	n.
	H,h	H,h	H,h	H,h	H	H	H
	L,h	L,h	L	H,l	H,l	H,l	L,h
	L	L,l	L,l	L,h	L	L,l	L

	o.	*p.*	q.	r.	s.	t.
	H	*H*	H,l	H,l	H,l	L,h
	L,h	*L*	L,h	L,h	L	L
	L,l	*L,l*	L	L,l	L,l	L,l

(204) four-height systems:

a.	b.	c.	*d.*	e.	f.
H,h	H,h	H,h	*H,h*	H,h	H,h
H	H	H	*H*	H	H
H,l	H,l	H,l	*L,h*	L,h	L
L,h	L	L,l	*L*	L,l	L,l

g.	h.	i.	j.	k.	l.
H,h	H,h	H,h	H,h	H	H
H,l	H,l	H,l	L,h	H,l	H,l
L,h	L,h	L	L	L,h	L,h
L	L,l	L,l	L,l	L	L,l

m.	n.	o.
H	H	H,l
H,l	L,h	L,h
L	L	L
L,l	L,l	L,l

To simplify the discussion, I initially consider only the three-height systems, taking up the four-height systems later on.

7.2.1 Three-height systems

While there does not appear to be any single factor that distinguishes the attested three-height systems from all of those which are unattested, it is presumably significant that all of the attested systems make minimal use of secondary specifications. Most of the unattested systems on the other hand use two or even three secondary specifications. This suggests a constraint militating against use of secondary feature specifications:

(205) *Secondary Avoid secondary height features.

One violation of *Secondary is assessed for each secondary feature specification employed by a vowel system, for example the systems in (203h,j) each incur two violations of *Secondary, while the system in (203p) incurs only a single violation.

Given the logical requirement that all contrastive height levels be minimally distinguished,[69] a three-height system of necessity requires at least one secondary height specification, since the primary features H and L alone can serve to distinguish only two heights.[70] Specification of a single secondary feature leads to one violation of *Secondary. Since the heights in a three-height system can be minimally distinguished using only a single secondary specification (as evidenced by the systems in (203c,l,n.p)), all logically possible systems with more than one secondary specification are necessarily excluded, provided we assume (as I now propose) that *Secondary is not dominated by any competing constraint.[71] This rules out all of the three-height systems in (203) except the following:

(206)	*a.* *H,h* = (203c)	b. H = (203l)	c. H = (203n)	*d.* *H* = (203p)
	H	H,l	L,h	*L*
	L	L	L	*L,l*

[69] Here I assume that two height levels which are not minimally distinguished by some feature specification do not actually constitute separate height levels, e.g. a "three-height" system in which only two heights are representationally distinguished is really a two-height system, since the two non-distinguished heights would be merged phonetically under any reasonable view of phonetic interpretation.

[70] Here I assume that all heights in a system must be specified with some primary feature, i.e. a height which bears no primary specification is ill-formed. This may be taken to follow from the definitions of the primary features in (199): assuming that "region" is characterized roughly as "half," a vowel must reside either in the upper half of auditory space (in which case it will be H) or in the lower half (in which case it will be L).

[71] This reasoning of course relies on the assumption that, in contrast to the situation with primary height features, a height level not specified for any secondary height feature is not ill-formed. This property of secondary features is entirely consistent with their definition in (201): while a claim that a vowel resides in neither half of auditory space is incoherent, a claim, entailed by the absence of a secondary specification, that a vowel is neither raised nor lowered with respect to the center of its height region, is both logically and phonologically intelligible.

A further consequence of an undominated *Secondary is that it makes it unnecessary to independently stipulate that both primary specifications must be used before secondary specifications are introduced. Systems which would violate this requirement would be two-height systems using either H or L (but not both) and one or two secondary specifications. These are the systems in (207).

(207)			
	a. H,h H,l	b. H,h H	c. H H,l
	d. L,h L,l	e. L,h L	f. L L,l

Since each of these systems violates *Secondary at least once, they are all less optimal than a two-height system that uses only H and L (i.e. the one in (202a)), which satisfies *Secondary completely.

Not excluded by *Secondary are the unattested systems in (206b,c). The most obvious characteristic of these unattested systems is that they involve height levels specified using a H primary feature in combination with an l secondary feature or an L primary feature with an h secondary feature. This indicates a preference for the pairings H,h and L,l in which both the primary and secondary features involve the same directional tendency, i.e. either both tend to increase auditory height or both tend to decrease auditory height. Exploiting this preference for "directionally reinforcing pairings," we might propose the following constraint:

(208) Secondary Reinforcement: H should be specified as h, L should be specified as l.

Stated in this way, as a requirement that H be paired with h and L with l, Secondary Reinforcement is violated not only by the "mismatched" pairings H,l and L,h but also by a primary feature H or L which lacks a secondary specification. Given however that the total number of secondary specifications which must be used in a system is already rigidly determined by *Secondary (which I take to be undominated), violations incurred by primary features lacking secondary specifications can have no effect in determining the optimal system(s), since all systems which survive the assessment of *Secondary violations will have the same number of secondary-less primary specifications, i.e. two in the case of a three-height system. The Secondary Reinforcement violations which are decisive are therefore those incurred by H,l or L,h, since these specifications are present in some systems (i.e. the unattested systems in (206b,c)) but not others (i.e. the attested systems in (206a,d)). Consequently, any three-height system which contains a non-reinforcing H,l or L,h specification is necessarily suboptimal, given the existence of a viable alternative which use only reinforcing pairings H,h or L,l. This eliminates the unattested three-height systems in (206b,c), leaving only the two attested systems in (206a,d), which tie on both *Secondary violations (one each) and Secondary Reinforcement violations (two each). This result of course assumes that *Secondary is universally ranked above Secondary Reinforcement.

7.2.2 Excursus on constraint motivation

Although the constraints *Secondary and Secondary Reinforcement have been stated as purely formal requirements on feature specifications, it is worth asking what plausible functional basis, if any, might be ascribed to these constraints. I consider first the case of Secondary Reinforcement. Given the definitions of the secondary height features in (201), it is clear that the pairings H,h and L,l will both have the effect of locating a vowel closer to the periphery of the vowel space, away from the neighboring vowels in the system.[72] In contrast, the specifications H,l and L,h will always have the effect of "pushing" a vowel closer to some other vowel of the same frontness/roundness. We may therefore reasonably claim that the "matching" specifications H,h and L,l tend to increase dispersion of vowels, while the "non-matching" specifications H,l and L,h tend to decrease dispersion, and we may view the constraint Secondary Reinforcement as encoding a functional preference (related to a concern for maximum perceptual discriminability) for more dispersed vowel systems.

[72] This statement needs to be qualified slightly once the presence of /a/ in a system is taken into account. Assuming (as I claim below) that /a/ occupies a separate, "extra-low" height, a L,l specification on a front or round vowel will presumably tend to move the vowel closer to the still-lower vowel /a/. Even so, we may reasonably assume that this encroachment is less serious than the encroachment which results from an L,h specification, given that (1) only a single vowel is being encroached upon and (2) /a/ contrasts with a relatively low front or round vowel in more than just height.

It must be emphasized, however, that the level at which this preference for dispersion applies is the rather abstract level of featural representation. Since the actual auditory (and acoustic) level at which a particular height is ultimately realized depends on other factors as well, the vowels in any real system may not entirely reflect this preference for dispersion in their actual F1 values. Also, the degree of dispersion attainable in a system, even at the abstract featural level, is limited by the undominated position of *Secondary. A maximally dispersed three-height system with heights specified as H,h--L--L,l, for example, is universally excluded because it violates *Secondary more severely than other alternatives.

The most obvious interpretation of the other constraint, *Secondary, is that it reflects some kind of general economization principle which prefers minimal use of classificatory labels or features. This is of course reminiscent of underspecification theories, which have lately lost much of their earlier appeal. Regardless of whether or not underspecification theories in any of their original canonical forms (or their more recent offshoots, e.g. Combinatorial Specification) are viable, however, there remains a large number of phonological processes which behave as though certain otherwise acceptable feature specifications were systematically lacking in particular segments and/or particular contexts. In the absence of some fully developed alternative account of these cases, it may be premature to conclude that a preference for minimizing feature specifications plays no role in Universal Grammar.

A preference for representational economy is not however the only conceivable basis which we might ascribe to *Secondary. Just as it is possible to construe Secondary Reinforcement as reflective of a well-established phonetic tendency, we might also consider that possibility that *Secondary is an abstract incarnation of some phonetic preference. The particular possibility I wish to explore here is that *Secondary reflects, at some level, a dispreference for articulatory difficulty.

In order to make sense of this claim, it is of course first necessary to clarify what is meant in this context by articulatory difficulty. Here there are at least two different interpretations to consider. The most obvious of these is that articulatory difficulty could be equated with sheer muscular effort. There is however a second possibility, that articulatory difficulty associated with secondary specifications can be interpreted as arising from a greater requirement for articulatory precision imposed by these specifications. This is the possibility which I will pursue here.

Consistent with their definitions in (201), we might propose that secondary height features impose an additional requirement on the range of height values at which a vowel may be realized. For example, an H specification on a vowel requires only that it be realized in the upper region of auditory space, while an additional h specification would further constraint it to be realized above the center of the upper region. We shall see later that this overly simplified view of height level implementation must give way to a more specific set of principles for translating height specifications into actual positions within auditory space. Nevertheless, it remains true that adding secondary specifications always leads to more stringent requirements on the realizations of the vowels in a system. Assuming that these stricter auditory requirements need greater articulatory precision to accurately implement them, it is reasonable to view *Secondary in this way as ultimately motivated by a preference for avoidance of articulatory difficulty.

Flemming (1995) proposes that segment inventories are governed by three competing aims: (1) minimizing articulatory effort (2) maximizing the distinctiveness of these contrasts, and (3) maximizing the number of contrasts. Under the interpretations proposed above for *Secondary and Secondary Reinforcement, these constraints correspond to two of these three goals: *Secondary is related to the aim of minimizing articulatory effort (construed in terms of requirements for precise implementation), while Secondary Reinforcement is related to the second goal of maximizing distinctiveness of contrasts (in that contrasts among more widely dispersed vowels should be more readily perceived). In fact, the third functional goal has also played a role, albeit a tacit one, in our discussion so far, in that we have only allowed the constraints *Secondary and Secondary Reinforcement to compare systems containing the same number of heights. In the absence of this restriction, undominated *Secondary would require that all vowel systems have (at most) two heights, since only the two-height system lacks secondary features entirely. Making our unstated assumption explicit, we may follow Flemming in assuming an additional family of constraints 'Maintain n" which require maintaining at least n height contrasts. These will be ranked according to the following fixed schema:

(209) Maintain 1 height contrast >> Maintain 2 height contrasts >> Maintain 3 height contrasts ...

A four-height system will now emerge whenever *Secondary is ranked below Maintain 4, a three-height system will result when *Secondary is ranked between Maintain 3 and Maintain 4, and a two-height system will result when *Secondary is ranked between Maintain 2 and Maintain 3. For simplicity, I will however ignore the role of Maintain in the discussion which follow and continue to restrict the discussion to a comparison of systems having the same number of height levels.

7.2.3 Four-height systems

Having considered possible functional motivations for the constraints *Secondary and Secondary Reinforcement, I return to the problem of ruling out the unattested vowel systems. Left to be considered are the four-height systems. Although the constraints *Secondary and Secondary Reinforcement, ranked in that order, are sufficient to admit only the two attested three-height systems, they do not entirely suffice for the four-height systems. As things stand, these constraints actually judge the unattested system H,h--H--L--L,l (=(204f)), rather than the attested system

H,h--H--L,h--L (=(204d)), to be most optimal. This state of affairs is illustrated in the tableau in (210), in which I show only (and all) candidates having the minimum number (two) of *Secondary violations possible in a four-height system.

(210)

		*Secondary	S. R.
	H,h H (=(204b)) H,l L	**	***
	H,h *H (=(204d))* *L,h* *L*	**	***
⇒	H,h H (=(204f)) L L,l	**	**
	H H,l (=(204k)) L,h L	**	****
	H H,l (=(204m)) L L,l	**	***
	H L,h (=(204n)) L L,l	**	***

In purely formal terms, it seems that what is required in order to render the attested system H,h--H--L,h--L more optimal than the wrongly-predicted winner H,h--H--L--L,l is an additional constraint which effectively disallows use of both h and l within a single system. There are several different ways in which such a constraint might be stated. The approach I tentatively adopt is to state the constraint as an identity requirement between secondary features used in the H and L regions:

(211) Secondary Harmony — Secondary features used in the H and L regions should be identical.

The constraint name 'Secondary Harmony" is adopted for a reason. Unless we are content to construe this constraint as a purely formal dispreference for unlike objects, the most plausible functional motivation I can envision for such a constraint is that its satisfaction gives rise to systems in which vowel harmony based on a secondary height feature is a transparent possibility. If we assume that vowel harmony is a device which languages exploit in order to render difficult contrasts more salient by realizing the features which encode them over longer temporal spans (Kaun 1995, Gorecka 1996), then we may reasonably assume that the use of harmony in a four-height system, in which the perceptual challenges posed by the larger number of height contrasts is particularly acute, might constitute a significant advantage. And in fact, it appears to be rare for languages with four heights not to employ some kind of harmony or co-occurrence restrictions based on a secondary height feature.[73]

In order for the constraint system to judge the system H,h--H--L--L,l as less optimal than the desired winner H,h--H--L,h--L, Secondary Harmony must be ranked above Secondary Reinforcement. This ranking will also rule out all of the other candidates in (210) except for the system H--H,l--L--L,l (=(204m)), which now ties with H,h--H--L,h--L as the only surviving candidate:

[73] It is certainly true that four-height Niger-Congo (and probably Nilo-Saharan as well) without [ATR] harmony are extremely rare.

(212)		*Secondary	S. H.	S. R.
	H,h H (=(204b)) H,l L	**	*	***
⇒	*H,h* *H* *(=(204d))* *L,h* *L*	**		***
	H,h H (=(204f)) L L,l	**	*	**
	H H,l (=(204k)) L,h L	**	*	****
⇒	H H,l (=(204m)) L L,l	**		***
	H L,h (=(204n)) L L,l	**	*	***

The remaining competitor H--H,l--L--L,l can be eliminated by splitting Secondary Reinforcement into two more specific constraints which apply separately to the H and L regions, as in (213), provided we adopt, in addition, a fixed universal ranking of h-Reinforcement over l-Reinforcement.

(213) h-Reinforcement: H should be specified as h
l-Reinforcement: L should be specified as l.

The constraint system is now sufficiently fine-tuned to identify the attested system H,h--H--L,h--L as the uniquely optimal candidate:

(214)

		*Secondary	S. H.	h-R.	l-R.
	H,h H (=(204b)) H,l L	**	*	**	*
⇒	*H,h* *H (=(204d))* *L,h* *L*	**		*	**
	H,h H (=(204f)) L L,l	**	*	*	*
	H H,l (=(204k)) L,h L	**	*	**	**
	H H,l (=(204m)) L L,l	**		**	*
	H L,h (=(204n)) L L,l	**	*	*	**

Although splitting Secondary Reinforcement into h-Reinforcement and l-Reinforcement does not seem unreasonable, it is not clear what functional motivation, if any, might underlie the fixed ranking h-Reinforcement >> l-Reinforcement upon which the success of this approach crucially depends. Here I refrain from speculation and simply assume that such a fixed ranking does exist, whatever its ultimate motivation may be.

Happily, the adoption of Secondary Harmony and a fixed ranking between the two constraints h-Reinforcement and l-Reinforcement introduces no undesired side effects in the case of the three-height systems. The two attested systems H,h--H--L (i.e. the Kikuyu type system) and H--L--L,l (i.e. the Yoruba type system) continue to emerge as the two equally optimal candidates as demonstrated in (215). (Here I compare only the four candidates, shown previously in (206), which are not immediately eliminated because they incur more than one *Secondary violation.)

(215)

		*Secondary	S. H.	h-R.	l-R.
⇒	*H,h* *H* (=(203c)) *L*	*		*	*
	H H,l (=(203l)) L	*		**	*
	H L,h (=(203n)) L	*		*	**
⇒	*H* *L* (=(203p)) *L,l*	*		*	*

7.3 The status of /a/

The treatment so far has ignored the status of the low vowel /a/. Although there are various approaches we might take toward integrating this vowel into the overall framework, the empirical result we must aim for is fairly clear: it should be possible for /a/ to bear an additional lowness specification not possessed by any other vowel. (Whether /a/ must be so specified in all languages is an open question, to which I tentatively assume an affirmative answer.) There is evidence for this from systems of two, three, and four heights. In the case of two-height systems, the Coalescence pattern in Afar and the Feature-Sensitive Elision pattern in Modern Greek both show some feature of /a/ being preserved in preference to the frontness of /e/ and roundness of /o/; the most plausible candidate is a height feature which only

/a/ possesses, analogous to the feature [low] of Standard Height Theory. In the case of three-height systems, both Dangme and Esimbi provide evidence that /a/ occupies a height lower than the other vowels, as discussed in section 5.2 above. (These three-height cases are especially crucial, given that in these languages there is no way that the feature l could be employed to distinguish the level of /ɛɔ/ from that of /a/, since, in these Yoruba type languages, l is already required to distinguish the level of /eo/ from that of /ɛɔ/.) Finally, evidence for a height unique to /a/ from four-height systems comes from the well-known opacity of /a/ to [+ATR] vowel harmony in languages like Akan. Standard accounts of this opacity refer to a [low] specification unique to /a/; if /a/ does not possess a uniquely low height specification, then some other account of this phenomenon must be found.

Assuming that /a/ is to be assigned to a lower height level than the other vowels, the question arises within the present framework whether the additional height feature assigned to /a/ is a primary or a secondary feature. Tentatively, I assume that it is the former; this will have the advantage of preventing possible undesirable interactions of this feature with the constraints *Secondary and Secondary Reinforcement. I designate this additional feature as XL; this is of course mnemonic for "extra low":

(216)	XL	characterizes a vowel that is in a maximally low region of vowel space.

Here I assume that "maximally low" designates an auditory height that is lower than that which is ordinarily attainable by front or round vowels. The impossibility of front or round XL vowels may be expressed by means of constraints like the following:

(217)	*[front, XL]	A front vowel must not be XL.
	*[round, XL]	A round vowel must not be XL.

If we take these constraints to be undominated, as I tentatively propose, then front low or round vowels must, in languages in which they are permitted at all, be specified as L,l rather than XL.

It remains to account for the fact (assuming it is true) that /a/ is always XL, i.e. that every language has a maximally low vowel. There are a variety of ways of achieving this effect; for example, we might propose a constraint requiring that all primary heights be filled. In combination with the constraints against XL front or round vowels in (217), this will entail that the XL height be filled by a central vowel if one is present. Other ways of achieving this result can also be envisioned. For our purposes, I will simply assume that some appropriate mechanism ensures that a language will have a central vowel specified as XL. With these assumptions about the vowel /a/ in place, the systems in (202) may now be more fully specified as in (218):

(218) a. two-height system:

H	i		u
L	e		o
XL		a	

b. three-height system (Yoruba type)

H		i	u
L		e	o
	l	ɛ	ɔ
XL		a	

c. three-height system (Kikuyu type)

H	h	i	u
		ɪ	ʊ
L		ɛ	ɔ
XL		a	

d. four-height system

H	h	i	u
		ɪ	ʊ
L	h	e	o
		ɛ	ɔ
XL		a	

7.4 Phonetic interpretation of height specifications

We have yet to consider the principles by which the height specifications present in a given vowel system are assigned to actual auditory height levels. With respect to most of the assigned specifications, this matter could be viewed as relatively trivial. As a reasonable first approximation, we might simply stipulate that H,h is interpreted as an auditory height appropriate to that of IPA [i]/[u], H (with no secondary specification) is interpreted as a height corresponding to that of IPA [ɪ]/[ʊ], etc. It would seem, however, that there is a more substantial debt to be paid in at least one case, that of the specification L (with no secondary specification), which we desire to be construed as the level of [ɛ]/[ɔ] in the four-height system and the three-height Kikuyu type system, but as the [e]/[o] level in the three-height Yoruba type system. It is not difficult to conceive of plausible interpretation principles which will achieve this result; in fact, there are a number of approaches which might be considered. Here I will simply describe one potentially workable system. I frame the system once again in terms of a ranked set of constraints which, in this case, evaluate possible mappings of height representations specified in terms of primary and secondary height features onto levels along a continuous auditory height scale. In principle we might specify the values along this scale in terms of first formant frequency or (perhaps more adequately) some appropriate transform of these values; for our purposes it will suffice to consider a scale whose values at appropriate points are specified in terms of IPA vowel qualities. I assume that the upper and lower extremes of this scale are represented respectively by the qualities [i] and [æ] (for simplicity I express all points in terms of front vowel qualities only), and that the intermediate qualities [ɪ], [e], and [ɛ] are distributed at roughly equal distances along the scale between these extremes, as in (219):

(219) - i
- ɪ
- e
- ɛ
- æ

The first constraint I propose is one which disprefers phonetic localization of non-central vowels in the space below [ɛ]. This constraint, which will play a very important role in the system, is presumed to be due to the articulatory difficulty in producing extremely low front or round vowels. I state the constraint in (220).

(220)	*[æ]	Avoid non-central vowels lower than [ɛ].

The second constraint is one which prefers H and L vowels to be located roughly in the middle of the upper and lower auditory regions respectively. This constraint is given in (221).

(221)	Mid-Primary	Realize an H vowel at the vertical midpoint of the H region and an L vowel at the midpoint of the L region.

The exact locations of the upper and lower midpoints is a matter that is subject to investigation and refinement; for our present purposes I assume that the H region consists of qualities ranging from a relatively low [ɪ] to cardinal [i], while the L region ranges from a somewhat raised [e] to a low [æ]; assuming roughly even distribution of the IPA vowel qualities in (219), this will equate the midpoint of the H region with a height intermediate between [i] and [ɪ], and the midpoint of the L region with a height approximating that of [ɛ].

Mid-Primary might perhaps better be viewed as representing a compromise between two independent constraints: a perceptually motivated constraint that prefers an H vowel to be at least as high as the midpoint of the H region and an L vowel to be at least as low as the midpoint of the L region, and an articulatory constraint that disprefers the more extreme articulations required to make even more peripheral articulations. While it would be a straightforward matter to decompose Mid-Primary in this way, the formulation in (221) will make the presentation somewhat simpler and will suffice for our purposes.

As things stand, the constraint Mid-Primary would assign to <u>all</u> H vowels a height intermediate between [i] and [ɪ] and to <u>all</u> L vowels a height approximating that of [ɛ]. This is obviously an unacceptable result in the case of systems with more than two heights, since it would lead to the auditory merger of all pairs of heights which are distinguished only by secondary features. Further constraint(s) are therefore needed. Before considering what these constraints may be, however, I would like to justify a claim that the constraint Mid-Primary by itself already gives a very reasonable first approximation to the realization of the non-central vowels in a two-height system.

It is often held (see for example Archangeli & Pulleyblank (1994), Calabrese (1995)) that there are basically two contrastive types of two-height five-vowel systems which may occur in languages, i.e. those in (222).

(222) a. Five-vowel system (type 1)

i u

ɛ ɔ

a

b. Five-vowel system (type 2)

i u

e o

a

The difference between these systems is that in the system in (222a), the mid vowels are phonetically [-ATR] [ɛ] and [ɔ], while in the system in (222b), these vowels are [+ATR] [e] and [o].

There are two important characteristics of this point of view. First, it is claimed that in some languages the mid vowels are phonetically [+ATR], whereas in others they are phonetically [-ATR]. Second, the high vowels are always phonetically [+ATR] [i] and [u] rather than [-ATR] [ɪ] and [ʊ]. In clear contrast to this view, the prediction of my model is that high vowels in a five-vowel system will tend toward a level intermediate between [i]/[u] and [ɪ]/[ʊ], while mid vowels will tend toward the level of [ɛ]/[ɔ]. I would also like to propose however that the pronunciation of both high and vowels will often vary considerably, i.e. the high vowels in some five-vowel languages, while centered on a level intermediate between [i]/[u] and [ɪ]/[ʊ] may exhibit considerable free or contextual fluctuation between a slightly higher level (approaching that of [i]/[u]) and a slightly lower quality (approaching that of [ɪ]/[ʊ]). Analogous variation is expected for the mid vowels in at least some languages. Although nothing in the two constraints proposed so far requires such variation, there is nothing that clearly prevents it, assuming that the "midpoint" referred to in the statement of Mid-Primary is flexibly interpreted. We shall see below that additional constraints which come into play where secondary height specifications exist will severely limit the amount of vertical variation that is expected in cases where more than two heights occupy the same primary region.

While the model developed so far says nothing about inter-language variability, it is presumably the case that the five-vowel systems vary both in their typical qualities of corresponding vowels and in the amount of variation which they permit in the realizations of these vowels. Although it is clear that some mechanisms must therefore be introduced to allow for (and constrain) such inter-language variability, a treatment of this issue must await further study. What I wish to claim here however is that while an adequate model must ultimately allow for inter-language variation in the height realization in five-vowel systems, an accurate characterization of this variation is unlikely to resemble the view in which all five systems divide neatly into one of the two types in (222). Rather, my expectation is that there will be a wide range of intermediate types exhibiting subtle variations in their vowel qualities and in the amount of variability they permit. I predict, moreover, that there will be relatively few five-vowel systems in which the high vowels will be realized invariably as [i]/[u] (as these vowels exist for example in four-height systems like Akan) or in which the mid vowels are realized invariably as either [e]/[o] or [ɛ]/[ɔ] (as these qualities occur in four-height systems). Instead, I expect the more usual situation to be one in which the high vowels exhibit variation around a target height intermediate between [i]/[u] and [ɪ]/[ʊ] while the mid vowels exhibit variation about a target height approximating [ɛ]/[ɔ]. (If we assume that this latter variation is influenced by the constraint *[æ], moreover, then we will expect most of the variation away from [ɛ]/[ɔ] to be in the upward direction.)

The model proposed here thus makes fairly clear predictions about the realizations of the heights in a five-vowel system, which should in principle be easy to confirm or falsify. Unfortunately, despite the fact that the two-height system is extremely common, no systematic investigation of these issues has so far been carried out as far as I am aware. It seems to me, however, that the available evidence is reasonably consistent with my prediction that the high vowels in a two-height system should tend toward a quality intermediate between [i]/[u] and [ɪ]/[ʊ], and the mid vowels toward a quality approximating [ɛ]/[ɔ], but with the possibility of considerable variation in the realizations of both high and mid vowels. Descriptions of such variation are not hard to come by in the literature. Some examples (which could easily be multiplied) are listed below.

1. In describing the vowels of Bemba (which has a five-vowel system /ieaou/), Kashoki (1968:8) says that "The mid vowels /e/ and /o/ each appear to have two allophones, viz., [e ɛ] or [o ɔ], which are in free fluctuation. With regard to [o] and [ɔ], however, there are certain phonological environments where [ɔ] generally seems to occur more frequently than [o], namely following velar stops and wherever /o/ occurs as a sequence of identical vowels (i.e. as a long vocoid). Even so, no definite environments can be determined to show that [o] and [ɔ] are mutually exclusive in their occurrence. The occurrence of [e] and [ɛ] is even less predictable."

2. According to Sasse (1976), the short vowels in Dasenech, which has the system /ieaou/, are generally 'lax'; in addition, short /i/, /a/, and /u/ are centralized. Long /i:/ and /u:/ are consistently realized as lax (but not centralized) [ɪ:] and [ʊ:].[74]

[74] Sasse's actual symbol for the phonetic realization of /u:/ is a barred [u], rather than [ʊ:]. I assume that this is a typo, since he uses the same barred [u] to symbolize the phonetic realization of short /u/, which he describes as lax and centralized. He states quite explicitly that /u:/ is not centralized in its realization, but only lax.

3. Gbari and Gbagyi (Rosendall 1992) have five-vowel systems (/ieaou/) in which there is fluctuation between [+ATR] and [-ATR] realizations of non-low vowels, based primarily on position within the word.

4. In Ila, Smith (1907) describes the non-low vowels /ieou/ as similar to the corresponding English tense vowels when long but as approximating the English lax vowels [ɪɛɔʊ] in their pronunciations when short. (The low vowel /a/ is similarly realized as [a] when long but [æ] when short.)

5. Banda (Sampson 1985) has a ‘two and a half’ height system /ieɨəauoɔ/ (with two diphthongs /^{e}a/ and /^{o}a/ in addition) in which every vowel has “close” and “open” variants in free fluctuation, e.g. /i/ varies freely between close [i] and open [ɪ].

6. Meinhof (1932:157) states that Kongo /i/ is usually realized as a somewhat “wider” (more open) vowel word-finally and a narrower (more close) vowel word-initially. /u/ is “often open, especially at the end of demonstratives such as kyau, mau, zau etc.” The mid vowels are consistently open [ɛ] and [ɔ].

7. Carter (1974:31-32) provides the following description of the phonetic realization of the five vowel system of Teton Dakota: “Vowels are treated as being universally tense [in their underlying features specifications--RC], whereas in fact

there is considerable variation in degree of tenseness. In no case is the variation a criterion for distinctness; rather, degree of tenseness is produced by a feature interpretation rule of the type that is not dealt with here. Suffice it to say that this type of variation is totally automatic and completely predictable. For example, stressed vowels are always more tense than their unstressed counterparts; unstressed vowels in word-final position are always less tense than unstressed vowels in other environments."

The proposed view of the phonetics of five-vowel systems may shed light on an otherwise surprising disagreement (which has not, however, been actively debated as far as I am aware) that exists over which of the two systems in (222) is less marked. The position that the system in (222a) is less marked is held by Archangeli & Pulleyblank (1994) and Calabrese (1995). (Calabrese's theory in fact appears to predict that all five-vowel systems will normally be of this type.) In stark contrast to this position, Kaye, Lowenstamm & Vergnaud (1985:312-313) claim not only that the system in (222b) is less marked, but that "systems of the form /iuɛɔa/, if they exist at all, are quite rare and accordingly highly marked." I suggest that this disagreement, which is on the surface extremely puzzling, given the great frequency with which five-vowel systems occur, is symptomatic of the fact that five-vowel systems do not in fact neatly subdivide into the two types in (222), since it is not generally possible to identify the mid vowels in such a system as being consistently either [+ATR] or

[-ATR] phonetically. The question of which system is less marked is therefore ill-conceived, and it should not be surprising if no clear consensus has emerged regarding its answer.

Having argued that the constraints Mid-Primary and *[æ] yield a reasonable approximation to the phonetics of five-vowel systems, I return to the matter of the additional constraints that are needed to fully distinguish heights in the three- and four-height systems. The most obvious problem to be addressed is how to distinguish the secondarily specified height in a given primary region from the corresponding height which lacks a secondary specification. I propose that this is accomplished by a constraint Secondary Displacement which requires that a secondarily specified height is displaced a vertical distance d upward (in the case of h) or downward (in the case of l) from the corresponding vowel with no secondary specification.

(223) Secondary Displacement (Sec-Dis)

a. A vowel specified h is displaced upward a distance d from a vowel with no secondary specification in the same primary region.

b. A vowel specified l is displaced downward a distance d from a vowel with no secondary specification in the same primary region.

The actual value of d is presumably subject to some language-specific variation. As a reasonable first approximation, however, we may equate d with the auditory distance between any two of the adjacent vowel qualities specified with IPA symbols in (219).

I now suggest that there is a fixed universal ranking Sec-Dis >> *[æ] >> Mid-Primary. Motivation for this ranking comes from the phonetic realization of the L vowels in the seven-vowel system in (218b), repeated here as (224).

(224) three-height system (Yoruba type)

H		i	u
L		e	o
	l	ɛ	ɔ
XL		a	

The fact that the L height with no secondary specification is realized at the auditory [e] level rather than the [ɛ] level means that Mid-Primary is violated. The higher-ranked constraints Sec-Dis and *[æ] are however satisfied. It is easy to show that any other phonetic implementation of the L vowels leads to worse violations. Moving the L and L,l vowels closer together phonetically by lowering the L level (e.g. realizing the L at a level intermediate between [e]/[o] and [ɛ]/[ɔ]) would lead to a less severe violation of Mid-Primary (which we may take to be a gradient constraint), since it would move L closer to the midpoint of the L region (i.e. [ɛ]/[ɔ]). This move would however violate Sec-Dis; since this constraint is ranked higher than Mid-Primary, this choice is necessarily sub-optimal. Moving L higher while keeping L,l fixed violates Mid-Primary more severely while leading to no improvement with respect to the other constraints, and as a consequence this option is also sub-optimal. Finally, lowering

L,l below the [ɛ] level would incur a fatal violation of *[æ], which is ranked higher than Mid-Primary. Thus, the winning phonetic implementation is the one shown in (224), in which L is realized at the [e] level and L,l is realized at the [ɛ] level. The success of this candidate depends crucially on the ranking Sec-Dis >> *[æ] >> Mid-Primary, which we must therefore adopt.

In the case of the high (H) vowels, things are much simpler. Here the constraints Sec-Dis and *[æ] are both irrelevant. The auditory height placement of the H vowels is therefore dictated entirely by Mid-Primary, which requires these vowels to be located at the midpoint of the H region, which I have taken to be a height intermediate between [i] and [ɪ].

Although we have not yet explicitly accounted for the realization of /a/ in this system, this poses no great difficulty in principle. For our purposes, it will suffice to simply assume a constraint which requires an XL vowel to lie within the (center of the) XL region (however this region is ultimately defined in more precise terms).

Let us now consider the phonetic implementation of the four-height system in (218d), repeated as (225).

(225) four-height system

H	h	i	u
		ɪ	ʊ
L	h	e	o
		ɛ	ɔ
XL		a	

The phonetic implementation shown (i.e. the implementation in which all of the height levels have the indicated phonetic values) incurs only a relatively minor violation of Mid-Primary, in that the H vowels [ɪ] and [ʊ] are realized approximately a distance d/2 below the midpoint of the H region, which we have taken to be roughly halfway between [i] and [ɪ]. Raising these vowels to this midpoint would however entail that the H,h and H vowels would be separated by less than d, in violation of undominated Sec-Dis. Lowering the H vowels would also be suboptimal, as it would only lead to a worse violation of Mid-Primary. Thus, any movement of the H vowels can never lead to a more optimal configuration. Movement of the H,h vowels would likewise fail to improve things. We may assume to begin with that upward movement of these vowels is simply impossible, as they are already at the highest point in the vowel space. Downward movement, on the other hand, would fatally violate Sec-Dis (unless offset by simultaneous downward movement of the H vowels, which, as we have already seen, only leads to other fatal violations). The implementation specified in (225) is therefore optimal.

Remaining to be considered is the three-height Kikuyu type system. Since however the treatment of this system is virtually identical to that of the four-height system, I will not discuss it in detail. I simply note that this system differs from the four-height system only in its L region. Since this contains only one height (and no secondary features), this height will be realized phonetically at the [ɛ]/[ɔ] level, as dictated by Mid-Primary (Sec-Dis being irrelevant).

Nothing has been said so far about the articulatory mechanism by which the various auditory height levels assigned to a vowel system are implemented. I do not believe that it is in fact possible to identify cross-linguistically invariant correlates of particular auditory height features. Consider in particular the secondary feature h. This feature corresponds fairly regularly to the traditional feature [+ATR]. We might reasonably propose, in fact, that the acoustic raising associated with h is in many languages, particularly four-height West African languages similar to Akan, implemented primarily by advancement of the tongue root. There is however no expectation that h will be realized through tongue root advancement in all languages. There are a variety of ways in which the vocal apparatus can effect a slight acoustic raising (i.e. decrease in F_1). In addition to tongue root advancement, these include (at least) lowering of the larynx or raising of the tongue body (Lindau 1975). I expect that different languages (and perhaps to some extent even different speakers of the same language) may use somewhat different combinations of these various mechanisms. This leads to a view similar in spirit to Ladefoged's (1980) notion that the features needed in phonological representations are different from the parameters which serve to specify the phonetic representation of an utterance, and that the mapping of phonological features onto phonetic parameters is not one-to-one.

At this point, our treatment of the matter of phonetic interpretation is nearly complete. There is however one final prediction of the model that is worth pointing out. This concerns the realizations of the H vowels in the three-height Yoruba type. For exactly the same reasons discussed above in connection with the two height system, these are predicted to be realized most typically as vowels which are centered on a height intermediate between [i] and [ɪ], but with the possibility of considerable fluctuation in some languages. I wish to stress this because it constitutes another point at which the present theory departs in its predictions from the usual assumptions of Standard Height Theory. Under the latter, it is normally assumed that the high vowels in Yoruba type systems are phonetically [+ATR]. In fact, this assumption plays a fairly critical role within some varieties of the theory (cf. Archangeli & Pulleyblank 1994, Calabrese 1995), since it is claimed that the historical development of these systems from nine-vowel systems with full [ATR] harmony via loss of /ɪ/ and /ʊ/ is motivated at least in part by the articulatory markedness of these latter segments in comparison to the unmarked high vowels /i/ and /u/. Partial support for this claim comes from the alleged fact that languages rarely have /ɪ/ and /ʊ/ unless they also have /i/ and /u/. This line of reasoning is seriously undermined if it turns out that there is no clear sense in which the allegedly high [+ATR] vowels in Yoruba type systems are in fact phonetically [+ATR], but rather are intermediate in quality between and/or fluctuate between [i]/[u] and [ɪ]/[ʊ], as my theory predicts. Which view is ultimately correct is a matter to be settled empirically. Unfortunately, there has so far been no systematic investigation into this question, as far as I know. I would like to note however the existence of at least one language, Anufɔ, in which the highest front vowel is clearly described as <u>not</u> being invariably [i]. Although both Adjekum, Holman & Holman (1993) and Stanford & Stanford (1970) posit a conventional Yoruba type vowel system for this language, the former source states that the vowel /i/ is optionally realized as [ɪ].[75]

Finally, a word of caution is in order here about the interpretation of phonological descriptions. The mere fact that the highest vowels in three-height Yoruba type systems are virtually always phonemicized as /i/ and /u/ cannot be taken, in the absence of a clear description of their phonetic realizations, to mean that these

[75] Stanford & Stanford also describe /i/ as having an allophone [ɪ] (which they symbolize as [i] with a dot beneath it), but only in non-final syllables. Several years ago I had the opportunity to listen to some Anufɔ data together with Tom and Mary Holman. My own impression is that word-final high front vowels are commonly realized as a sound that very closely approximates the [ɪ] found in Nawuri, a Kwa language with a Kwa language with a four-height system and completely productive [ATR] harmony of the type found in Akan.

vowels are in fact consistently realized with a phonetic quality corresponding to that of the contrastively [+ATR] high vowels that occur in four-height languages like Akan. In phonemicizing a three-height system, there are certainly a number of factors unrelated to the phonetic facts which would lead a researcher to favor /i/ and /u/ over /ɪ/ and /ʊ/ as the phonemic representations of the highest vowels in a language with a symmetric vowel system. These range from typographic and/or orthographic convenience (these undeniably played a very important role in early descriptions, and continue to have influence even today), to the well-known expectation that nearly all languages will have /i/ and /u/, though many will lack /ɪ/ and /ʊ/.[76] That is, the expectation will naturally tend to lead to its own fulfillment: given the well-known "naturalness" of systems with /i/ and /u/, it seems to me that a linguist describing a language in which the highest vowels were intermediate between and/or varied in height between [i]/[u] and [ɪ]/[ʊ], would almost certainly tend to favor /i/ and /u/ as the phonemic representations of these vowels. While one might ideally hope that such phonemicization would also be accompanied by a more detailed description of the actual phonetic realization of these vowels, it is clear that many descriptions do not in fact provide this level of detail. It seems to me in fact that vowels which were intermediate in height between [i]/[u] and [ɪ]/[ʊ] (as these occur

[76] For a recognition and brief discussion of the difficulties inherent in attempting to infer information about phonetic vowel quality from inventories presented in descriptive sources, see Disner (1980:73).

for example in Akan) would almost certainly be transcribed as [i]/[u], and that it would be the exceptional description which would say anything further about their phonetic quality. Thus, the unqualified use of /i/ and /u/ in phonemic or even phonetic transcriptions does not necessarily say very much about the actual pronunciation of these vowels.

REFERENCES

Adive, John Raji. 1984. A descriptive study of the verbal piece in Ebira. Ph.D. dissertation, University of London.

Adjekum, Grace, Mary E. Holman, and Thomas W. Holman. 1993. Phonological processes in Anufɔ. (Language Monographs, 2.) Legon: Institute of African Studies, University of Ghana.

Agheyisi, Rebecca N. 1987. Verb serialization and lexical reanalysis: The case of compound verbs in Edo. In Current Approaches to African Linguistics 4, ed. by David Odden. Dordrecht: Foris Publications.

Andersen, Torben. 1987. An outline of Lulubo phonology. Studies in African Linguistics 18:39-65.

Andersen, Torben. 1993. Notes on (Mayak) Burun phonology. MS, Aalborg University.

Aoki, Paul K. 1974. An observation of vowel contraction in Xhosa. Studies in African Linguistics 5:223-241.

Archangeli, Diana, & Douglas Pulleyblank. 1994. Grounded Phonology. (Current Studies in Linguistics, 25.) Cambridge: MIT Press.

Armstrong, Lilias E. 1940. The phonetic and tonal structure of Kikuyu. London: Oxford University Press.

Ashton, E.O., E.M.K. Mulira, E.G.M. Ndawula & A.N. Tucker. 1954. A Luganda grammar. London: Longman, Green & Co.

Awobuluyi, Oladele. 1972. The morphophonemics of Owon Afa. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:25-44.

Baumbach, E.J.M. 1987. Analytical Tsonga Grammar. Pretoria: University of South Africa.

Beckman, Jill. 1995. Shona height harmony: Markedness and positional identity. University of Massachusetts Occasional Papers 18:53-75.

Bentinck, Julie. 1978. Etude phonologique du Niaboua. Abidjan: Institut de Linguistique Appliquee and Societe Internationale de Linguistique.

Bentinck, Julie. 1979. Morphophologie du Niaboua. MS.

Bergman, Richard 1968. Vowel sandhi in Igede and other African languages. M.A. thesis, Hartford Seminary Foundation.

Bergman, Richard. 1971. Vowel sandhi and word division in Igede. Journal of West African Languages VIII, 1:13-25.

Birk, D.B.W. 1976. The Malakmalak language, Daly River (Western Arnhem Land). Pacific Linguistics, Series B, no. 45. Canberra: The Australian National University.

Bliese, Loren F. 1981. A generative grammar of Afar. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

Blust, Robert A. 1977. Sketches of the morphology and phonology of Bornean languages 1: Uma Juman (Kayan). Papers in Borneo and Western Austronesian Linguistics no. 2:9-122. (Pacific Linguistics Series A, no. 33.) Canberra: The Australian National University.

Bonvini, Emilio. 1988. Prédication et énonciation en Kàsim. Paris: Éditions du Centre National de la Reserche Scientifique.

Brown, Gillian. 1969. Syllables and redundancy rules in generative phonology. Journal of Linguistics 6:1-17.

Bunkowske, E. W. 1972. Eliding boundaries in Ogoja Yala. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:59-71.

Cahill, Michael. 1993. Underspecification and vowel harmony in Kɔnni. MS, Ghana Institute of Linguistics, Literacy, and Bible Translation.

Cahill, Michael. 1994. Vowel coalescence in Siswati. MS, Ohio State University.

Calabrese, Andrea. 1995. A constraint-based theory of phonological markedness and simplification procedures. Linguistic Inquiry 26:373-463.

Callow, John. 1965a. Kasem nominals -- a study in analyses. Journal of West African Languages II, 1:29-36.

Callow, John. 1965b. Collected field reports on the phonology of Kasem. (Collected language notes, 1.) Legon: Institute of African Studies, University of Ghana.

Capo, H.B.C. 1985. Vowel features in Gbe. Journal of West African Languages XV, 1:19-30.

Carter, Richard T. Jr. 1974. Teton Dakota phonology. University of Manitoba Anthropology Papers, 10.

Casali, Roderic F. 1988. Vowel clusters and syllable structure in Nawuri. Papers in Ghanaian Linguistics 7:40-61, ed. by Kofi Saah & Emmanuel Osam. Legon: Institute of African Studies, University of Ghana.

Casali, Roderic F. 1992. Vowel Elision, Glide Formation, and Syllabification in Niger-Congo languages. MS, Summer Institute of Linguistics and Ghana Institute of Linguistics, Literacy, and Bible Translation.

Casali, Roderic F. 1994. Vowel Elision and Glide Formation in Niger-Congo: A Harmony Theoretic Approach. Paper presented at the January 1994 LSA meeting, Boston, January 9, 1994.

Casali, Roderic F. 1995a. Patterns of Glide Formation in Niger-Congo: An Optimality Account. Paper presented at the January 1995 LSA meeting, New Orleans, January 7, 1995.

Casali, Roderic F. 1995b. Labial opacity and roundness harmony in Nawuri. Natural Language & Linguistic Theory 13:649-663.

Casali, Roderic F. 1995c. On the reduction of vowel systems in Volta-Congo. African Languages and Cultures 8, 2:109-121.

Casali, Roderic F. 1995d. Nawuri Phonology. (Language Monographs no. 3.) Legon: Institute of African Studies, University of Ghana.

Christensen, John & Sylvia Christensen. 1992. Kisar phonology. In Phonological Studies in Four Languages of Maluku, ed. by Donald A. Burquest & Wyn D. Laidig, 33-65. Dallas: Summer Institute of Linguistics and University of Texas at Arlington..

Chumbow, Beban Sammy. 1982a. Contraction and tone polarization in Ogori. Journal of West African Languages XII, 1:89-103.

Chumbow, Beban Sammy. 1982b. Ogori vowel harmony: An autosegmental perspective. Linguistic Analysis 10, 1:61-93.

Clements, George N. 1976. Vowel harmony in nonlinear generative phonology. Bloomington: Indiana University Linguistics Club.

Clements, George N. 1981. Akan vowel harmony: A nonlinear analysis. Harvard Studies in Phonology 2:108-177.

Clements, George N. 1984. Vowel harmony in Akan: A consideration of Stewart's word structure conditions. Studies in African Linguistics 15:321-337.

Clements, George N. 1986. Compensatory lengthening and consonant gemination in LuGanda. In Studies in Compensatory Lengthening, ed. by Leo Wetzels & Engin Sezer, 37-77. Dordrecht: Foris Publications.

Clements, George N. 1991. Vowel height assimilation in Bantu languages. Working Papers of the Cornell Phonetics Laboratory 5:37-76.

Collier, Kenneth & Kenneth Gregerson. 1985. Tabla verb morphology. Papers in Papua New Guinea Linguistics no. 22:155-172. (Pacific Linguistics Series A, no. 63.) Canberra: The Australian National University.

Cook, Thomas. L. 1969(?). The pronunciation of Efik for speakers of English. Bloomington: African Studies Program and Intensive Language Training Center, Indiana University.

Creider, Chet A. & Jane Tabsubei Creider. 1989. A grammar of Nandi. Hamburg: Buske.

Dakubu, M. E. Kropp. 1987. The Dangme language: An introductory survey. London: Macmillan Publishers.

Dawson, Keith. 1975. L'accord vocalique en Tépo. Annales de l'Université d'Abidjan, série H (Linguistique), 8:15-26.

Dawson, Willa. 1985. The Tibetan vowel feature 'constricted'. In Studies presented to Andre-G. Haudricourt, ed. by Suriya Ratanakul, David Thomas, and Suwilai Premsrirat, 158-177. Bangkok: Mahidal University.

Disner, Sandra F. 1980. Insights on vowel spacing: results of a language survey. UCLA Working Papers in Phonetics 50:70-92.

Doke, Clement M. & S.M. Mofokeng. 1957. Textbook of Southern Sotho grammar. Johannesburg: Longmans.

Doke, Clement M. 1922. The grammar of the Lamba language. London: Kegan Paul, Trench, Trubner & Co.

Doke, Clement M. 1926. The phonetics of the Zulu language. Bantu Studies II. Johannesburg: University of the Witwatersrand Press.

Doke, Clement M. 1931. A comparative study in Shona phonetics. Johannesburg: University of the Witwatersrand Press.

Doke, Clement M. 1938. Textbook of Lamba grammar. Johannesburg: Witwatersrand University Press.

Doke, Clement M. 1954. Textbook of Zulu grammar. London: Longmans, Green & Co.

Donwa-Ifode, Shirley. 1985. Glide formation, elision, assimilation and contraction: A reassessment - evidence from Isoko. Journal of West African Languages XV, 2:41-55.

Donwa-Ifode, Shirley. 1989. Prefix vowel reduction and loss of noun class distinctions: The Edoid case. Afrika und Übersee 72:229-253.

Dunstan, Elizabeth. 1969. Twelve Nigerian languages. New York: Africana Publishing.

Elimelech, Baruch. 1976. A tonal grammar of Etsako. UCLA Working Papers in Phonetics 35.

Elugbe, Ben Ohiomame. 1989. Comparative Edoid: Phonology and lexicon. (Delta Series, 6.) Port Harcourt: University of Port Harcourt Press.

Elugbe, Benny. 1972. Assimilation and elision in Urhobo and Ghotuo. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:45-49.

Emenanjo, E.N. 1972. Vowel assimilation in Igbo. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:7-18.

Eynde, Karel van den. 1968. Éléments de grammaire Yaka: Phonologie et morphologie flexionnelle. Kinshasa: Université Lovanium.

Faraclas, Nicholas. 1982. Elision and other morpheme boundary phenomena in the western dialects of Obolo. Journal of West African Languages XII, 2:69-82.

Faraclas, Nicholas. 1985. Vowel Coalescence--a reply. Journal of West African Languages XV, 1:14-18.

Flemming, Edward S. 1995. Auditory representations in phonology. Ph.D. dissertation, UCLA.

Folarin-Schleicher, A.Y. 1992. Nasal stability and feature hierarchy: The case of Edo, Emai, and Yoruba. Afrika und Übersee 75:59-73.

Fortune, G. 1955. An analytical grammar of Shona. London: Longmans, Green & Co.

Frajzyngier, Zygmut. 1980. The vowel system of Pero. Studies in African Linguistics 11:39-74.

Gilley, Leoma G. 1992. An autosegmental approach to Shilluk phonology. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

Givon, Talmy. 1970a. On ordered rules and the modified base of ChiBemba verbs. African Studies 29:47-54.

Givon, Talmy. 1970b. The Si-Luyana language: A preliminary linguistic description. University of Zambia Institute for Social Research Communication No. 6.

Goad, Heather. 1993. On the configuration of height features. Ph.D. dissertation, USC.

Goldsmith, John. 1987. Vowel Systems. Papers from the 23rd annual regional meeting of the Chicago Linguistic Society, Part Two, 116-133.

Gorecka, Alicja. 1996. Vowel harmony vs. vowel reduction in Optimality Theory. Paper presented at the 2nd Southwest Optimality Theory Workshop, University of California Irvine, May 11, 1996.

Goyvaerts, D. L. 1983. Some aspects of Logo phonology and morphology. In Nilo-Saharan Language Studies, ed. by M. Lionel Bender, 272-280. East Lansing: African Studies Center, Michigan State University.

Grimes, Barbara F. 1992. Ethnologue, 12th edition. Dallas: Summer Institute of Linguistics.

Guma, S. M. 1971. An outline structure of Southern Sotho. Pietermaritzburg: Shuter and Shooter.

Haas, Wim G. de. 1988a. Phonological implications of skeleton and feature underspecification in Kasem. Phonology 5:237-254.

Haas, Wim G. de. 1988b. A formal theory of vowel coalescence: A case study of Ancient Greek. Dordrecht: Foris.

Hansford, Keir L. 1988. A phonology and grammar of Chumburung. MS. (Earlier version of 1991 University of London Ph.D. dissertation.)

Herman, Rebecca. 1995. Degrees of invisibility in SiSwati. MS, Ohio State University.

Hoffman, Carl. 1972. A note on vowel contraction in Central Kambari. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:73-91.

Hoffman, Carl. 1973. The vowel harmony system of the Okpe monosyllabic verb. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan, 6:79-111.

Hsu, Chai-Shune. 1995. Coda lenition in Taiwanese. Paper presented at the UCLA Phonology Seminar, February 2, 1995.

Hualde, Ignacio José & Gorka Elordieta. 1992. On the lexical/postlexical distinction: Vowel assimilation in Lekeitio Basque.

Hyman, Larry M. 1988. Underspecification and vowel height transfer in Esimbi. Phonology 5:255-273.

Hyman, Larry M. 1989. Advanced tongue root in Kinande. MS, University of California Berkeley.

Hyman, Larry M., ed. 1979. Aghem grammatical structure. Southern California Occasional Papers in Linguistics 7. Los Angeles: University of Southern California.

Itô, Junko, Armin Mester & Jaye Padgett. 1995. Licensing and underspecification in Optimality Theory. Linguistic Inquiry 26:571-613.

Itô, Junko. (1986). Syllable theory in prosodic phonology. Ph.D. dissertation, University of Massachusetts, Amherst.

Iwara, Alexander Ubi. 1982. Phonology and Grammar of Lokəə: A preliminary study. M.Phil. thesis, University of London.

Jones, Peggy. 1987. Collected field reports on the phonology of Dilo. (Collected language notes, 19.) Legon: Institute of African Studies, University of Ghana.

Jun, Jungho. 1995a. Perceptual and articulatory features in place assimilation: An Optimality Theoretic approach. Ph.D. dissertation, UCLA.

Jun, Jungho. 1995b. Place assimilation as the result of conflicting perceptual and articulatory constraints. Paper presented at the fourteenth WCCFL, March 1995.

Ka. Omar. 1988. Wolof phonology and morphology: A non-linear approach. Ph.D. dissertation, University of Illinois.

Kaisse, Ellen M. 1977. Hiatus in Modern Greek. Ph.D. dissertation, Harvard University.

Kashoki, Mubanga. 1968. A phonemic analysis of Bemba: A presentation of Bemba syllable structure, phonemic contrasts and their distribution. Manchester: Manchester University Press.

Katamba, Francis. 1985. A non-linear account of the syllable in Luganda. In African Linguistics: Essays in memory of M.W.K. Semikenke (Studies in the sciences of language, 6.), ed. by Didier L. Goyvaerts, 267-283. Amsterdam: John Benjamins Publishing Company.

Kaun, Abigail. 1995. The typology of rounding harmony: An Optimality-Theoretic Approach. Ph.D. dissertation, UCLA.

Kaye, Jonathan D. 1982. Harmony processes in Vata. In Projet sur les Langues Kru, ed. by Jonathan Kaye, Hilda Koopman, and Dominique Sportiche, 60-151. University of Quebec at Montreal.

Kaye, Jonathan, Jean Lowenstamm & Jean-Roger Vergnaud. 1985. The internal structure of phonological elements: a theory of charm and government. Phonology Yearbook 2:305-328.

Keach, Camillia N. Barrett. 1987. Phonological allomorphy in Swahili: On the form of inanimate pronominal clitics. Studies in African Linguistics 18:263-298.

Kenstowicz, Michael & Charles Kisseberth. 1979. Generative Phonology. New York: Academic Press.

Kidima, Lukowa. 1991. Tone and accent in KiYaka. Ph.D. dissertation, UCLA.

Kilpatrick, Eileen. 1985. Bongo phonology. Occasional Papers in the Study of Sudanese Languages 4:1-62. Juba: Summer Institute of Linguistics, Institute of Regional Languages, and University of Juba.

Kiparsky, Paul. 1985. Some consequences of Lexical Phonology. Phonology Yearbook 2: 83-138.

Kirchner, Robert. 1993. Turkish vowel harmony and disharmony: an Optimality Theoretic account. MS, UCLA.

Kirchner, Robert. 1995. Going the distance: Synchronic chain shifts in Optimality Theory. MS, UCLA.

Kisseberth, Charles. 1970. On the functional unity of phonological rules. Linguistic Inquiry 1:291-306.

Kurrle, Gertrud. 1988. Some word tone patterns in Nuni. Journal of West African Languages XVIII, 1:29-40.

Ladefoged, Peter. 1980. What are linguistic sounds made of? Language 56:485-502.

Leakey, L. S. B. 1959. First lessons in Kikuyu. Nairobi: East African Literature Bureau.

Leitch, Myles. 1994. Consonant-dropping in a Bantu language: An optimality account. MS, University of British Columbia.

Leitch, Myles. In progress. Vowel Harmony in the Congo Basin: A Constraint-Based Analysis of Variation. Ph.D. dissertation, University of British Columbia.

in the Bantu C. Zone

Lindau, Mona. 1975. Features for vowels. UCLA Working Papers in Phonetics 30.

Lojenga, Constance Kutsch. 1994a. The vowel system of BILA, a Bantu language of the northern Bantu borderland in Zaire. Paper presented at the Leiden University annual African Linguistics Colloquium.

Lojenga, Constance Kutsch. 1994b. Ngiti: A Central-Sudanic language of Zaire. (Nilo-Saharan, 9.) Köln: Köppe.

Long, Ronald W. & Raoul S. Diomande. n.d. Basic Dyula. Indiana University Intensive Language Training Center.

MacEachern, Margaret. 1995. Laryngeal similarity effects in Quechua and Aymara. MS, UCLA.

Maddieson, Ian. 1972. Verb-nominal contraction in Eggon. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:51-58.

Mamet, M. 1960. Le langage des Bolia. Tervuren: Commission de Linguistique Africaine.

Marlett, Stephen A. & Joseph Paul Stemberger. 1983. Empty consonants in Seri. Linguistic Inquiry 14:617-639.

Masagbor, Grace A. 1989. Glide formation and vowel elision processes in Ivie (North Ibie). Journal of West African Languages XIX, 1:87-103.

McCarthy, John & Alan Prince. 1993. Prosodic morphology I: Constraint interaction and satisfaction. MS, University of Massachusetts, Amherst, and Rutgers University.

McCarthy, John & Alan Prince. 1995. Faithfulness and reduplicative identity. University of Massachusetts Occasional Papers 18: 249-384.

McLaren, J. 1955. A Xhosa grammar. Cape Town: Longmans, Green & Co.

Meier, Paul, Inge Meier & John Bendor Samuel. 1975. A grammar of Izi. Norman, Oklahoma: Summer Institute of Linguistics.

Meinhof, Carl. 1932. Introduction to the phonology of the Bantu languages (translated by N.J.V.Warmelo). The Institute of African Languages and Cultures, Carnegie Corporation of New York, and Witwatersrand Council of Education, Johannesburg.

Michelson, Karin. 1986. Ghost R's in Onondaga: An autosegmental analysis of *R-stems. In Studies in compensatory lengthening (Publications in language sciences, 23), ed. by Leo Wetzels & Engin Sezer, 147-166. Dordrecht: Foris Publications.

Minkova, Donka. 1982. The environment for open syllable lengthening in English. Folia Linguistica Historica 3:29-58.

Motingéa, Mangulu. 1993. Esquisse du parler des Yakata (République du Zaïre). Afrika und Übersee 76, 2:209-246.

Mtenje, Al. 1980. Aspects of Chichewa derivational phonology and syllable structure. M.A. thesis, Southern Illinois University, Carbondale.

Mtenje, Al. 1992. Extralinguistic constraints on rule application in Chichewa and Chiyao. African Languages and Cultures 5, 1:65-73.

Murane, Elizabeth. 1974. Daga grammar: from morpheme to discourse. Norman, Oklahoma: Summer Institute of Linguistics.

Mutaka, Ngessimo & Larry M. Hyman. 1990. Syllables and morpheme integrity in Kinande reduplication. Phonology 7:73-119.

Ngunga, Armindo S. A. 1995. Phonological vs. phonetic vowel length in Ciyao. Paper presented at the Linguistic Society of America meeting, New Orleans, January 1995.

Nivens, Richard. 1992. A lexical phonology of West Tarangan. In Phonological Studies in Four Languages of Maluku, ed. by Donald A. Burquest & Wyn D. Laidig, 127-227. Arlington, TX: University of Texas at Arlington and Summer Institute of Linguistics.

Noonan, Michael. 1992. A grammar of Lango. Berlin: Mouton de Gruyter.

Nurse, D. & G. Philippson. 1977. Tones in Old Moshi (Chaga). Studies in African Linguistics 8:49-80.

Omamor, Augusta Phil. 1973. "Uvwie--a case of vowels merging. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 6:113-143.

Omamor, Phil. Augusta. 1979. A phonological sketch of Isekiri. Afrika und Übersee 62, 3:190-223.

Omamor, Phil. Augusta. 1988. Okpe and Uvwie: A case of vowel harmony galore. Journal of West African Languages XVIII, 1:47-64.

Omozuwa, Victor Edosa. 1992. Vowel elision, 'floating" tone, and downstep in Edo VCV # VCV constructions. Afrika und Übersee 75:253-267.

Painter, Colin. 1970. Gonja: A phonological and grammatical study. (African series, 1.) Bloomington: Indiana University.

Parker, Elizabeth. n.d. Some aspects of the phonology of Mundani. M.A. thesis, University of Reading.

Parker, Kirk. 1985. Baka phonology. Occasional Papers in the Study of Sudanese Languages 4:63-85. Juba: Summer Institute of Linguistics, Institute of Regional Languages, and University of Juba.

Payne, David L. 1981. The phonology and morphology of Axininca Campa. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

Prince, Alan & Paul Smolensky. 1993. Optimality Theory: Constraint interaction in generative grammar. MS, Rutgers University and University of Colorado.

Pulleyblank, Douglas. 1986. Underspecification and low vowel harmony in Okpe. Studies in African Linguistics 17:119-153.

Pulleyblank, Douglas. 1988. Vowel deletion in Yoruba. Journal of African Languages and Linguistics 10:117-136.

Rennison, John. 1986. On tridirectional feature systems for vowels. In Dependency and non-linear phonology, ed. by Jacques Durand, 281-303. London: Croom Helm.

Roberts-Kohno, R. Ruth. 1995a. Vowel coalescence and hiatus in Kikamba. In Theoretical Approaches to African Linguistics, ed. by Akinbiyi Akinlabi, 313-327. Trenton, New Jersey: Africa World Press.

Roberts-Kohno, R. Ruth. 1995b. Empty root nodes in Kikamba: Conflicting evidence and theoretical implications. Paper presented at the 26th Annual Conference on African Linguistics, UCLA.

Rosendall, Heidi James. 1992. A phonological study of the Gwari lects. Dallas: Summer Institute of Linguistics.

Rosenthall, Samuel & Marten Mous. 1995. Prosodic aspects of Iraqw word formation. Paper presented at the 26th Annual Conference on African Linguistics, UCLA.

Rosenthall, Samuel. 1994. Vowel/glide alternation in a theory of constraint interaction. Ph.D. dissertation, University of Massachusetts, Amherst.

Russell, Jan M. 1985. Moba Phonology. Sydney: Macquarie University master's thesis.

Saloné, Sukari. 1980. Vowel coalescence and tonal merger in Chagga (Old Moshi): A natural generative approach. Studies in African Linguistics 11:75-100.

Samarin, William J. 1967. A grammar of Sango. The Hague: Mouton.

Sambeek, J. van. 1955. A Bemba Grammar. Cape Town: Longmans, Green & Co.

Sampson, Douglas. 1985. A preliminary phonological overview of Banda-Tangbago. Occasional Papers in the Study of Sudanese Languages 4:133-152. Juba: Summer Institute of Linguistics, Institute of Regional Languages, and University of Juba.

Sapir, David J. 1965. A grammar of Diola-Fogny. (West African Language Monographs, 3.) Cambridge: Cambridge University Press.

Sasse, Hans-Jürgen. 1976. Dasenech. In The Non-Semitic languages of Ethiopia, ed. by M. Lionel Bender, 196-221. East Lansing: African Studies Center, Michican State University.

Schachter, Paul & Victoria Fromkin. 1968. A Phonology of Akan: Akwapim, Asante, and Fante. UCLA working papers in phonetics 9.

Schaefer, Ronald P. 1987. An initial orthography and lexicon for Emai. Indiana University Linguistics Club.

Schane, Sanford A. 1973. Generative Phonology. Englewood Cliffs, New Jersey: Prentice-Hall.

Schane, Sanford A. 1987. The resolution of hiatus. Papers from the 23rd annual regional meeting of the Chicago Linguistic Society, Part Two, 279-290.

Schlindwein, Deborah. 1987. P-bearing units: A study of Kinande vowel harmony. Proceedings of NELS 17:551-567.

Schuh, Russell. 1995. Aspects of Avatime phonology. Studies in African Linguistics 24:31-67.

Scorza, David. 1985. A sketch of Au morphology and syntax. Papers in Papua New Guinea Linguistics 22:215-273. (Pacific Linguistics Series A, no. 63) Canberra: The Australian National University.

Shaw, Patricia A. 1980. Theoretical issues in Dakota phonology and morphology. New York: Garland Publishing.

Sims, Geo. W. 1959. An elementary grammar of Cibemba. Fort Rosebery, North Rhodesia: Christian Missions in Many Lands.

Smith, Edwin W. 1907. A handbook of the Ila language. London: Oxford University Press.

Smith, N.V. 1967. The phonology of Nupe. Journal of African Languages 6:153-169.

Smith, N.V. 1969. The Nupe verb. African Language Studies X:90-160. University of London School of Oriental and African Studies.

Snider, Keith L. 1989b. The vowels of proto-Guang. Journal of West African Languages XIX, 2:29-50.

Snider, Keith L. 1989c. Vowel coalescence in Chumburung: An autosegmental analysis. Lingua 78:217-232.

Snider, Keith L. 1985. Vowel coalescence across word boundaries in Chumburung. Journal of West African Languages XV, 1:3-13.

Snider, Keith L. 1986. Apocope, tone, and the glottal stop in Chumburung. Journal of African Languages and Linguistics 8:133-144.

Snider, Keith L. 1989a. North Guang comparative word list: Chumburung, Krachi, Nawuri, Gichode, Gonja. (Comparative African Wordlists, 4.) Legon: Institute of African Studies, University of Ghana.

Stahlke, Herbert F. W. 1976. Segment sequences and segmental fusion. Studies in African Linguistics 7:41-63.

Stanford, Ronald & Lyn Stanford. 1970. Collected field reports on the phonology and grammar of Chakosi. (Collected language notes, 11.) Legon: Institute of African Studies, University of Ghana.

Steriade, Donca. 1993. Positional neutralization. Paper presented at the 23rd meeting of NELS.

Steriade, Donca. 1995. Neutralization and the expression of contrast. MS, UCLA.

Thomas, Elaine. 1978. A grammatical description of the Engenni language. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

Thomas, John Paul. 1992. A morphophonology of Komo: Non-tonal phonology. M.A. thesis, University of North Dakota.

Trubetzkoy, N.S. 1939. Grundzüge der phonologie. Travaux du Cercle linguistique de Prague, 7. (Appears in English translation as Principles of Phonology, translated by Christiane A. M. Baltaxe. Berkeley and Los Angeles: University of California Press, 1969.)

Tucker, A. N. 1929. The comparative phonetics of the Suto-Chuana group of Bantu languages. London: Longmans, Green & Co.

Tucker, A. N. 1962. The syllable in Luganda: A prosodic approach. Journal of African Languages 1, 2:122-166.

Walker, Stephen P. 1989. Tonal instability: Tone as part of feature geometry. SIL-UND Work Papers 30:149-169.

Ward, Ida C. 1933. The phonetic and tonal structure of Efik. Cambridge: W. Heffer & Sons.

Welmers, William E. 1968. Efik. Ibadan: Institute of African Studies, University of Ibadan.

Welmers, William E. 1973. African language structures. Berkeley: University of California Press.

Wescott, Roger W. 1962. A Bini Grammar. (Part 1: Phonology) African Language and Area Center, Michigan State University.

Westbury, John R. & Patricia A. Keating. 1986. On the naturalness of stop consonant voicing. Journal of Linguistics 12:145-166.

Westermann, Diedrich. 1930. A study of the Ewe language. (Translated by A.L. Bickford-Smith) London: Oxford University Press.

Whitehead, John. 1899. Grammar and dictionary of the Bobangi language. London: Kegan Paul, Trench, Trübner & Co.

Whitely, W.H. & M.G. Muli. 1962. Practical introduction to Kamba. London: Oxford University Press.

Williamson, Kay. 1965. A grammar of the Kolokuma dialect of Ijo. (West African Language Monographs, 2) Cambridge: Cambridge University Press.

Williamson, Kay. 1972. Assimilation in Ogbia. Research Notes from the Department of Linguistics and Nigerian Languages, University of Ibadan 5, 2:1-5.